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DCP/NRC0854
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Document Control Desk
U.S. Nuclear Regulatory Commission
Washington, DC 20555

ATTENTION: T. R. QUAY

SUBJECT: TRANSMITTAL OF WCAP-14477 REVISION 1 AND RESPONSE TO REMAINING ASI QUESTION

References:
1. NSD-NRC-97-5056 (DCP/NRC0800), "Revised Responses to NRC Questions Regarding the Adverse Systems Interactions Evaluation Report, WCAP-14477", dated April 4, 1997.
2. Letter from NRC to Westinghouse (Huffman to Liparulo), "Discussion Items for AP600 Meeting on Adverse Systems Interactions", dated 10/3/96.

Dear Mr. Quay:

Reference 1 provided responses to all but one of the NRC questions regarding the Adverse Systems Interactions (ASI) Evaluation Report, WCAP-14477. This letter provides the response for the final question (discussion item 4 of Reference 2) regarding design and operation of the AP600 fan coolers and chilled water system (VWS). With this response, the Westinghouse status for DSER open item tracking system (OITS) item 3961 is changed to Action-N to confirm this response closes or resolves item 3961.

This letter also provides Revision 1 of WCAP-14477, which incorporates resolution of ASI concerns presented in Reference 2 as noted in Reference 1, as well as the attached resolution of discussion item 4. NRC is asked to review this WCAP to confirm changes were made consistent with NRC requirements and expectations, based on Westinghouse commitments presented in Reference 1. With this WCAP submittal, the Westinghouse status for DSER OITS items 4148 and 4188 is changed to Action-N to confirm resolution of Key Licensing Issues 2c and 25.

The NRC is asked to review the attached response and enclosed WCAP and provide Westinghouse with feedback for updating the NRC status for DSER OITS for items 3961, 4148, and 4188. If there are any comments regarding AP600 ASI or this letter, please contact Robin K. Nydes at 412-374-4125.

EVU 4

Brian A. McIntyre, Manager
Advanced Plant Safety and Licensing

jml

Attachment
Enclosure

140083

cc: Bill Huffman, NRC (1L, 1A, 10E)
Alan Levin, NRC (1L, 1A, 1E)
Amy Cubbage, NRC (1L, 1A, 1E)
Nicholas Liparulo, Westinghouse (w/o Attachment/Enclosure)

Westinghouse Revised Response to ASI Discussion Item #4

Discussion Item #4

The discussion on fan coolers (pp. 2-17 - 2-18) appears to be focused on an extreme situation without regard for other potential adverse conditions. For example; recent concerns were raised regarding operating PWRs via Westinghouse's Nuclear Safety Advisory Letter on containment fan coolers. Are there any high heat load conditions (such as during DBA or Severe Accidents) for the AP600 in which the cooling water system supplying non-safety-related fan coolers (Chilled Water) might be subject to water hammer or other potentials for containment bypass? Could operation of the fan coolers with chilled water isolated by a containment isolation signal result in overpressurization of the chilled water line or flashing/water hammers if the heated chilled water lines from the fan coolers were suddenly unisolated?

The Chapter 9 SSAR description of the fan coolers state that they have two speed motors. The high speed is used for normal conditions and the low speed is used during high containment air density conditions - such as those that might be present during DBA or severe accidents. How is fan speed controlled during accident conditions. Since this is a non-safety related function, how is operation of the fans in fast speed prevented in a high steam environment. Does the fan control circuitry automatically shift to low speed in accident conditions? Are there interlocks to prevent operators from manually shifting to high speed when conditions may be inappropriate in containment. Is there any potential for the fans to catastrophically fail if operated at high speed in a dense steam environment thereby creating a possible adverse system interaction which could damage the chill water cooling coils (Containment bypass scenario)? The emergency response guidelines (ERGs) for reactor trip or safety injection, AE-0, step 22, does not specify at what speed the fans should be operating under safety injection conditions.

Westinghouse Response:

Westinghouse has performed an evaluation to assess the design and operation of the AP600 fan coolers and chilled water system following an accident, with regard to the concerns raised about fan coolers for operating plants in NRC Generic Letter 96-06. The following is a summary of that evaluation.

The AP600 has containment fan coolers which remove heat from the containment during normal operations. These fan coolers are cooled by chilled water supplied by the central chilled water system (VWS). The AP600 fan coolers and VWS are not relied on for safety-related containment cooling. The only safety function of the VWS is to isolate the chilled water supply and return lines to the containment recirculation system (VCS) fan cooler coil units, following any event resulting in a containment isolation signal to provide containment integrity. During cold weather when the plant is shut down, the high capacity subsystem is also designed to permit use of the chilled water piping inside containment for containment

heating. Manual realignment of the system allows hot water to be supplied from the hot water heating system (VYS) to the VCS fan coils units. Therefore, the chilled water piping inside containment is insulated.

The postulated accident scenario for the evaluation is a double-ended guillotine break of one of the reactor coolant system cold legs. This event results in a rapid increase in containment pressure (and temperature) to near the containment design pressure, and in the longer term containment pressure and temperature can remain elevated. As a result of the increase in containment pressure and/or the loss of reactor coolant the chilled water supply and return piping from the fan coolers is isolated almost immediatly. In the AP600 design the operating fan cooler fans continue to operate at low speed, circulating the heated containment atmosphere across the cooler coils. This would cause the stagnant chilled water in the coolers to heat-up to and be maintained at the containment air/mixture temperature. If the VWS piping is subsequently unisolated after the water in the coolers has been heated, the heated water in the coolers may flash. The subsequent supply of cold water from the VWS to the coolers, could collapse the steam creating a water hammer. Also of concern is that flashing could occur in the coolers when they are in operation at elevated containment temperature conditions, causing two-phase flow and loss of cooling flow capability. Unlike other PWR plants, the VCS and VWS in the AP600 are not required to operate post-accident and they are not restarted automatically. The purpose of the evaluation given in this report is to determine *if and when*, in view of the GL96-06 water hammer concerns, the VWS system can be used post accident.

The Westinghouse evaluation has concluded that sufficient overpressure exists such that the AP600 chilled water system can be unisolated and operated with no flashing of chilled water, provided that the containment temperature is below 2280°F. This evaluation provides the following precautions and limitations to prevent flashing and potential water hammer in the chilled water piping:

- Following an event which results in heat up of the containment air/steam above 228°F, the isolated cooling water supply and return containment isolation valves should not be opened to restore chilled water flow to the operating fan coolers, until the containment atmosphere temperature has been reduced to ≤ 228°F.

- Following an event which results in heat up of the containment air/steam above 228°F, cooling water flow should not be initiated to fan cooler coils unless the fans for these coolers has been running for a sufficiently long time to ensure the water in the coils is at equilibrium temperature with the containment atmosphere temperature, and until the containment atmosphere temperature has been reduced to ≤ 228°F.

- The chilled water flow to operating fan coolers should be stopped and isolated using the containment isolation valves, whenever the containment atmosphere temperature exceeds 228°F.

- Following an event which results in heat up of the containment air/steam above 228°F, chilled water flow to operating fan coolers should be initiated by first opening the

chilled water return line isolation valves before the supply line isolation valves.

The evaluation concludes that if these precautions and limitations are adhered to, the chilled water piping inside containment will not be subject to water hammer, that could lead to a containment bypass scenario. Overpressure protection of the chilled water system is provided by a thermal relief valve. The relief valve prevents the chilled water piping design pressure to be exceeded following containment isolation, and subsequent heatup of the containment, with the chilled water system pipimg water solid. Another design feature of the chilled water piping and containment fan cooler coils is the ability of these systems to withstand a perfect vacuum. Following the containment heatup and cooldown postulated in the evaluation, the resulting minimum pressure in the system piping and components can approach a perfect vacuum, and the system piping and components shall be designed to accomodate this condition.

The containment fan coolers are equipped with two-speed fans. The high speed is used for normal conditions, and the low speed is used primarily to perform the containment integrated leak rate testing, that requires the containment to be pressurized to design pressure. Normally, the fans are manually re-aligned to perform this test. However, following a transient or accident that results in the containment pressure and temperature to be elevated, the fan motors receive a signal to automatically switch to low-speed operation, based on a pre-set containment pressure signal. This is accomplished via the nonsafety-related plant control system. In addition, if the fans were to operate in a high containment pressure / temperature condition, the fan motors are provided with a thermal overload switch that would automatically trip the motor to prevent damage. Operation of the fans at high speed with high containment pressure could damage the fan motors, but would not cause damage to the chilled water system.

This response has been incorporated into section 2.2.12 of the ASI report. The AP600 emergency response guidelines background documents will be updated to incorporate the precautions and limitations associated with restarting the chilled water system following an accident.