DCS

DEC 0 3 1985

MEMORANDUM FOR: James G. Keppler, Regional Administrator
Region III

FROM: Harold R. Denton, Director
Office of Nuclear Reactor Regulation

C. J. Heltemes, Jr., Director
Office for Analysis and Evaluation
of Operational Data

SUBJECT: FAILURES IN UPPER HEAD INJECTION SYSTEM

This is in response to your memorandum dated November 28, 1984 (same subject). The enclosure to your memorandum outlined two concerns by an anonymous individual regarding the upper head injection system (UHI): first, failure of the UHI isolation valves to close could lead to injection of the contents of the nitrogen accumulator into the reactor coolant system (RCS); and second, the degassing of nitrogen-saturated water from the UHI water accumulator after UHI injection into the reactor vessel. Both of these concerns were postulated to increase the likelihood of core melt due to the non-condensible gas.

We have evaluated both of these concerns and concluded that failures of the UHI system do not represent an "ultra high risk" as postulated by the anonymous individual. The enclosure provides our evaluation which shows that the risk due to failures of the UHI system is sufficiently low that no immediate action is needed, and that UHI plants can continue to operate without undue risk to the health and safety of the public.

You should also be aware that licensees with UHI plants have informed the staff that they may make application to remove the UHI system from some or all of their UHI plants, in particular the two McGuire Units. We will keep you informed of the staff activities in this regard.

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This memorandum should assist you in being responsive to the individual's concerns. If you should need additional information or if we can provide further assistance, please contact Norman Lauben at FTS 492-7579 or Wayne Lanning at FTS 492-4433.

/s/

H. R. Denton, Director
Office of Nuclear Reactor Regulation

/s/

C. J. Heltemes, Jr., Director
Office for Analysis and Evaluation
of Operational Data

Enclosure:
As Stated

Distribution
DCS
AEOD CF
AEOD SF
ROAB CF
WLanning
KSeyfrit
TIppolito
CHeltemes
NLauben
BSheron
WHouston
RBernero
DEisenhut
HDenton
JSneizek
GHolahan
TMurley, R I
NGrace, R II
RMartin, R IV
JMartin, R V

C:ROAB:DL as modified
GHolahan
10/29/85

ROAB:AEOD	C:ROAB:AEOD	RSB:DSI	C:RSB:DSI	AD:DSI	D:DSI	DD:AEOD
WLanning:jz	KSeyfrit	NLauben	BSheron	WHouston	RBernero	TIppolito
02/5/85	02/5/85	02/12/85	02/13/85	2/13/85	2/13/85	2/26/85

OFFICE	D:AEOD	DD:NRR	D:NRR				
SURNAME	CHeltemes	DEisenhut	HDenton				
DATE	2/24/85	11/8/85	11/8/85				

ENCLOSURE

Evaluation of UHI Concerns

Two concerns were identified by an anonymous individual regarding the upper head injection system (UHI): first, a failure of the UHI isolation valves to close could lead to injection of the contents of the nitrogen accumulator into the reactor coolant system (RCS); and second, the degassing of nitrogen-saturated water from the UHI water accumulator after UHI injection into the reactor vessel. Both of these concerns were postulated to increase the likelihood of core melt due to the non-condensible gas. Each of these concerns is evaluated in the following discussion.

Recent operating experience shows that there have been three events at Westinghouse-designed UHI plants that could be considered precursors for introducing nitrogen into the RCS. Two separate events at Sequoyah Units 1 and 2 involved a ruptured membrane between the nitrogen and water accumulators. Both units operated for about a year providing the potential for the UHI accumulator water to become saturated with nitrogen. The licensee was aware that the membranes were ruptured, and more frequent surveillances of the UHI water for nitrogen concentration were performed. However, the nitrogen concentration was erroneously calculated to be within technical specifications limits. Thus, had the UHI actuated during a LOCA, the nitrogen from the injected water could have been released into the RCS as a non-condensible gas. The third event at McGuire involved the incorrect replacement of the differential pressure transmitters, which sense water level and provide the initiating signal for isolation valves closure. Consequently, the isolation valves would not have automatically closed on low level had a LOCA occurred, and without operator action, the contents of the nitrogen accumulator could have been injected into the RCS.

The consequences of injecting nitrogen from the accumlator into the RCS during a LOCA were part of the staff's review of the UHI design and discussed with the ACRS on several occasions (most recently on November 29, 1984). At the time the generic ECCS evaluation model was approved, neither the staff nor the licensees had the analytical capability to perform a LOCA analysis which assumed the accumulator nitrogen entered the system and to quantify the effects of this non-condensible gas on the predicted peak cladding temperature. The safety evaluation (NUREG-0297) found that the UHI system conformed to the staff's acceptance criteria (e.g., isolation valves met single failure criteria and multiple failures would have to be postulated in order to inject the nitrogen cover gas into the RCS). Technical specifications were imposed for each UHI plant to minimize the dissolved nitrogen concentration in the UHI accumulator water.

Very recently, RES has completed development of the advanced systems performance codes (RELAP5, TRAC-PF1) and these codes have the capability to treat non-condensible gas effects. In the NRR/DSI FY85 technical assistance program, Sandia National Laboratory has been contracted to perform LOCA calculations for UHI plants to study the affects of accumulator nitrogen injection.

As a result of the operating experience, and in the absence of definitive calculations, we have performed a qualitative assessment to determine what could be the potential consequences if a LOCA occurred and the UHI accumulator nitrogen entered the RCS.

If the nitrogen were injected following the UHI accumulator water injection, it would most likely sweep out water residing in the lower plenum. Thus, at the end of blowdown, less water would remain in the vessel, and a longer period of time would be necessary for the low pressure safety injection pumps to replenish the water in the vessel and reflood the core. Because of this longer time needed to refill the vessel and reflood the core, the fuel would be expected to heat up to higher temperatures before being reflooded. Using conservative Appendix K assumptions, a LOCA analysis of this scenario would most likely cause the predicted peak cladding temperature to exceed 2200°F.

A realistic calculation of UHI performance during a LOCA without isolation valve failure is expected to result in peak cladding temperatures on the order of 1200°F. Thus, isolation valve failure and gas injection could raise the peak cladding temperature in excess of 1200°F. Conservative estimates based on best estimate computer modeling indicate that the cladding temperature could reach about 2300°F. However gross fuel failure or core melt should not result.

Estimates of the risk impact were also performed. In general, break sizes of 3 inches or greater in Westinghouse plants could result in pressure decreases great enough to possibly allow nitrogen injection (nitrogen injection is not expected to occur until the system pressure drops to about 400-500 psi). The probability of breaks in the range of 3 inches and greater is somewhere between 10^{-3} and 10^{-5} per reactor year.

Perhaps the most uncertain aspect is the probability of the human errors that were necessary at McGuire to cause all of the pressure transmitters to be installed incorrectly and the incorrect installation then allowed to go undetected. A typical value for this type of error used in PRAs is about 10^{-2} or less. If the conservative bounds of the above two LOCA contributions are used, and it is further conservatively assumed that all LOCAs with UHI isolation valve failures result in core melt, then the core melt estimate for this event is conservatively estimated to be 10^{-5}. The consequence of degassing the nitrogen-saturated water after injection is bounded by the above estimates for isolation valve failures. To further minimize the potential for the accumulator water to become saturated, we are evaluating the need to increase the surveillance frequency now required by the technical specifications.

Based on this analysis, we do not believe that failures of the UHI system represent an "ultra high risk" as postulated by the anonymous individual. Furthermore, the failure of the UHI system is not a risk "outlier," and the risk from the event is sufficiently low that no immediate action is needed and that the UHI plants can continue to be operated without undue risk to the health and safety of the public.