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

Attention: NRC Operations Center

FORMAL NOTIFICATION OF THE
POTENTIAL EXISTENCE OF A FAILURE TO COMPLY PURSUANT TO
10 CFR 21.21

This transmittal represents formal written notification of a potential existence of a failure to comply pursuant to 10 CFR 21.21. The issue was initially reported by Westinghouse in Reference 3. This notification supersedes Reference 3. The revisions are primarily: 1) The affected plant list has been reduced due to a subsequent review of plant specific fluid system configuration, 2) Clarified technical content on the nature of the issue and, 3) Westinghouse evaluation.

Westinghouse previously communicated via Interim Report 91-046 (References 1 and 2) that an evaluation pursuant to 10 CFR 21 was underway regarding the potential for boron precipitation in the reactor core in the long term cooling mode following a postulated Loss of Coolant Accident (LOCA). This evaluation has been completed and has been found to not be reportable under 10 CFR Part 21. The basis for this conclusion is described below.

During the evaluation of the boron precipitation issue, another issue related to supplying adequate flow to the reactor coolant system to maintain long term core cooling was identified and has been determined to be a potential for a failure to comply with the criteria of 10 CFR 50.46 as initially reported in Reference 3.

ISSUE DESCRIPTION

The potential for inadequate core cooling flow as a result of isolation of the Residual Heat Removal/Low Head Safety Injection (RHR/LHSI) pumps (or other flows from low pressure SI pumps) from the Reactor Coolant System (RCS) when attempting to align them to the RCS hot legs has been identified. A single failure of a valve has been postulated which can prevent RHR/LHSI alignment to the RCS hot legs, in the hot leg recirculation mode of core cooling, typically required to begin between 8 and 24 hours following a postulated LOCA. However, plant specific Emergency Operating Procedures (EOPs) or operator training may or may not advise the operator to realign the RHR/LHSI back to the RCS cold legs and thus mitigate the event

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TECHNICAL EVALUATION

Westinghouse has provided the NRC with two interim 10 CFR 21 reports (References 1 & 2) describing an issue related to hot leg switchover and Emergency Core Cooling System (ECCS) hot leg recirculation. Westinghouse has continued to evaluate this issue and has determined that alignment of high pressure ECCS to the RCS hot legs will prevent boron precipitation given that the high pressure ECCS exceeds decay heat boiloff at the prescribed switchover time by 30% (1.3 times decay heat boiloff). Westinghouse designed plants are capable of supplying the required ECCS flow to the RCS hot legs to prevent boron precipitation and has, therefore, concluded that the boron precipitation issue is not reportable pursuant to 10 CFR 21 requirements.

The concern for providing adequate ECCS flow to the Reactor Coolant System (RCS) as a result of a potential single failure associated with the Residual Heat Removal/Low Head Safety Injection (RHR/LHSI) hot leg header isolation Motor Operated Valve (MOV) was identified in Reference 2. However, the development of plant specific EOPs is not within Westinghouse scope and Westinghouse cannot determine what actions the operator would take following an unsuccessful attempt to align the RHR/LHSI to the RCS hot legs. Westinghouse is therefore providing this notification so that the plant specific EOPs can be confirmed or modified to assure that the operator would not leave the RHR/LHSI isolated from the RCS while attempting to correct the situation which resulted in the unsuccessful attempt to align the RHR/LHSI to the RCS hot legs.

Table 1 identifies plants which are known to have an RHR/LHSI valve arrangement susceptible to a single failure such that alignment to the RCS hot legs may not be possible and for which minimum ECCS flow requirement analysis had not been performed with consideration for this failure. Plausible single failure scenarios are the loss of the diesel generator which provides power to the hot leg header isolation valve, or a mechanical failure of the valve. The diesel generator single failure will result in one train of ECCS available for the traditional Westinghouse ECCS design utilizing two ECCS trains operating from two electrical trains. For the mechanical single failure case, all ECCS trains would be operating. However, in the mechanical single failure case, both RHR/LHSI pumps would still be isolated from the RCS while the operator attempted to diagnose and resolve the failure which resulted in the unsuccessful attempt to align the RHR/LHSI to the RCS hot legs. The additional high pressure ECCS, available when the single failure is related directly to the valve, may make it easier to meet the minimum required ECCS flows, but the potential for inadequate core cooling should still be assumed to exist until the required ECCS flow verification has been completed.

Additionally, a subset of Westinghouse designed plants which may not have the capability to align the RHR/LHSI to the RCS hot legs was identified in Reference 3, since these plants may be using the RHR/LHSI for containment spray. This subset included plants whose original design did not include capability for supplying RHR/LHSI flow to the hot legs and may be using RHR/LHSI either directly for containment spray or to provide suction pressure to the containment spray pumps in which case the RHR/LHSI may be isolated from the RCS cold legs during hot leg recirculation. These plants were considered to be potentially affected by this issue due to a single failure which may prevent alignment of the single active RHR/LHSI pump to the RCS cold legs during the recirculation periods. Subsequent to the initial NRC notification, Westinghouse has been made aware of the existence of plant specific licensing bases for, and in some cases specifically reviewed, the long term cooling capability following a LOCA for these plants. These plant specific licensing bases include, in some cases, plant specific modifications to the RHR/LHSI system. Thus, this category of plants is being dropped from this formal notification on the potential single failure described above. However, by transmittal of this information to this subset of plants, they have been made aware of and should verify these current Westinghouse minimum ECCS flow requirements in order to support the conclusions of the large break LOCA analysis performed by Westinghouse.

All other Westinghouse NSSS design plants are not affected by this issue since they have an ECCS fluid system arrangement for which a single failure described above will not prevent RHR/LHSI/LPSI flow from being provided to the RCS hot legs or are capable of supplying sufficient flow from the high pressure ECCS pumps.

ASSESSMENT OF SAFETY SIGNIFICANCE

10 CFR 50.46 requires "Each boiling and pressurized light-water nuclear power reactor fueled with uranium oxide pellets within cylindrical Zircaloy cladding must be provided with an emergency core cooling system (ECCS) that must be designed such that its calculated cooling performance following postulated loss-of-coolant accidents conforms to the criteria set forth in paragraph (b) of this section." The Westinghouse ECCS design requires that the operator align the ECCS to the RCS hot legs to prevent boron precipitation, assuring a coolable geometry as required by 10 CFR 50.46. Further, sufficient ECCS flow must be provided in the long term to keep calculated core temperatures at acceptably low values. Since it is possible that the operator may keep the RHR/LHSI/LPSI/recirculation pumps (or other source of low pressure (high flow rate) SI) isolated from the RCS while attempting to diagnose and resolve any difficulties in the alignment of these systems to the RCS hot legs, the potential for inadequate core cooling flow may exist.

WESTINGHOUSE RECOMMENDATION

Utilities should review plant specific EOPs to determine if there is a possibility that the operator would isolate the RHR/LHSI while attempting to diagnose and resolve any difficulties in the alignment of the RHR/LHSI to the RCS hot leg. If so, the EOPs should be revised to include appropriate cautions or warnings to require alignment of the RHR/LHSI back to the RCS cold legs. Further, alignment of the high pressure ECCS to the RCS hot legs should proceed without delay during this period regardless of the RHR/LHSI alignment.

Tables 2 and 3 present the minimum ECCS flow requirement during hot leg recirculation which Westinghouse has deemed to be adequate for large break LOCAs. These flow requirements were developed during the investigation of the hot leg switchover issue (References 1 & 2). The specified minimum flows to the RCS hot legs are necessary to prevent boron precipitation for breaks located in the RCS cold legs. The specified minimum flow to the RCS cold legs is the minimum flow needed, in the absence of RHR/LHSI flow, to ensure adequate core cooling for breaks located in the RCS hot legs. Since it is not possible to predict break location or for the operator to easily determine break location, simultaneous injection, in the absence of RHR/LHSI, is needed to insure that the boron does not precipitate and that the core is adequately cooled.

Note that the requirements in Tables 2 and 3 are applicable for Westinghouse 3 and 4 loop plants in general and would apply to any equivalent scenario. Therefore plants which do not appear on Table 1 do not need to verify that the minimum cold leg flows are achievable for the specific issue reported here, but, if, for any reason, RHR/LHSI cannot or may not be aligned to the RCS hot legs, then the minimum hot leg flow requirement must still be satisfied.

Some Westinghouse designed PWRs use the RHR/LHSI pumps as containment spray pumps during cold leg recirculation. If the plant uses RHR/LHSI for containment spray, the EOPs should be revised to ensure that the operator would align the RHR/LHSI to the RCS cold legs in the event that alignment to the RCS hot legs is unsuccessful. Additionally, alignment of the high pressure ECCS to the RCS hot legs should proceed without delay regardless of the RHR/LHSI alignment.

If it is not possible to implement the recommended EOP changes, but the plant can meet the minimum ECCS flow, then Westinghouse recommends that design controls be placed on the high pressure ECCS to assure that ECCS flows are not degraded below the recommended minimum requirement as a result of future plant changes or potential pump degradation.

For most Westinghouse designed plants the LHSI pumps deliver flow from the containment sump directly to the reactor and also supply suction flow to the high head pumps. If the LHSI supply to the reactor is isolated, this results in a higher suction pressure to the high head pumps than would exist if the LHSI reactor flow path were available. If operation with LHSI reactor flow isolated is the chosen option, the flow verification should also assure that the associated increase in high head pump suction pressure does not cause the high head pump flow to exceed runout limits.

CONCLUSION

As part of the evaluation performed by Westinghouse on the issue identified in References (1) & (2) the potential exists that certain information provided by Westinghouse may have been used by utilities to develop EOPs which do not provide the operator with enough guidance should alignment of the RHR/LHSI pump(s) to the RCS hot legs be unsuccessful. In these instances, the operator may leave the RHR/LHSI isolated from the RCS for a period of time, and depending upon plant design, sufficient ECCS flow may not be provided to keep cladding temperature below the criteria of 10 CFR 50.46. This concern for a potential failure to comply with the regulations was deemed reportable to the NRC. All Westinghouse designed NSSSs are being provided with this information so that each affected licensee can take appropriate action to assure operation within the regulations.

Very truly yours,

N. J. Liparulo, Manager
Nuclear Safety and Regulatory Activities

/EAD

Attachments

REFERENCES

1. Letter ET-NRC-92-3659, "Interim Report of Evaluation of a Deviation for Failure to Comply Pursuant to 10 CFR 21.21(a)(2)", January 27, 1992.

2. Letter ET-NRC-92-3712, "Interim Report of Evaluation of a Deviation for Failure to Comply Pursuant to 10 CFR 21.21(a)(2)", June 23, 1992.

3. Letter ET-NRC-92-3782, "Initial Notification of the Potential Existence of a Failure to Comply Pursuant to 10 CFR 21.21", December 9, 1992.

TABLE 1

PLANTS AFFECTED BY
A SINGLE FAILURE PREVENTING
RHR/LHSI ALIGNMENT TO RCS HOT LEGS

DIABLO CANYON UNITS 1 & 2	McGUIRE UNITS 1 & 2
CATAWBA UNITS 1 & 2	BEAVER VALLEY UNIT 2
VOGTLE UNITS 1 & 2	FARLEY UNITS 1 & 2
TROJAN	SALEM UNITS 1 & 2
WOLF CREEK	CALLAWAY
COMANCHE PEAK UNITS 1 & 2	SEQUOYAH UNITS 1 & 2
WATTS BAR UNITS 1 & 2	ZION UNITS 1 & 2
BYRON UNITS 1 & 2	BRAIDWOOD UNITS 1 & 2
V. C. SUMMER	SHEARON HARRIS

TABLE 2

ECCS FLOWS DURING HOT LEG RECIRCULATION
MATRIX TABLE

ECCS FLOWS DURING HOT LEG RECIRCULATION (3-LOOP PLANTS)				
CASE #	BREAK LOCATION	ECCS ALIGNMENT	ECCS FLOW TO RCS COLD LEGS	ECCS FLOW TO RCS HOT LEGS
1	RCS COLD LEG BREAKS	NORMAL	0.0	RHR/LPSI & CHRG/SI FLOW >3000 GPM
2		RHR/LPSI MOV FAILURE-RHR/LPSI TO COLD LEG	RHR/LPSI	CONFIRM: CHARGING/SI >1.3*DECAY HEAT
3		RHR/LPSI MOV FAILURE AND ISOLATED FROM RCS	0.0	CONFIRM: CHARGING/SI FLOW >1.3*DECAY HEAT
4	RCS HOT LEG BREAKS	NORMAL	0.0	RHR/LPSI & CHRG/SI FLOW > 3000 GPM
5		RHR/LPSI MOV FAILURE-RHR TO COLD LEG	CONFIRM: RHR/LPSI FLOW > 1.5*DECAY HEAT BOILOFF	CHRG/SI
6		RHR/LPSI MOV FAILURE-RHR ISOLATED FROM RCS	0.0	CHRG/SI*

NOTE: NOT ALL CASES ARE CONSIDERED PROBABLE BUT REPRESENT A POSSIBLE ECCS CONDITION GIVEN A SINGLE FAILURE ASSUMPTION, NUMBERS OF ECCS PUMPS USED IN THE DESIGN, AND THE POTENTIAL ISOLATION OF RHR/LPSI FROM THE RCS OR ALIGNMENT OF THE RHR/LPSI PUMPS TO CONTAINMENT SPRAY.

- CASES 1 & 4 ARE THE TRADITIONAL CASES ASSUMED FOR ECCS ALIGNMENT DURING HOT LEG RECIRCULATION.
- CASES 3 AND 6 ASSUME RHR/LHSI/LPSI/RECIR PUMPS ISOLATED FROM RCS.

*-ALTHOUGH SUFFICIENT CHRG/SI FLOW (>1.3 *DECAY HEAT) MAY BE AVAILABLE TO SATISFY CASE 3 (COLD LEG BREAK), THIS SYSTEM CANNOT SUPPLY ADEQUATE FLOW TO SATISFY CASE 6 (HOT LEG BREAK).

TABLE 3

ECCS FLOWS DURING HOT LEG RECIRCULATION MATRIX TABLE

ECCS FLOWS DURING HOT LEG RECIRCULATION

(4-LOOP PLANTS, CHRG/SI, HHSI, LPSI)

CASE #	BREAK LOCATION	ECCS ALIGNMENT	ECCS FLOW TO RCS COLD LEGS	ECCS FLOW TO RCS HOT LEGS
1	RCS COLD LEG BREAKS	NORMAL	CHRG/SI	RHR/LPSI & HHSI > 3600 GPM
2		RHR/LPSI MOV FAILURE FLOW TO COLD LEG	RHR/LPSI & CHRG/SI > 1.5*DECAY DECAY HEAT	CONFIRM: HIGH PRESSURE SI > 1.3*DECAY HEAT
3		RHR/LPSI MOV FAILURE AND ISOLATED FROM RCS	CHRG/SI FLOW > 1.5*DECAY HEAT	CONFIRM: HIGH PRESSURE SI > 1.3*DECAY HEAT
4	RCS HOT LEG BREAKS	NORMAL	CHRG/SI OR 0.0	RHR/LPSI & HHSI > 3600 GPM
5		RHR/LPSI MOV FAILURE FLOW COLD LEG	CONFIRM: RHR/LPSI & CHRG/SI > 1.5 * DECAY HEAT	HIGH PRESS SI OR 0.0
6		RHR/LPSI MOV FAILURE AND ISOLATED FROM RCS	CONFIRM: CHRG/SI FLOW > 1.5*DECAY HEAT	HIGH PRESS SI OR 0.0

NOTE: NOT ALL CASES ARE CONSIDERED PROBABLE BUT REPRESENT A POSSIBLE ECCS CONDITION GIVEN A SINGLE FAILURE ASSUMPTION, NUMBERS OF ECCS PUMPS USED IN THE DESIGN, AND THE POTENTIAL ISOLATION OF RHR/LPSI FROM THE RCS OR ALIGNMENT OF THE RHR/LPSI PUMPS TO CONTAINMENT SPRAY.

- CASES 1 & 4 ARE THE TRADITIONAL CASES ASSUMED FOR ECCS ALIGNMENT DURING HOT LEG RECIRCULATION.
- CASES 3 AND 6 ASSUME RHR/LHSI/LPSI/RECIRC PUMPS ISOLATED FROM RCS.