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U. S. Nuclear Regulatory Commission
Division of Licensing
Office of Nuclear Reactor Regulation
Washington, D. C. 20555

Attention: D. G. Eisenhut, Director

Gentlemen:

Subject: NUREG-0660 Requirement II.K.3.13

This letter transmits an evaluation performed by General Electric on behalf [illegible]e BWR Owners Group of NUREG-0660 recommendation II.K.3.[illegible] attache[illegible]port presents the analyses, conclusions and recomm[illegible]ations re[illegible]ing separation of the initiation levels of the High Pressure Coolant Injection (HPCI) and Reactor Core Isolation Cooling (RCIC) systems.

If you have any further questions regarding the BWR Owners Group response to NUREG-0660 requirement II.K.3.13, please contact Mr. S. J. Stark (408) 925-1822 of my staff.

Very truly yours,

S. J. Stark for R. H. Buchholz

R. H. Buchholz, Manager
BWR Systems Licensing
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Attachment

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cc: J. A. Olshinski
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EVALUATION OF PROPOSED MODIFICATION TO HPCI and RCIC OPERATION

I. Introduction

This report has been prepared as the BWR Owners' Group generic response to NUREG-0660 task item II.K.3.13 which addresses the operation of the High Pressure Coolant Injection (HPCI) and Reactor Core Isolation Cooling (RCIC) systems. The text of this requirement is as follows:

> Currently, the reactor core isolation cooling (RCIC) system and the high pressure coolant injection (HPCI) system both initiate on the same low water level signal and both isolate on the same high water level signal. The HPCI system will restart on low water level but the RCIC system will not. The RCIC system is a low-flow system when compared to the HPCI system. The initiation levels of the HPCI and RCIC system should be separated so that the RCIC system initiates at a higher water level than the HPCI system. Further, the RCIC system initiation logic should be modified so that the RCIC system will restart on low water level. These changes have the potential to reduce the number of challenges to the HPCI system and could result in less stress on the vessel from cold water injection. Analyses should be performed to evaluate these changes. The analyses should be submitted to the NRC staff and changes should be implemented if justified by the analyses.

II. Conclusions

This report presents the analyses, conclusions, and recommendations regarding separation of the initiation levels of the HPCI and RCIC systems. As previously confirmed by discussions with the staff on June 13 and 17 (Reference 1), the fundamental issue of the separation requirement is the potential benefit of reducing the number of thermal cycles on the reactor vessel and internals resulting from HPCI operation. Thus, the evaluation which follows concentrates on thermal cycle analyses of RCIC and HPCI system operation.

The most severe thermal cycle due to RCIC and HPCI initiation at the current low water level setpoint is assessed and compared to the thermal cycle analysis for the limiting reactor components. Operating plant experience is evaluated to estimate the frequency of occurrence of HPCI and RCIC initiations. Based on the foregoing, it is concluded that the current design is satisfactory, and a significant reduction in thermal cycles is not necessary.

The potential for reducing thermal cycles by separating the RCIC and HPCI initiation setpoint is also examined. The results of these analyses indicate that no significant reduction in thermal cycles is achievable by separating the setpoints.

II. Conclusions (cont)

An analysis which evaluates the proposed logic change for the RCIC system automatic reset/restart has also been completed. This evaluation concludes that such a change would be both beneficial and achievable. This analysis and conclusion will be documented in a separate report as discussed in a telecon with the NRC (Reference 2).

III. Evaluation of Thermal Cycles due to HPCI and RCIC Actuation

The analyses presented are for typical BWR/3 and 4 designs where the HPCI and RCIC systems inject via the feedwater spargers. Later plant designs (BWR/5 and 6) have separate injection locations for the RCIC and HPCI/HPCS systems and are less limiting in comparison to the typical BWR/3 and 4 configuration. Differences in the thermal fatigue analyses are identified where appropriate.

Chapter 15 of the Final Safety Analysis Report (FSAR) examines postulated plant transients. Examination of these events has identified transients which result in the loss of feedwater, including the loss of feedwater transient, as resulting in the most limiting thermal cycle due to HPCI and RCIC actuation.

The portions of the reactor vessel and its internals which may be affected by operation of HPCI and RCIC are the reactor vessel shell, core shroud, and feedwater nozzles and spargers. Thermal fatigue analyses show that the limiting reactor component is the feedwater nozzle for all plants equipped with HPCI and RCIC systems. The feedwater sparger is exposed to thermal cycles resulting from HPCI and RCIC operation as well as feedwater temperature changes during daily and weekly power swings. HPCI/HPCS and RCIC injection locations on plants that do not inject through the feedwater system are not exposed to temperature variations, during daily and weekly power swings.

Upon loss of feedwater, the temperature of the feedwater sparger and the nozzles approaches the normal reactor operating temperature. Initiation of HPCI and RCIC at low water level then cools the sparger and nozzle. The most severe thermal cycle identified by anlaysis results in a temperature change from 550°F (reactor operating temperature) to 50°F (HPCI/RCIC injection temperature). This temperature change is included in the loads assumed in fatigue analysis based on normal operation (which itself includes many cold water injections) as well as expected transients and other postulated events. The duty imposed on the feedwater nozzle from all causes is summed to obtain a calculated fatigue usage of 0.95, which is less than the limit of 1.0. The design basis includes 70 thermal cycles due to HPCI and RCIC injection of the type described. The calculated fatigue usage of these cycles is 0.16, or about 17% of the total fatigue usage. An evaluation for plants with other RCIC and HPCI/HPCS injection locations results in a calculated total fatigue usage of less than 0.2. It should be noted that there is no significant thermal effect on the reactor vessel shell due to the operation of HPCI and RCIC for any plant configuration.

III. Evaluation of Thermal Cycles due to HPCI and RCIC Actuation (cont)

Operating plant experience indicates an average of approximately 1.5 RCIC and HPCI actuations per year per plant. Even if every actuation resulted in the most severe thermal transient described earlier, the thermal analysis has shown that the design is within the fatigue limit.

Therefore, the current design is conservative and minimally effected by HPCI and RCIC actuation due to loss of feedwater events for all plants with HPCI/HPCS and RCIC.

IV. Evaluation of the Potential for Reducing Thermal Cycles by Separation of HPCI and RCIC Initiation Setpoints

The discussion that follows addresses the potential for reducing the thermal cycles due to HPCI and RCIC initiation. The transients considered are those cited in FSAR Chapter 15. Two classes of transients can cause RCIC and HPCI initiation:

1. Initiation of HPCI and RCIC on low water level after feedwater is tripped on high reactor water level. For these transients, the inventory is slowly lost due to decay heat steam generation.

2. Initiation of HPCI and RCIC following a sudden loss of feedwater. For these transients, inventory loss is rapid with HPCI and RCIC initiation occurring approximately 20 seconds after event initiation.

The majority of transients from Chapter 15 which require HPCI and RCIC initiation can be grouped into Category 1. In this case, the level decrease is slow because of the low power condition at the time the feedwater is tripped. A small amount of makeup water is needed and if feedwater cannot be restored, sufficient time is usually available such that RCIC would be started manually as the water level slowly decreases below the normal operating range. Since such manual action has been demonstrated to be successful for avoidance of HPCI actuation, it is considered sufficient and more desirable than an increase of the RCIC setpoint close to the normal operating water level. If neither feedwater or RCIC is manually started, both HPCI and RCIC would automatically be initiated at the low level setpoint.

The second class of transient to be considered is the loss of feedwater event. Loss of feedwater flow is accompanied by a large and rapid drop in water level. Low level scram is initiated in approximately 5 seconds, with RCIC and HPCI actuation occurring shortly thereafter. With both systems operating, water level is quickly restored. Due to the rapidity of the transient, HPCI initiation cannot be avoided even if the RCIC setpoint is raised to the normal operating level. Therefore raising the RCIC setpoint for this type of transient can have no beneficial effect on thermal cycles and will interfere with normal plant operation.

IV. Evaluation of the Potential for Reducing Thermal Cycles by Separation of HPCI and RCIC Initiation Setpoints (cont)

For both types of events, automatic RCIC operation could avoid HPCI initiation if the HPCI setpoint were lowered; however, no significant benefit is realized unless the HPCI setpoint is lowered to near the low-low water level (level 1). Since the actuation of RCIC and HPCI has been previously shown to be of minimal impact in fatigue usage analyses, and lowering of the HPCI setpoint lessens the existing margin for assurance of adequate core cooling, such a separation of HPCI and RCIC setpoints by lowering the HPCI setpoint is not warranted.

V. Summary

In the foregoing discussion, it has been shown that HPCI and RCIC initiations at the current low water level setpoints is within the design basis thermal fatigue analysis of the reactor vessel and its internals. Separating HPCI and RCIC setpoints as a means of reducing thermal cycles has been shown to be of negligible benefit. In addition, raising the RCIC setpoint or lowering the HPCI setpoint have undesirable consequences which outweigh the benefit of the limited reduction in thermal cycles. Therefore, when evaluated on this basis, GE recommends no change in RCIC or HPCI/HPCS setpoints.

VI. References

1. R. H. Buchholz (GE) letter to D. G. Eisenhut (NRC), Implementation of NUREG-0660 Requirement II.K.3.13, dated July 11, 1980 (MFN-124-80)

2. R. H. Buchholz (GE) letter to D. F. Ross, Jr. (NRC), NUREG-0660 Requirement II.K.3.13, dated September 29, 1980 (MFN-167-80)