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MURRAY R. EDELMAN
VICE PRESIDENT
NUCLEAR

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Mr. B. J. Youngblood, Chief
Licensing Branch No. 1
Division of Licensing
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Perry Nuclear Power Plant
Docket Nos. 50-440; 50-441
License Condition No. 4: BWROG
Inadequate Core Cooling (ICC)
Instrumentation Requirements Report

Dear Mr. Youngblood:

This letter and its attachments are provided to address the Perry Nuclear Power Plant SER license condition number 4, regarding inadequate core cooling instrumentation requirements. This response further addresses TMI Action Plan Item II.F.2 and will be incorporated into a future FSAR amendment.

If you have any questions, please contact me.

Very truly yours,

Murray R. Edelman

Murray R. Edelman
Vice President
Nuclear Group

MRE:kh

cc: Jay Silberg, Esq.
John Stefano
Max Gildner
B. K. Sun

Attachment

B001

Response

This response describes the Perry Nuclear Power Plant implementation action based on the submittal of BWROG Reports SLI-8211 and SLI-8218 to the NRC.

As discussed in Section 4.4.7 of the Perry Safety Evaluation Report (NUREG-0887, May 1982), the BWR Owners Group committed to develop a report analyzing inadequate core cooling (ICC) instrumentation requirements for subsequent submittal to the NRC Staff. The Perry Nuclear Power Plant as a participant in the Owners Group was directed to apply all conclusions/recommendations to its plant design. Accordingly, the operating license of the Perry Nuclear Power Plant is conditioned to the submittal of the report and the design action taken.

In conjunction with the submittal of BWROG Reports SLI-8211 and SLI-8218 to the NRC, the Perry Nuclear Power Plant has reviewed and evaluated the reports against its plant design. Based on this evaluation, the Perry Nuclear Power Plant has concluded that its reactor vessel water level system, as modified by specific changes identified in Report SLI-8211, will provide suitable means for detection of adequacy of core cooling. Additional new instrumentation to monitor ICC conditions is not considered warranted based on the improvements made.

BWROG report SLI-8211 was developed as the first phase in addressing acceptable means in detecting inadequate core cooling conditions in BWR's. The objective of this report was to review existing BWR water level measurements systems for the purpose of identifying improvements which would enhance the system's capability or reliability.

The results of the analysis results as presented in Report SLI-8211, revealed that BWR water level measurement systems, through years of operating experience, have demonstrated very high degrees of capability to provide required information in various conditions of reactor operation. Information presented to the operator, almost without exception, has not been ambiguous, and trips, initiations, and other signals taken from the level systems have occurred as required. However, vulnerabilities in a very small segment of operating conditions were identified in the report. Detailed analyses of those weaknesses were performed for the purpose of developing recommendations for improvement. Conclusions and recommendations developed for Reference Plant B in Report SLI-8211 were evaluated as applicable to the Perry Nuclear Power Plant.

The Perry Nuclear Power Plant Plant, as indicated in the Perry FSAR, utilizes a BWR 6 reactor plant with a Mark III Containment. The reactor vessel water level instrumentation utilized by the Perry Nuclear Power Plant is identical to the system described for Plant B in SLI-8211. Four redundant sets of level transmitters (wide and narrow ranges per division) are included in the design with each set connected to an unheated static reference leg through a condensing chamber. The physical arrangement of the Perry Nuclear Power Plant's references and variable leg piping does differ form that described for reference plant B in the drywell. The Perry Nuclear Power Plant's wide and narrow range variable leg piping configuration (condensing chamber to drywell penetration) in the drywell reflects a 1 foot 6 inch vertical drop. The Perry Nuclear Power Plant's reference leg piping configuration reflects a vertical drop from 6 feet 10 inches to 7 feet 9 inches in the drywell.

The first concern addressed by Report SLI-8211 and applicable for Reference Plant B deals with effects of high drywell temperature. As noted in the report, plant transients can cause errors in sensed water level because of process pressure and drywell temperature variations. Under worst case conditions, high drywell temperatures incurred from loss of drywell coolers and/or recovery from a LOCA, and followed by vessel depressurization, could result in flashing and subsequent boiloff of the level instrumentation reference legs. Level instrumentation readings under this condition would be erroneous to the control room operator, resulting in an unsafe condition of the plant. As described for the cold reference leg design, the degree of instrumentation error can be correlated to the amount of reference leg vertical drop in the drywell from the condensing chamber to the exit drywell penetration. Based on a drywell temperature of 340°F, the amount of error reflected by level instrumentation could be up to 16 inches per foot of reference leg vertical drop, once flashing occurred. Review of the Perry Nuclear Power Plant's reference leg configuration in the drywell indicates that errors in magnitude from 106 inches to 125 inches could be prevalent under the conditions stated. In addition to the above, two other areas of concern were addressed by the report with respect to variation in drywell temperature and process pressure. Under changes in drywell temperature, density differences between the water in the references and variable legs can cause level instrumentation errors up to 13% of the difference in vertical drop between the two legs. To eliminate this concern, the report recommended that the difference in vertical drops of the reference and variable legs in the drywell be made approximately equal. Review of the Perry Nuclear Power Plant's piping configuration indicates that this design feature has not been achieved. A worst case error of 9 inches could be realized based on the Perry Nuclear Power Plant's current piping configuration.

Under the conditions of transient flashing described previously, the magnitude of level error was also shown to be dependent on the location of flow limiting orifices in the reference legs. If the orifices are located close to the reactor vessel nozzles and flashing occurs, a resultant pressure gradient across the orifice would cause significant errors in water level, particularly at low pressures. If the flow restricting orifices were located close to the drywell penetrations, its effect on flow and pressure in the legs is rendered insignificant. Orifice locations in the Perry Nuclear Power Plant's design has been verified to be close to the vessel nozzles.

The second concern included in Report SLI-8211 addressed reliability of system trips based on water level measurement system failures. A failure analysis study was performed on the level measurement system of Reference Plant B to determine plant vulnerability to potential logic failure combinations and the subsequent consequences of each failure. The worst case scenario utilized in performing the analysis was a reference leg break with postulated instrument failures in a division unrelated to the reference leg break. Five separate event types (depending on the unrelated instrument failure) were analyzed in the study under the accident scenario presented. The event types were as follows:

1) Failure of an RPS transmitter.
2) Failure of an MSIV transmitter.

3) Failure of a low pressure coolant injection system transmitter.
4) Failure of HPCS transmitter.
5) Failure of a feedwater control transmitter.

Subsequent analysis in the report concluded that the consequences of an additional single failure was not of any immediate concern for the event types described above. No challenge to fuel design limits, danger of core uncover, or need for unusual operator action to mitigate the event consequences was apparent or needed.

A final objective of report SLI-8211 was to review available industry data of actual events against water level measurement systems, to assure all potential concerns were considered. The results of this review revealed that mechanical instrumentation utilizied in some BWR plants had a large number of failures in comparison to analog instrumentation. Since Reference Plant B was verified to utilize analog equipment in its level measurement system, the results of this survey has little impact on the design of the Perry Nuclear Power Plant.

Based on the concerns presented here, a study was developed in Report SLI-8211 to identify improvements for BWR water level measurement systems. The Perry Nuclear Power Plant evaluation of these improvements has resulted in the following conclusions relevant to its water level measurement system design:

1) Water level instrumentation reference legs from each condensing chamber must be rerouted out to the drywell penetrations with minimum vertical drop as achievable. Meeting this requirement will minimize the effects of reference leg flashing.

2) The reference and variable vertical leg drops in the drywell must be equal to within ±1 foot. Accomplishment of the above will negate instrument errors due to changes in the density of process fluid in the instrument lines.

3) Flow limiting orifices in the instrument piping reference legs should be located close to its associated drywell penetration.

This design arrangement will minimize transient flashing effects on system trips.

In accordance with the stated conclusions, the following design modifications will be implemented at the Perry Nuclear Power Plant:

1) New penetrations will be installed in the drywell walls for subsequent rerouting of the water level system reference legs. The vertical drop of the reference legs from the condensing chamber to the drywell penetrations will be 1 foot, 6 inches ± 6 inches.

2) Orifices as presently located in the reference legs will be installed close to and on the inboard side of the drywell penetrations.

The design action described above is considered responsive to the recommendations addressed in BWROG Reports SLI-8211 and SLI-8218. The modifications made to the level system piping configurations will provide significant system reliability in detection of inadequate core cooling conditions. The addition of new instrumentation as discussed in Report SLI-8218 is not warranted based on the Perry Nuclear Power Plant's responsiveness to Report SLI-8211 recommendations.

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