UNITED STATES
NUCLEAR REGULATORY COMMISSION
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SAFETY ASSESSMENT

OFFICE OF NUCLEAR REACTOR REGULATION

MODERATE-ENERGY LINE PIPE BREAK CRITERIA

PERRY NUCLEAR POWER PLANT, UNIT NO. 1

DOCKET NO 50-440

1. INTRODUCTION

By letter dated August 11, 1997, the licensee provided a response to NRC Inspection Report 50-440/97-201, dated June 10, 1997, which discussed the NRC Design Inspection conducted at the Perry Nuclear Power Plant (PNPP) by the Office of Nuclear Reactor Regulation between February 17 and March 27, 1997. One of the unresolved issues identified in the inspection report concerns the pipe break/crack criteria for nonseismic Category 1, moderate-energy piping systems (URI 97-201-10). The August 11, 1997, response describes the licensee's position that nonseismic, moderate-energy piping is considered to have the same failure modes as seismic Category 1 moderate-energy piping, and thus, is subject only to the postulation of "controlled cracks" in piping and branch runs, even in the event of a design basis earthquake. The staff's Request for Additional Information dated June 11, 1998, stated that due to a design basis earthquake, nonseismic Category 1 moderate-energy piping could fail catastrophically, and the ability to achieve and maintain safe reactor shutdown following such failures must be demonstrated in order to be in compliance with General Design Criterion (GDC) 2, "Design Bases for Protection Against Natural Phenomena."

A second unresolved issue identified in the inspection report concerns the suppression pool cleanup (SPCU) system interface with the high pressure core spray (HPCS) system (URI 97-201-11). The SPCU system takes suction from the HPCS suppression pool suction line between the containment isolation valve and the HPCS pump. This arrangement requires that the HPCS system be aligned to the suppression pool instead of the preferred source, i.e., the condensate storage tank, during SPCU system operation. The URI focuses on whether sufficient net positive suction head (NPSH) will be available to the HPCS pump if HPCS initiation is required during SPCU system operation.

2. DISCUSSION

URI 97-201-10, "Pipe Crack Criteria for Moderate-Energy Piping Outside Containment"

During the NRC Design Inspection conducted at PNPP between February 17 and March 27, 1997, the staff learned that the licensee did not analyze the plant for postulated ruptures in nonseismic piping in moderate-energy systems (except for expansion joint failures of the

circulating water system). The licensee only analyzed for postulated "critical cracks" in these nonseismic systems which is the same as the analysis performed by the licensee for seismic Category 1 moderate energy systems. The licensee interpreted Branch Technical Positions (BTPs) ASB 3-1, "Protection Against Piping Failures in Fluid Systems Outside Containment," and MEB 3-1, "Postulated Break and Leakage Locations in Fluid System Piping Outside Containment," to require that only cracks, as opposed to full, double-ended ruptures, be postulated in moderate-energy piping systems without any distinction between seismic and nonseismic piping.

In the staff's letter dated June 11, 1998, the staff concluded that the licensee's application of moderate-energy line break criteria for nonseismic Category 1 piping systems may not be consistent with the Perry Safety Evaluation Report (NUREG-0887) nor with Standard Review Plan (SRP) Section 3.6.1. In addition to postulating cracks in nonseismic moderate-energy systems in accordance with SRP Section 3.6.2, the staff concluded that pipe ruptures (unless the piping is seismically supported) initiated by an earthquake must also be postulated and evaluated for the effects of flooding on safe shutdown equipment in addition to the effects on the operation of any seismic Category 1 systems to which they are connected to satisfy the requirements of General Design Criterion 2, "Design Bases for Protection Against Natural Phenomena (GDC 2)."

During subsequent discussions with the licensee, the staff described its interpretation of the BTPs. Specifically, BTP ASB 3-1 was intended to require that complete, double-ended ruptures be postulated in nonseismic moderate-energy piping caused by a seismic event and BTP MEB 3-1 was intended to require the postulation of cracks in this same piping during normal operating conditions. However, the staff agreed with the licensee that the 1981 revisions to these BTPs failed to clearly articulate the staff's intent.

In order to determine whether Perry was unique in this interpretation of the BTPs, the staff conducted a brief survey (i.e., a review of various Updated Safety Analysis Reports) of plants that were licensed based on our post-1981 BTPs. The survey determined that a significant number of operating facilities (20-30 units) used the same interpretation of the BTPs as the Perry licensee. The survey also determined that in 1972, licensees and applicants for many of the earlier licensed plants (40-50 units) were sent letters from the AEC that required them to review their plants for flooding effects from the complete rupture of nonseismic, moderate-energy piping systems. Therefore, it appears that this interpretation of the BTP pipe break criteria applies mainly to the more recently licensed plants of the 1980s.

The staff attempted to determine the safety significance of these findings and whether a backfit analyses would be appropriate. The staff reviewed responses from licensees that were specifically requested to perform flooding analyses based on the assumed complete double-ended rupture of nonseismic, moderate-energy piping. The staff also reviewed the internal flooding aspects of the Individual Plant Examination (IPE) reports and the results of the staff's evaluations of those IPEs. The IPE results showed that, in most cases, the risk associated with internal flooding due to the rupture of moderate-energy piping was not a major contributor to the overall plant risk. The IPE results also showed that improvements were made to about 16 plants (the plants are identified in NUREG-1560, Volume 2, Parts 2-5) as a result of the internal flooding analyses performed as part of the IPE. The staff's review of the responses from the

licensees that were specifically requested to assume ruptures of nonseismic, moderate energy piping showed that few physical modifications were required as a result of the licensee's findings. Most modifications that took place were related to turbine building flooding as a result of postulated circulating water system failures (expansion joints).

Since the licensees referencing BTPs ASB 3-1 and MEB 3-1 as part of their licensing basis also assumed complete failure of a circulating water system expansion joint (SRP Section 10.4.5, "Circulating Water System") in their flooding analysis, the staff concludes that any risk reduction which might be gained from requiring (via backfit) complete rupture analyses versus leakage crack analyses at operating plants would not be cost beneficial. Additionally, the licensee's IPE internal flooding analyses assumed complete piping ruptures for determining core damage frequency.

Based on this evaluation, the staff concludes that the IPE program has adequately addressed the issue of flooding due to pipe breaks and that no further action by the licensee is warranted. Therefore, the staff finds the Perry licensee's response of August 11, 1997, to URI 97-201-10, acceptable. However, to clarify the staff's position, modifications will be proposed to the appropriate SRP sections and BTPs, making clear the staff's interpretation relative to failures of nonseismic, moderate-energy piping. The proposed revisions to the SRP will be made available for public comment prior to implementation.

URI 97-201-11, "Suppression Pool Cleanup System Interface with High Pressure Core Spray System"

The PNPP design of the suppression pool cleanup (SPCU) system interfaces directly with the high pressure core spray (HPCS) system. The SPCU system takes suction from the HPCS suppression pool suction line between the containment isolation valve and the HPCS pump. This arrangement requires that the HPCS system be aligned to the suppression pool instead of the preferred source, i.e., the condensate storage tank, during SPCU system operation. Since the SPCU system is normally in operation at PNPP, the HPCS system is, therefore, normally aligned to take suction from the suppression pool.

The ability of the SPCU system to support HPCS operation by isolating suction valves upon HPCS initiation is the subject of URI 97-201-11. General Electric specifications require that the HPCS system must be capable of starting and delivering rated flow into the reactor vessel within 27 seconds following receipt of an initiation signal. Two butterfly valves in the SPCU piping, powered from Division I and II power supplies, isolate the SPCU suction from the HPCS system. The closing time for these valves is 35 seconds. Therefore, a finite time period exists, while the SPCU valves are closing, when flow will be directed to both pumps after automatic initiation of HPCS. With concurrent flow to both pumps, questions were raised regarding the operability of the HPCS pumps from an available NPSH perspective.

The licensee's letter of August 11, 1997, described their calculations of NPSH. The SPCU system takes suction (12" diameter pipe with a maximum flow of 2,000 gpm) from the HPCS system 24" suction piping outside of the HPCS system isolation valve. The licensee's calculation assuming maximum SPCU operating flow (2,000 gpm), HPCS run-out flow (7,800

gpm), and a suppression pool temperature of 185°F, resulted in significant NPSH margin for the HPCS pump.

The SPCU piping from the isolation valves to the SPCU pump is non-safety but seismically supported, whereas the piping downstream of the SPCU pumps is non-safety and is not seismically supported. As part of URI-97-201-10 discussed above, the inspectors questioned whether a full double-ended rupture of the SPCU piping should be considered. SPCU pump run-out flow of 3,500 gpm would, therefore, appear to be a more conservative value as opposed to the maximum operating flow of 2,000 gpm. However, as stated by the licensee, the Perry licensing basis states that pipe breaks or cracks outside containment are not postulated to occur concurrently with a loss-of-coolant accident. Since HPCS is required to operate in response to a loss-of-coolant accident, the LOCA initiating event is the only pipe break that is considered.

The staff concurs with the licensee in that the design basis does not require the accident analysis to assume a concurrent LOCA and seismic event. Thus, a LOCA event requiring HPCS initiation should not be assumed concurrent with SPCU pump run-out conditions associated with a seismic event. Therefore, the staff accepts the licensee's calculations showing that adequate NPSH will be available for the HPCS pumps. This closes URI 97-201-11.

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