January 4, 2002

MEMORANDUM TO: John A. Grobe, Director
Division of Reactor Safety
Region III

FROM: Ledyard Marsh, Acting Deputy Director ***/RA/***
Division of Licensing Project Management
Office Of Nuclear Reactor Regulation

SUBJECT: TASK INTERFACE AGREEMENT 2000-18, DESIGN-BASIS ASSUMPTIONS FOR NON-SEISMIC PIPING FAILURES AT THE PERRY PLANT (TAC NO. MB1629)

By memorandum dated March 27, 2001, Region III requested Nuclear Reactor Regulation (NRR) assistance related to design-basis assumptions for non-seismic piping failures at the Perry Nuclear Power Plant. As originally identified in the Nuclear Regulatory Commission Design Inspection conducted at Perry by the Office of Nuclear Reactor Regulation (Inspection Report 50-440/97-201, dated June 10, 1997), the licensee has taken the position that non-seismic, 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 in lieu of pipe breaks, even in the event of a design-basis earthquake. Our letter to the licensee dated January 29, 1999, acknowledged that the 1981 revisions to the Standard Review Plan failed to clearly articulate our position regarding design-basis assumptions for non-seismic piping failures and recognized that there could be some confusion on this point. However, in the case of the Perry plant, the staff concluded that flooding in the turbine building had been adequately addressed and no further action with respect to this particular issue was necessary.

NRR has concluded that the postulation of leakage cracks in non-seismically designed moderate-energy piping systems is acceptable for purposes of evaluating environmental effects under normal operating conditions. However, it is not acceptable to extend this position (postulating leakage cracks rather than full-size breaks) to other applications. The attachment provides NRR's detailed response to TIA 2000-18.

This completes the response to TIA 2000-18 and closes out TAC No. MB1629.

Docket No. 50-440

Attachment: As stated

cc: B. Platchek, RI
L. Plisco, RII
K. Brockman, RIV

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*See B Thomas to A Mendiola memo of November 6, 2001
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RESPONSE TO TASK INTERFACE AGREEMENT 2000-18
DESIGN-BASIS ASSUMPTIONS FOR NON-SEISMIC PIPING FAILURES AT PERRY

1.0 INTRODUCTION

By memorandum dated March 27, 2001, Region III requested Nuclear Reactor Regulation assistance related to design-basis assumptions for non-seismic piping failures at the Perry Nuclear Power Plant. As originally identified in the Nuclear Regulatory Commission (NRC) Design Inspection conducted at Perry by the Office of Nuclear Reactor Regulation (Inspection Report 50-440/97-201, dated June 10, 1997), the licensee has taken the position that non-seismic, 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 in lieu of pipe breaks, even in the event of a design-basis earthquake. Our letter to the licensee dated January 29, 1999, acknowledged that the 1981 revisions to the Standard Review Plan (SRP) failed to clearly articulate our position regarding design-basis assumptions for non-seismic piping failures and recognized that there could be some confusion on this point. However, in the case of the Perry plant, the staff concluded that flooding in the turbine building had been adequately addressed and no further action with respect to this particular issue was necessary.

2.0 EVALUATION

As previously described, the licensee has taken the position that non-seismic, 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 in lieu of pipe breaks. The licensee's reason is that the criteria of SRP 3.6.2, "Determination of Rupture Locations and Dynamic Effects Associated with the Postulated Rupture of Piping," recommends postulation of only leakage cracks in non-seismic moderate energy piping. While there may be some confusion as to whether only leakage cracks need to be postulated for environmental effects (e.g., spraying, flooding), as discussed in the staff's safety evaluation dated January 27, 1999, it is incorrect for the licensee to assume the same failure mode of piping (i.e., leakage crack) can be used for purposes other than environmental effects especially under accident conditions. The problem with the licensee's assumptions exists because it is failing to differentiate between the failure mode of piping under seismic loadings and the failure mode under normal operating conditions. This is explained further below.

It should be recognized that SRP Sections 3.6.1, "Plant Design for Protection Against Postulated Piping Failures in Fluid Systems Outside Containment," and SRP Section 3.6.2 provide design review guidelines for satisfying 10 CFR Part 50, Appendix A, General Design Criteria (GDC) 4, "Environmental and dynamic effects design bases." GDC 4 addresses environmental and dynamic effects associated with postulated failures of piping and equipment. Dynamic effects are those directly related to pipe rupture including pipe whip and jet impingement. Environmental effects include those related to flooding, spraying, temperature, and humidity. The guidelines in SRP Section 3.6.2 (MEB 3-1) were developed to address where pipe breaks and leakage cracks should be postulated as well as the size of the breaks and cracks to be postulated. These breaks and cracks were to be postulated mechanistically, in other words, as an initiating event; not as a consequence of an event. This is clearly stated

in Branch Technical Position (BTP) Auxiliary Systems Branch (ASB) 3-1, paragraph B.3.a, "In applying the provision of BTP MEB 3-1, each longitudinal or circumferential break in high-energy fluid system piping or leakage crack in moderate-energy fluid system piping should be considered separately as a single postulated initial event occurring during normal plant conditions."

Because the failure mode of moderate energy piping is postulated during normal plant conditions for environmental and dynamic effects, it did not matter whether the piping was seismically designed or not. The MEB 3-1 guidelines postulating only leakage cracks in moderate-energy piping systems applied to both seismic and non-seismically designed piping. The reasoning was that during normal plant conditions, there was not sufficient energy in a moderate-energy piping system to cause a flaw or crack to propagate into a full-size break. However, during accident conditions (e.g., a seismic event), the inertia acceleration of the piping mass and seismic anchor displacements (relative motion of the piping connections) could be sufficient to cause the pipe to fail catastrophically. Seismic experience shows that non-seismically designed piping typically fails at unreinforced branch connections, threaded joints, expansion joints, and equipment nozzles in a catastrophic manner. Therefore, it would not be appropriate to postulate only leakage cracks in non-seismically designed piping under a seismic event. Seismic design of piping is covered under GDC 2, "Design-basis for protection against natural phenomena," not GDC 4.

It should be noted that the failure mode of high-energy piping during normal plant conditions does contain sufficient energy to cause the pipe to rupture catastrophically (i.e., full-size break). MEB 3-1 clearly specifies that full-size breaks should be postulated in high-energy piping systems for both seismically-designed and non-seismically designed piping.

In summary, the postulation of leakage cracks in non-seismically designed moderate-energy piping systems is acceptable for purposes of evaluating environmental effects under normal operating conditions. However, it is not acceptable to extend this position (postulating leakage cracks rather than full-size breaks) to other areas such as for determining the differential pressure across an motor-operated valve when the failure mode could occur under accident conditions or to establish the operability of a system when the non-seismically designed piping could fail under a seismic event because the SRP guidelines in Sections 3.6.1 and 3.6.2 were not intended to be used for purposes other than addressing environmental and dynamic effects of piping and equipment failures.

2.1 Specific Questions

In the task interface agreement request, Region 3 asked the following specific questions:

1. In evaluating a motor operated valve's design-basis capability, can the differential pressure be based on the assumption that non-seismically supported piping will only leak as specified in MEB 3-1, or should it assume that the non-seismic piping will completely rupture?

   Response:

   In general, non-seismic piping is assumed to rupture during a seismic event. This position stems from Position C.2 of Regulatory Guide 1.29, "Seismic Design

Classification," which states: "Those portions of structures, systems, or components whose continued function is not required but whose failure could reduce the functioning of any plant feature included in 1a through 1q above [structures, systems and components that are important to safety] to an unacceptable safety level or could result in incapacitating injury to occupants of the control room should be designed and constructed so that the SSE [Safe Shutdown Earthquake] would not cause such failure." The term "failure" as it applies to structures, systems, and components is not specifically defined by the Regulatory Guide and therefore, all potential failure modes must be considered. For piping, potential failures would include cracks as well as complete rupture. The criteria provided in MEB 3-1 is intended for pipe failures that are postulated as initiating events (as opposed to pipe failures that are postulated as a consequence of a seismic event), and for this particular application guidance is provided for the type of pipe failures that should be considered.

In responding to this issue (letter dated June 6, 2001), the licensee indicated that the regulations in effect at the time of the design and construction of the Perry Nuclear Power Plant (PNPP) did not provide any guidance with respect to the effects a safe-shutdown earthquake (SSE) has upon a non-seismically designed piping system. Absent such guidance, the licensee contends that the guidance for postulating pipe failures as initiating events (e.g., MEB 3-1) was used at PNPP for seismically induced pipe failures. While the criteria that was applied to PNPP for seismically induced pipe failure may seem unclear today, we believe that it was properly understood and applied by Gilbert/Commonwealth, Inc. (the Architect Engineer for PNPP) during plant construction and licensing as indicated in Licensee Event Report 90-035 dated January 3, 1991.

2. In general, for determining the operability of a structure, system, or component, is it technically adequate to assume that non-seismic piping, for which the licensing/design-basis does not take credit in the mitigation of accidents, will only leak instead of completely break?

<u>Response</u>:

In general, during normal plant operation, pipe breaks are assumed in high-energy non-seismic systems and cracks are postulated in moderate-energy non-seismic systems as initiating events. However, the criteria varies somewhat depending on when the application for a construction permit was submitted and when the operating license was issued. See Section 4 of BTP ASB 3-1, which is attached to SRP Chapter 3.6.1, for additional guidance.

Pipe failure concurrent with a postulated accident is not assumed unless the break is a consequence of the accident. It is generally assumed that non-seismic pipes will fail (either crack or rupture) during a seismic event. However, safety systems should not be adversely affected at plants where regulatory guide properly applied (see response to Question 1, above).

With respect to internal flooding during a seismic event, it was the NRC's practice to assume a complete rupture of one non-seismic pipe in each compartment individually during a SSE (the most limiting rupture with respect to fluid loss) concurrent with a

single active failure (the most limiting with respect to plant shutdown). Only seismic Category I structures, systems, and components were credited for mitigating the consequences of flooding due to a non-seismic pipe break during a seismic event. While we would expect this criterion to be applicable to the Perry plant, we have not reviewed the design-basis documentation for the Perry plant in sufficient detail to confirm that this is in fact the case. Licensees of plants that were constructed before this criterion was implemented (does not apply to the Perry plant) were sent letters around September 1972 following a failure of an expansion bellows in the circulating water lines at the Quad Cities plant. These licensees were asked to determine whether the failure of any non-seismic equipment, particularly in the circulating water and fire protection systems, could result in a condition (such as flooding or the release of chemicals) that might adversely affect the performance of safety-related equipment. The licensee's response to this letter establishes (in part) the non-seismic pipe failure design-basis for these plants.

While in general, these are the criteria that were applied for pipe failure, the specific criteria that were applied to a particular plant (including any approved exceptions) must be determined on a plant-specific basis by reviewing the design-basis documentation for the plant.