



UNITED STATES  
NUCLEAR REGULATORY COMMISSION  
WASHINGTON, D.C. 20555-0001

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

GPU NUCLEAR INC., ET AL., REQUEST

TO REMOVE THE MISSILE SHIELD FROM THE DESIGN BASIS

OF THE THREE MILE ISLAND NUCLEAR STATION, UNIT NO. 1

1.0 Background

By letter dated March 31, 1997, (Ref. 1), as supplemented by letters dated June 3, and July 13, 1998, GPU Nuclear, Inc., (GPUN or licensee) submitted a license amendment request to the staff. In this letter, GPUN informed the staff that it was seeking staff approval for removal of the missile shield from the Three Mile Island Unit 1 (TMI-1) plant design, as described in the TMI-1 plant-specific Final Safety Analysis Report (FSAR). The licensee's June 3, 1998, letter was in response to the staff's October 3, 1997, request for additional information, and the licensee's July 13, 1998, letter forwarded an affidavit for the proprietary treatment of the June 3, 1998, letter.

2.0 Safety Evaluation

2.1 Staff Criteria for Removing Dynamic Effects from a Plant-Specific Design Basis

General Design Criteria (GDC) 4 of 10 CFR Part 50, Appendix A, in part, allows for the dynamic effects (including missile generation effects) associated with postulated pipe ruptures in nuclear power plants to be removed from the plant design bases when "analyses reviewed and approved by the Commission demonstrate that the probability of fluid system piping rupture is extremely low under conditions consistent with the design basis for the piping."

In the final modification and Statement of Considerations (SOC) for GDC 4 (Ref. 4), the NRC stated that it would consider allowing the dynamic effects to be excluded from the plant-specific design basis if it could be demonstrated that the probability for pipe rupture is extremely low under conditions consistent with the design for the pipe. In the SOC, the Commission stated that it would allow such dynamic effects to be excluded from the plant-specific design basis if the staff could determine that the application of leak-before-break (LBB) technology to a particular piping system would maintain a sufficiently high margin of safety in regard to the potential for the pipe to rupture, and if application of the technology would not affect the capability of the containments to perform their function of isolating the outside containment from potential leaks, breaks, or malfunctions within the containment. The dynamic effects covered by the rule include missile generation, pipe whipping, pipe break reaction forces, jet impingement forces, decompression waves within the ruptured pipe, and dynamic or nonstatic pressurization in cavities.

In the SOC, the Commission indicated that it does not intend to consider near-term changes to emergency core cooling system and containment design bases as discussed in the Final Rule section. The staff has not considered removal of dynamic effects for any structure, system, or component other than high energy piping. The rule allows removal of plant hardware which it is believed negatively affects plant performance and safety, while not affecting emergency core cooling systems, containments, and environmental qualifications.

The Commission further determined in its consideration of the final rule, that a deterministic fracture mechanics evaluation is mandatory for permitting the use of analyses to exclude dynamic effects of pipe ruptures in all high energy piping from the design basis. Other evaluations, such as the potential for waterhammer, corrosion, creep damage, fatigue, erosion, environmental conditions, indirect failure mechanisms and other degradation sources which could lead to pipe rupture are also required.

## 2.2 GPUN's Basis for Removing the Missile Shield from the Design Basis of the TMI-1 Nuclear Plant

According to the TMI-1 plant design, the limiting missile postulated in the accident analyses (e.g., Chapter 15) of the TMI-1 FSAR would occur as a result of a catastrophic failure of a control rod drive mechanism (CRDM) penetration nozzle or housing assembly. GPUN's basis for removing the TMI-1 missile shield from the plant design has been provided in the Failure Mode and Effects Analysis (FMEA) of Babcock and Wilcox Owners Group (B&WOG) Proprietary Report No. 51-1230140-00, "Reactor Vessel Missile Shield Removal Report (December 1995, Ref. 2)," and the postulated flaw analysis for the CRDM penetration nozzles and housing assemblies is provided in B&WOG Non-Proprietary Topical Report BAW-10190P, Addendum 1, "External Circumferential Crack Growth for B&W Design Reactor Vessel Head Control Rod Drive Mechanism Nozzles (December 1993, Ref. 3)."<sup>1</sup> GPU's basis for removing the TMI-1 missile shield stems primarily from the claim that GPUN does not consider a catastrophic failure of a CRDM penetration nozzle, housing assembly, or adapter tube to be a credible event, even though a control rod ejection event is covered by the scope of design basis analyses described in Chapter 15 of the TMI-1 FSAR. This basis for removing the missile shield from the TMI-1 plant design includes the following two premises:

- ejection of a control rod drive from the TMI-1 vessel head is not likely to occur because "upon opening of postulated circumferential crack, a significant part of the crack driving force would be relieved so that either the crack growth rate is drastically reduced or the crack growth is terminated."
- a gross LBB mechanism exists in that, even if a large portion of a nozzle contains a through-wall circumferential crack, there is ample room for leakage to occur and be detected before the propagating crack would approach the net section limit ligament of the penetration nozzle.

## 2.3 Staff Assessment Regarding GPUN's Analysis for Removal of the TMI-1 Missile Shield from the TMI-1 Design Basis

The modification to GDC 4 which allowed licensees to propose detailed quantitative LBB technology as a basis for removing the dynamic effects associated with a postulated pipe rupture from a plant-specific design basis is only applicable to high energy piping. The Commission specifically addressed comments to allow extending the use of leak-before-break technology to relax pipe rupture for containment design, emergency core cooling systems, and environmental qualification and stated that it does not intend to consider near term changes to other than environmental qualification. GPUN's proposal to remove the missile shields from the TMI-1 design basis is also based on a qualitative LBB argument that was proposed to support GPUN's claim that

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<sup>1</sup> Topical Report No. BAW-10190P, Addendum 1 was originally issued as a Proprietary Topical Report. This report was changed to Non-Proprietary status per B&W Nuclear Technologies Letter ESL-96-574.

a full guillotine rupture of a CRDM penetration nozzle was an improbable event, and therefore, the dynamic effects, including missile generation effects, associated with a control rod drive ejection event were also improbable. To date, the staff has not considered evaluations other than fully quantitative LBB fracture mechanics analyses as a basis for removing the dynamic effects associated with postulated high energy pipe ruptures from a plant-specific design basis. Further, since CRDM penetration nozzles and housing assemblies are not high energy piping, GDC 4 cannot be used as a basis for removing the effects of a postulated control rod drive missile from the design basis for TMI-1 (as described in the TMI-1 FSAR).

GPUN's proposal also does not provide any information to show that failure to remove the missile shield could adversely affect plant performance and safety, which was a consideration in the final rule SOC for removal of hardware associated with preventing the dynamic effects of high energy pipe breaks.

### 3.0 Conclusion

Based on the above, the staff concludes that the proposal to remove the missile shield from the TMI-1 plant design based on the FMEA analysis presented in Proprietary Report No. 51-1230140-00, and the qualitative LBB analysis presented in Topical Report No. BAW-10190P, Addendum 1, is not acceptable.

### 4.0 References

1. March 31, 1997- Letter from R.W. Keaton, Vice President and Director of Engineering, General Public Utilities, to the U.S. Nuclear Regulatory Commission Document Control Desk (untitled).
2. December 1995 - Babcock and Wilcox Owners Group Proprietary Topical Report No. 51-1240140-00, "Reactor Vessel Missile Shield Removal Report."
3. December 1993 - Babcock and Wilcox Owners Group Non-Proprietary Topical Report No. BAW-10190P, Addendum 1, "External Circumferential Crack Growth Analysis for B&W Design Reactor Vessel Head Control Rod Drive Mechanism Nozzles.
4. October 27, 1987- Modification of General Design Criterion 4 Requirements for Protection Against Dynamic Effects of Postulated Pipe Ruptures, *Federal Register*, Volume 52, No. 207, pp. 41288 - 41294.
5. November 1994 - NUREG-1061, Volume 3, "Report of the Nuclear Regulatory Commission Piping Review Committee, Evaluation of Potential for Pipe Breaks."

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