GPU NUCLEAR

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February 13, 1998
6L20-98-20063

U. S. Nuclear Regulatory Commission
Attn.: Document Control Desk
Washington, DC 20555

Dear Sir:

Subject: Three Mile Island Nuclear Station, Unit 1 (TMI-1)
Operating License No. DPR-50
Docket No. 50-289
GPU Nuclear (Revised) Response to Generic Letter (GL) 96-06, "Assurance of Equipment Operability and Containment Integrity During Design-Basis Accident Conditions"

Generic Letter (GL) 96-06 requested that licensees determine if the piping which penetrates containment is susceptible to overpressurization from thermal expansion of fluid trapped between the containment isolation valves or if the containment air cooling water systems[1] are susceptible to either water hammer or two-phase flow conditions during postulated accidents. We were further requested to assess operability of any systems found to be susceptible to these phenomena and to provide a report on the actions taken, conclusions reached relative to susceptibility (including: identification of systems affected and the specific circumstances involved); the basis for continued operability of affected systems and components, as applicable; and, corrective actions implemented or planned.

GPU Nuclear has performed the evaluations as requested by the GL, including those specific scenarios referenced in the GL, and the results show that the affected systems remain operable. The purpose of this letter is to revise our February 14, 1997 response to reflect additional analysis which further demonstrates the capability of the RBEC system and to reflect the completion of modifications installed during the Cycle 12 Refueling (12R) Outage which ended in October 1997.

The concern identified by GL 96-06 involves the potential for heat transfer from an accident environment[2] to adversely affect the ability of the containment fan coolers and the piping which penetrates containment to perform their intended functions. Specifically, this concern addresses whether the liquid within containment

[1] For TMI-1 the containment air cooling water system to which the GL refers is the Reactor Building Emergency Cooling (RBEC) System which is comprised of three air handling units (AH-E1A/B/C) cooled by river water under accident conditions.
[2] The Loss of Coolant Accident (LOCA) and Main Steam Line Break (MSLB) inside containment are the only accidents which could add significant thermal energy to the containment. The Large Break LOCA was found to be the bounding accident for TMI-1.

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fan cooler cooling coils would boil leading to degraded heat transfer and possibly water hammer as well as whether heating of the liquid within the isolated piping penetrations could over-pressurize the piping. To assess the significance of this concern, GPU Nuclear evaluated the vulnerability of the fan coolers to void formation as well as the potential stresses on piping penetrations when isolated. The results of these evaluations were used to determine equipment operability as well as the need for procedure changes or design modifications. The following is a summary of our evaluations:

A. Containment Cooler Evaluations

In support of the efforts to evaluate the GL 96-06 issues a fan cooler model was developed to assess the vulnerability to void formation within the cooling coils and distribution piping. The GOTHIC computer code (version 5.0e) provides the analytical tool to model the fan cooler system. The model incorporates heat transfer to the cooling coils as well as the system piping within the containment for one train of the Reactor Building Emergency Cooling System. Relief valves (RR-V11A/B/C) which were located at the top of the cooling coils[3] have been relocated outside containment. Cooler isolation valves (RR-V4A/B/C/D) are provided at the system outlet[4] in an initially closed position. The Nuclear Services Closed Cooling System Surge Tank (NS-T1), which is normally connected to the inlet side of the piping for leak detection purposes provides an overpressure on the Reactor Building Emergency Cooling System piping inside containment. The surge tank would normally be available to provide an overpressure on the coolers during an accident. However, analysis has demonstrated that this overpressure is not required to prevent water hammer or two phase flow.

A variety of cases were analyzed using conservative worst case assumptions including: loss of offsite power with and without subsequent loss of air to the pressure control valve RR-V6[5] (loss of air causes RR-V6 to fail open), failure of the relief valve to close following actuation, inlet and discharge valves in either open or closed position, and with or without the overpressure normally provided by the NSCCW System. The conditions downstream of the RR-V4 valve are conservatively assumed to be at standard atmospheric conditions. The containment environmental conditions are based upon the bounding Equipment Qualification (EQ) temperature and pressure profiles. The coils and piping are initially assumed to be filled with liquid and maintained at a pressure of approximately (0 to 130) psig and a temperature of 130 °F. The temperature assumes thermal equilibrium between the stagnant fluid and the Technical Specifications maximum containment temperature (130 °F)[6]. The heating of the fluid causes it to expand raising the pressure to the relief valve setpoint. The relief valve opens relieving the pressure and closes several times prior to opening of the outlet valve.[7] During this time there is no voiding within the system as a direct result of the elevated pressure within the system being well above the saturation pressure of the fluid. As the outlet valve opens, further expansion of the fluid is accommodated by flow past the valve. The analysis reveals minimal (< 1%) voiding of the system during this evolution. The event is terminated upon start of the RBEC pumps (RR-P1A/B).

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[3] Each of the three cooling units contains a relief valve.
[4] RR-V4A and RR-V4B are the outlet isolation valves for Emergency Cooling Coils A and B respectively. RR-V4C and RR-V4D are provided as isolation valves in parallel for Emergency Cooling Coil C.
[5] Subsequent to modification during the 12R Outage, RR-V-6 now has a safety grade air supply.
[6] Normal Reactor Building temperature is approximately 90 °F.
[7] In the conservative case the relief valve is assumed to stick open.

Therefore, since our analyses show that only minimal voiding occurs even in the worst case design-basis accidents, neither two phase flow nor water hammer present a concern for TMI-1 containment air coolers.

B. Containment Penetration Pipe Section Evaluations

In this evaluation, a total of ninety seven (97) containment penetrations were identified for consideration. Each of these penetrations was reviewed against a specific set of criteria for susceptibility to the GL 96-06 concerns and ten (10) were found to be susceptible to the GL 96-06 concerns.[8] Those ten (10) piping segments which were determined to be affected are as follows: the "A" and "B" Once Through Steam Generator (OTSG) Sampling Lines, Intermediate Closed Cooling Water (ICCW) Return Line, Reclaimed Water Supply Line, Makeup and Purification Letdown Outlet Line, Pressurizer and Reactor Coolant Sampling Line, Reactor Coolant Drain Tank (RCDT) Transfer Line, Reactor Coolant Pump Cooling Return Line, and the "A" and "B" Core Flood Tank Sampling Lines.[9]

These pipe sections will have liquid trapped between two closed valves following an accident. The accident conditions inside containment will promote heat transfer and increase the pressure of the fluid trapped within the piping. The pressure increase will place stresses on the piping and could potentially challenge the integrity of the pipe and compromise containment integrity. A stress calculation was performed for each of the pipe sections identified to assess the potential impact on the primary containment integrity.

The first step in performing the pressurization analysis was to identify the appropriate initial fluid conditions prior to being exposed to an accident environment. The next step was to incorporate models of the piping systems into a containment model (GOTHIC) and analytically expose them to the accident. The computer model of the piping incorporates full heat transfer analytical capabilities. The peak fluid temperature is obtained in this manner for each pipe section and incorporated into the subsequent stress calculation. The stress calculation evaluates the fluid structure interaction using steam table properties and stress strain relationships of the piping material. The fluid pressure and piping stress for each piping segment is obtained using an iterative solution technique which solves for a fluid structure equilibrium condition.

It was found that seven (7) of the ten (10) affected piping segments could exceed material yield stresses, however none exceeded the ASME Section III, Appendix F criteria. Although the penetrations that were affected by the GL 96-06 concern remained operable, GPU Nuclear installed pressure relief devices during the 12R Outage to prevent the overpressure condition from occurring.

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[8] This event was reported in Licensee Event Report (LER) 97-001 as a condition that was outside of the design basis of the plant.
[9] Initially the Reactor Coolant Pump (RCP) Seal Water Return Line piping segment was found to be potentially susceptable; but it was later shown to be acceptable by additional calcuations.

C. Relief Valve Leakage Concerns

In evaluating the potential for overpressurization of isolated piping, the GL requested that any relief valves installed to prevent overpressure conditions be considered for flooding or radiation hazards in the event they were to lift and fail in the open position.

The RBEC System was the only system with relief valves (RR-V11A/B/C) that could relieve inside containment and contribute a significant amount of water to flood the Reactor Building during a design-basis accident if it were to lift and fail to close.[10] The source of leakage through RR-V11 is an unlimited supply of river water. Failure of an RR-V11 relief valve to close after opening was evaluated for post accident radiation hazards, flooding, and boron dilution concerns. Rather than rely upon operator actions to control this potential flooding event inside the Reactor Building, GPU Nuclear relocated the RR-V-11 relief valves to a location outside of the containment during the 12R Outage.

The details of our evaluations have been documented in a GPU Nuclear Technical Data Report (TDR) No. 1212. Therefore, GPU Nuclear has completed all of the actions required in response to GL 96-06.

Sincerely,

James W. Langenbach

James W. Langenbach
Vice President and Director, TMI

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cc: Administrator, Region I
TMI Senior Resident Inspector
TMI Senior NRC Project Manager

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[10] Other system piping with relief valves inside containment (e.g. Intermediate Closed Cooling Water, Decay Heat Removal, Core Flood, Nuclear Services Closed Cooling Water, Reactor Coolant System, etc.) have already been included in the Reactor Building flooding calculations or would remain isolated and therefore could not contribute a significant amount of water to flooding.

6L20-98-20063
Attachment

METROPOLITAN EDISON COMPANY
JERSEY CENTRAL POWER AND LIGHT COMPANY
PENNSYLVANIA POWER AND LIGHT COMPANY
GPU NUCLEAR INCORPORATED

Three Mile Island Nuclear Station, Unit 1 (TMI-1)
Operating License No. DPR-50
Docket No. 50-289

I, James W. Langenbach being duly sworn, state that I am a Vice President of GPU Nuclear, Inc. and that I am duly authorized to execute and file this response on behalf of GPU Nuclear. To the best of my knowledge and belief, the statements contained in this document are true and correct. To the extent that these statements are not based on my personal knowledge, they are based upon information by other GPU Nuclear employees and/or consultants. Such information has been reviewed in accordance with company practices and I believe it to be reliable.

James W. Langenbach
Vice President and Director, TMI

Signed and sworn before me this

13th day of February 1998.

Notary Public

Notarial Seal
Suzanne C. Midosik, Notary Public
Londonderry Twp., Dauphin County
My Commission Expires Nov. 22, 1999
Member, Pennsylvania Association of Notaries