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September 9, 1988
4410-88-L-0137/0414P

US Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555

Dear Sirs:

Three Mile Island Nuclear Station, Unit 2 (TMI-2)
Operating License No. DPR-73
Docket No. 50-320
Safety Evaluation Report for Completion of
Lower Core Support Assembly/Lower Head Defueling

By NRC Letter, dated August 11, 1988, the NRC staff commented on the subject Safety Evaluation Report which was submitted for NRC review and approval via GPU Nuclear 4410-88-L-0006 dated June 6, 1988. The attachment restates the NRC comment and provides the GPU Nuclear response.

Sincerely,

F. R. Standerfer
Director, TMI-2

RDW/emf

Attachment

cc: Senior Resident Inspector, TMI - R. J. Conte
Regional Administrator, Region 1 - W. T. Russell
Director, Plant Directorate IV - J. F. Stolz
Systems Engineer, TMI Site - L. H. Thonus

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ATTACHMENT
4410-88-L-0137

NRC COMMENT

"Your June 6, 1988 submittal included an evaluation of the lower head thermal response as a result of contact with a jet of molten materials falling into the lower head during the TMI-2 accident. The conclusions in the submittal are based upon the INEL report EGG-TMI-7811, 'Thermal Interaction of Core Melt Debris With The TMI-2 Baffle, Core-Former, and Lower Head Structures.' On pages 60-63 of that report, an evaluation was presented wherein it was assumed that heat transfer between the corium jet and the lower head was controlled by a convection process. However, the heatup of the lower head assumed a conductive process with transient temperatures being obtained using the Biot number. Such an approximation may be appropriate if the corium jet occurred in the center of the reactor vessel since any melted lower head material and the corium jet would accumulate in this region of the vessel. Since the TMI-2 corium jet occurred in the outer ring of the core, where there is significant curvature of the lower head, melted lower head material would be expected to be carried with the jet and settle in the bottom of the vessel. Thus, lower head material would be continuously exposed to the hot corium jet and abalation of the lower head would be controlled by a convective heat transfer process rather than the conductive process assumed in the analysis. This would result in increased abalation of lower head."

"Provide a revised analysis of the interaction between the corium jet and the lower head which accounts for this effect. If a decreased lower head thickness results, review its effect on other portions of your safety evaluation report and revise the report as appropriate."

GPU NUCLEAR RESPONSE

The apparent concern with the potential for a decreased Reactor Vessel (RV) lower head thickness due to corium jet ablation is whether the potential effect would be of such magnitude as to cause a loss of structural integrity of the RV lower head. Currently, no leakage of the RV lower head has occurred; thus, GPU Nuclear believes that the only safety concern regarding the NRC comment is whether a load drop on the ablated area could result in a loss of RV lower head structural integrity.

Visual examination of the TMI-2 core indicates that the corium flow was primarily through the baffle plates in the east-southeast edge of the core and down through the core former plates below the baffle plate break. Consequently, GPU Nuclear agrees with your premise that the jet stream may have fallen onto the RV lower head where the curvature of the head is steep enough to cause the corium stream and the ablated head material to have theoretically wash away faster than if it had fallen on a flat plate. However, the significance of this finding relative to the overall concern for lower head integrity, namely the potential of accidentally dropped objects penetrating the head and causing significant leakage, does not invalidate our conclusions. The following rationale supports the position that the RV lower head can sustain an accidental drop of the objects identified in Appendix A of Reference 1:

1. The large hole in the baffle plate, the corium buildup in the fuel assembly locations R-6 and R-7 in the lower grid, and the corium located at the bottom of incore guide tube number 45 indicate that the majority of melted corium flowing to the lower head used a pathway mostly outside the circumference or periphery of the active core.

2. Visual examinations of the periphery of the core support structure as viewed through the space between the bottom of the baffle plates and the top of the grid rib section and between the bottom of the grid rib section and top of the flow distributor plate show large accumulations of columns of solidified core material at and beyond the outside diameter of the core. This evidence demonstrates that molten core material not only passed through the core formers to the lower head, but also that this passage caused the molten material to spread out around the core periphery on its journey to the lower head. Visual examinations show that at least 180° of the core circumference contains large quantities of solidified material.

3. Experiments and mathematical evaluations presented in Reference 2 show that corium jet streams falling into water will break up and solidify more rapidly as their cross sectional area decreases. Therefore, it would be expected that as the TMI-2 melted fuel cascaded down through the core former plates and flowed through the outer periphery of the Lower Core Support Assembly (LCSA), it would impinge or strike the RV lower head in the form of many small jet streams as opposed to a single jet. Consequently, although the area of the vessel head ablation may be increased beyond that described in Reference 3, the depth of penetration would likely be less or at least no more severe.

4. Reference 3 states that if an ablation of one half of the thickness of the RV lower head occurred, loss of structural integrity of the vessel head would be expected. Since the RV lower head did not experience any leakage during the TMI-2 accident, it is highly unlikely that the thickness of the RV lower head was reduced by 50%. Further, Reference 3 calculated a direct jet impingement time of 15-20 minutes for melt ablation of about half the thickness of the RV lower head. While GPU Nuclear agrees that ablated material and molten corium will move away from the point of impact on a curved surface, time must be allowed for RV heat up after initial impact before RV material moves out of the impact area. It is expected that it would take 25 to 40 seconds before the RV surface would reach stainless steel melting temperatures and flow out of the impact area. Since the maximum jet impingement time calculated in Reference 3 is 75 seconds, GPU Nuclear concludes that any ablation of the RV lower head due to melted corium is bounded by the analyses in Reference 3.

5. Visual examinations of areas located directly under resolidified material in the LCSA, including that on the northside, have not shown any evidence of erosion of the RV lower head.

6. Most potential jet impact locations in the lower head, regardless of jet stream size, occurred outside the circumference or outer boundary of the active core. Consequently, any object which might fall into the RV would not be expected to strike the potentially ablated area. Therefore, head integrity would not be compromised.

Based on the above discussion, GPU Nuclear affirms the ability of the lower RV head, including any ablated areas, to withstand, notwithstanding that the corium jet fell on a curved surface, impact is bounded by the analysis provided in Reference 1.

REFERENCES

1. GPU Nuclear letter 4410-88-L-0006 dated June 6, 1988, "Safety Evaluation Report for Completion of Lower Core Support Assembly/Lower Head Defueling."

2. Paper presented at Fourth Miami International Symposium of Multi-Phase Transport and Particulate Phenomena, December 15-17, 1986, "Effect of Boiling Regime on Melt Stream Breakup in Water;" Spencer, Gaber, Cassulo; Argon National Laboratory.

3. EGG-TMI-7811, "Thermal Interaction of Core Melt Debris With the TMI-2 Baffle, Core Former, and Lower Head Structures."