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

OFFICE OF THE
SECRETARY

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July 27, 1984

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MEMORANDUM FOR: Parties to TMI-1 Restart Proceeding (Docket No. 50-289-SP)

FROM: Samuel J. Chilk, Secretary of the Commission

SUBJECT: NRC STAFF'S SAFETY EVALUATION OF SUBCOOLING CRITERIA FOR ACTUATING OR THROTTLING HIGH PRESSURE INJECTION (SECY-84-237)

The Commission has agreed with the Staff's first recommendation in the attached SECY paper, and hereby invites the comments of the parties on the conclusions reached in the Safety Evaluation. All comments must be received by this office no later than 5:00PM on Friday, August 24, 1984.

In connection with his vote on this matter, Commissioner Asselstine commented that he "would be particularly interested in comments on whether TMI-1 is being treated differently than other operating reactors regarding the subcooling criteria and, if so, what is the justification."

cc: EDO
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June 14, 1984

POLICY ISSUE
(Notation Vote)

SECY-84-237

FOR: The Commissioners

FROM: William J. Dircks, Executive Director for Operations

SUBJECT: THREE MILE ISLAND, UNIT 1 (TMI-1) RESTART CERTIFICATION

PURPOSE: To advise the Commission that the staff cannot, at present, complete action on one TMI-1 restart certification item because the installed system does not meet certain Appeal Board-imposed criteria, and to provide the staff's recommendation for resolving this matter.

BACKGROUND: In its decision on design issues (ALAB-729), the Appeal Board for the TMI-1 Restart proceeding, among other things, accepted the licensee's planned change in the criteria for actuating or throttling HPI from an indicated subcooling of 50°F to an indicated subcooling of 25°F, provided the subcooling margin monitor instrumentation error does not exceed 20°F, thus preserving the assumed 5°F physical configuration factor (ALAB-729, 17 NRC 814, 881 n. 315). The staff, following the methodology described at the June 15, 1983 Commission briefing, incorporated this item into the TMI-1 restart certification list by introducing certification item number 154 as presented in enclosure (1) to SECY 83-340 dated August 16, 1983.

The licensee, by submittal dated September 7, 1983, has reevaluated the subcooling margin monitor instrumentation string error and the physical configuration factor to account for instrument tap location below the top of the hot leg U-bends. These values are ±22.1°F and 1.3°F respectively or 23.4°F total which is within the 25°F value found acceptable by the Appeal Board and staff, but the ±22.1°F instrumentation string error exceeds the 20°F maximum specified in ALAB-729.

Contact:
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X28213

DISCUSSION:

In order to assure natural circulation following certain transient conditions, the high point in the reactor coolant system (top of the hot leg U-bends) should remain subcooled. The subcooling margin should account for the possible accumulated subcooling margin monitor instrumentation string error and for the detector location if it is not at the top of the hot leg U-bends (physical configuration factor).

The subcooling margin of 25°F was accepted for TMI-1 by the Appeal Board provided that the 20°F error in the TMI-1 instrumentation is not exceeded. GPU Nuclear subsequently provided an analysis indicating that the maximum subcooling margin monitor instrumentation string error may be as large as ±22.1°F, thus exceeding the Appeal Board imposed error limit. However, GPU Nuclear's analysis also concluded that the maximum physical configuration factor is 1.3°F rather than the 5°F previously assumed. Thus, the combined maximum effect of instrument error and physical configuration is 23.4°F, which is within the 25°F subcooling margin accepted by the Appeal Board.

The staff has reviewed the licensee's submittal and concludes, for reasons as set forth in the enclosed Safety Evaluation, that use of the 25°F indicated subcooling criteria for actuating or throttling HPI is acceptable for TMI-1.

RECOMMENDATION:

That the Commission: 1) Provide the enclosed Safety Evaluation to the parties to the TMI-1 Restart proceeding for comment, and 2) upon receipt and review of the parties comments, Approve the licensee's proposed criteria for reasons as set forth in the enclosed Safety Evaluation.

JW Roe

William J. Dircks, Executive Director
for Operations

Enclosure:
Safety Evaluation

Commissioners' comments or consent should be provided directly to the Office of the Secretary by c.o.b. Friday, June 29, 1984.

Commission Staff Office comments, if any, should be submitted to the Commissioners NLT Friday, June 22, 1984, with an information copy to the Office of the Secretary. If the paper is of such a nature that it requires additional time analytical review and comment, the Commissioners and the Secretariat should be apprised of when comments may be expected.

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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

THREE MILE ISLAND NUCLEAR STATION, UNIT 1

DOCKET NO. 50-289

SUBCOOLING CRITERIA FOR ACTUATING OR THROTTLING HIGH PRESSURE INJECTION

Introduction

By letter dated March 31, 1983, GPU Nuclear stated its intent to revise the criteria for actuating or throttling high pressure injection (HPI) flow from 50°F to 25°F indicated subcooling margin. These criteria had been an issue in the TMI-1 Restart hearing. The original 50°F subcooling margin criteria had been accepted on the assumption of a 45°F instrument error and a 5°F margin to saturation, which GPU Nuclear refers to as the "physical configuration factor". The motivation for the change in criteria is that GPU Nuclear has determined that a reduced subcooling margin allows better plant control during recovery from the events of interest. GPU Nuclear based the new 25°F subcooling margin criteria on a calculated instrument error of approximately 20°F and the assumed 5°F physical configuration factor. In ALAB-729, the Appeal Board for the TMI-1 restart hearing found the change acceptable provided the TMI-1 subcooling margin monitor instrumentation string error does not exceed 20°F. This instrumentation string error limitation preserves the original 5°F physical configuration factor. By letter dated September 7, 1983, GPU Nuclear provided a subsequent analysis indicating that the maximum subcooling margin monitor instrumentation string error may be as large as $\pm$22.1°F; thus violating the Appeal Board imposed provision for use of the new criteria. However, the submittal also provided a reanalysis of the actual physical configuration factor required to compensate for the difference in saturation temperature at the highest loop elevation and the saturation temperature at the elevation where the subcooling margin monitor instrument taps are located. This reanalysis concluded that the actual physical configuration factor is 1.3°F, rather than the previous 5°F factor. GPU Nuclear therefore concluded that the instrument uncertainty of $\pm$22.1°F, combined with a physical configuration factor of 1.3°F, still results in an overall indicated subcooling margin error less than the 25°F subcooling margin for actuating or throttling HPI. The staff evaluation of the GPU Nuclear analyses is provided below.

Evaluation

Instrumentation String Error

The GPU Nuclear analysis examined the subcooling margin monitor instrumentation components that use separate temperature and pressure signals to provide an indication of the subcooling margin. Each instrument in the string was identified along with those factors affecting instrument uncertainty (accuracy, linearity, supply voltage effects, ambient temperature effects,

radiation effects, repeatability, and dead band). GPU Nuclear first separated these factors into independent groups. Those uncertainties that were dependent on each other were algebraically added (as opposed to vectorially added) to obtain an independent group. For example, since the uncertainties associated with the supply voltage were considered dependent, they were added together when instruments were powered from a common supply. Independent groups of uncertainties were then combined by the root-summed-square method in order to arrive at an overall subcooling margin monitor uncertainty. Systematic errors were then added to the total. By this method, GPU Nuclear followed standard engineering practice for evaluating instrument uncertainties that the staff finds acceptable. This methodology has been approved and is used for the determination of safety system settings by the Instrument Society of America in ISA Standard S67.04.

The uncertainty values utilized by GPU Nuclear are bounded by two standard deviations for a two sided normal distribution. The use of these 95% confidence level values of uncertainty has been found acceptable by the staff in previous evaluations. For two cases, uncertainty values bounded by one standard deviation were used. The staff finds that proper justification was provided to validate their use in this analysis. Therefore, the staff finds that GPU Nuclear has properly determined the instrument uncertainty for the subcooling margin monitor.

HPI Actuation

The reactor coolant system (RCS) may become saturated under certain transient conditions. If saturation occurs, steam bubble formation in the top of the hot legs (the hot leg U-bends) may cause a loss of natural circulation which would make recovery more difficult. Operator action to actuate HPI before the hot leg U-bends become saturated acts to prevent or retard natural circulation loss. However, for certain accident conditions such as small break LOCA, steam bubble formation in the hot legs and loss of natural circulation are expected. The core, nevertheless, has been shown to remain adequately cooled for these accidents. Early HPI actuation provides an additional margin of protection for these events.

The hot leg U-bends will remain subcooled so that no steam bubbles will be formed as long as the indicated subcooling in the hot legs exceeds the sum of the instrument error and the loss in subcooling caused by the pressure drop between the instrument taps and the hot leg U-bends. The GPU Nuclear physical configuration factor analysis determined this pressure drop by considering gravity and friction losses between the hot leg U-bends and the saturation margin monitor pressure instrument tap location (appproximately 10 feet below the U-bends). This differential pressure

was determined to be 4.6 psi. The change in saturation temperature resulting from a differential pressure of 4.6 psi was then determined for a range of system operating pressures from 300 psia to 2100 psia. The resulting change in saturation temperature varied from 1.3°F at 300 psi system pressure to 0.3°F at 2100 psia system pressure. This yielded the maximum physical configuration factor of 1.3°F. Thus, as long as the indicated subcooling margin is greater than 23.4°F (22.1°F maximum instrument error plus 1.3°F physical configuration factor) saturation conditions at the top of the hot leg will be avoided. Based upon this analysis, GPU Nuclear concluded that the 25°F subcooling margin criteria for HPI actuating remains valid. The staff performed an independent calculation of the TMI-1 physical configuration factor and determined that the GPU Nuclear calculation is conservative. Therefore, since the 25°F subcooling margin criterion for actuating HPI is greater than the sum of the subcooling margin monitor instrument uncertainty and the physical configuration factor, the staff finds the criteria acceptable.

HPI Throttling

The principal concern in establishing HPI throttling criteria is that HPI only be throttled when the core is covered. Assurance that the core is covered is provided if the coolant above the core is subcooled. At TMI-1 the subcooling margin monitor instrument taps are at an elevation approximately 30 feet above core elevation. Thus, RCS pressure and therefore subcooling will be greater at core elevation than measured subcooling. (In fact, the elevation difference provides an additional margin of approximately 3°F between measured subcooling and actual subcooling in the core.) Therefore, since the subcooling margin monitor instrument error of +22.1°F is less than the HPI throttling criterion of 25°F subcooling, and since RCS subcooling is measured at an elevation above the core, the staff finds the 25°F subcooling criterion for HPI throttling to be acceptable for TMI-1.

Conclusion

The staff concludes for reasons as set forth herein that use of a 25°F subcooling margin criteria for actuating or throttling HPI is acceptable for TMI-1.

Dated: