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April 14, 1983

WRITER'S DIRECT DIAL NUMBER

822-1026

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Dr. Reginald L. Gotchy
Atomic Safety and Licensing Appeal
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Washington, D.C. 20555

In the Matter of
Metropolitan Edison Company
(Three Mile Island Nuclear Station, Unit No. 1)
Docket No. 50-289 (Restart)

Administrative Judges Edles, Buck and Gotchy:

In Mr. Baxter's absence I am enclosing as a notification to the Appeal Board a letter dated March 31, 1983, from Mr. H. D. Hukill, Director, TMI-1, to Mr. D. G. Eisenhut, Director, Division of Licensing, NRC, together with a copy of Mr. Eisenhut's letter to Mr. Hukill dated March 4, 1983, to which Mr. Hukill's letter responds. Mr. Hukill informs NRC of a planned change in the RCP trip setting and in the criteria for throttling HPI which were the subject of testimony and ASLB conditions in the TMI-1 restart hearing. After his return

DS03

to the office next week, Mr. Baxter will communicate further with the Appeal Board on the relationship of this change to the hearing record.

Respectfully submitted,

George F. Trowbridge
Counsel for Licensee

Enclosures

cc: Service List

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING APPEAL BOARD

In the Matter of	)	
	)	
METROPOLITAN EDISON COMPANY	)	Docket No. 50-289
	)	(Restart)
(Three Mile Island Nuclear	)	
Station, Unit No. 1)	)	

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March 31, 1983
5211-83-017

Office of Nuclear Reactor Regulation
Attn: D. G. Eisenhut, Director
Division of Licensing
U. S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Sir:

Three Mile Island Nuclear Station, Unit 1 (TMI-1)
Operating License No. DPR-50
Docket No. 50-289
RCS Trip on 25° Subcooling Margin

In response to your letter of March 4, 1983, GPUN intends to revise RCP trip criterion from 1600 psig ESAS to 25°F indicated subcooling margin by June 1, 1983. Enclosure 1 discusses the basis for a reduction in subcooling from 50°F to 25°F developed from plant specific error analyses. Enclosure 2 provides the basis for RC pump trip on subcooling margin. Enclosure 3 addresses RC pump operation criterion for normal, transient and accident conditions. These changes are in compliance with the requirements of 10 CFR 50.46 and improve the plant safety margins for certain non-LOCA events. Further, these changes do not involve a change to Technical Specifications or an unreviewed safety question and are, therefore, being implemented under 10 CFR 50.59.

Sincerely,

H. D. Hukill
Director, TMI-1

HDH:LWH:vjf
Enclosures
cc: R. C. Haynes
J. F. Stolz
J. Van Vliet

25°F Subcooling Margin

I. Background

Since the accident at TMI-2 the NRC and utilities recognized the need to maintain adequate subcooling margin. The NRC, through bulletins and NUREGs required each PWR Licensee to assure that adequate subcooling margin was maintained and in the long term to install a saturation margin monitor. Through coordination with the utilities a minimum margin of 50°F was established. For B&W units, the 50°F was based on an actual margin of 5°F (which allows for the differences in loop temperature of the highest elevation and the point where the hot leg temperature is measured) with a 45°F instrument error. The 50°F subcooling margin became the determining criterion for allowing throttling of HPI.

II. Analysis

GPUN has performed plant specific calculations of instrument string error using the Root Mean Square (RMS) method for subcooling margin at pressures greater than 300 psig. The calculations show that during normal and accident conditions (E.g., SB LOCA's), the maximum instrument string error is -18.7°F (+ 21.7°F). With the addition of the 5°F physical configuration margin, a 25°F subcooling margin is justified. During a Large Break LOCA the subcooling margin monitor is not required for RC pump trip. Further, HPI operation criteria is not dependent on the saturation margin monitor but rather LPI operation. In order to provide specific guidance to the operator, GPUN proposes that the 25°F subcooling margin monitor criteria be used and alarmed.

III. Discussion

Since the fall of 1979 analyses performed by GPUN and B&W have demonstrated that HPI initiation and throttling based on subcooling margin is adequate to ensure subcooling during the three main events of interest.

a. Small Break LOCA Events

The reduction in subcooling margin to 25°F during SB LOCA events allows better plant control during system recovery by allowing HPI throttling sooner. The lower subcooling margin allows a broader control band which permits the operator to maintain conditions with greater margins to possible overcooling conditions. The SB LOCA events are bounded by the analysis discussed in Sectiom II (Containment Temperature - 245°F, Containment Pressure -<30 psig, RH - 100% and dose - 5×10^4 R).

b. Steam Generator Tube Rupture Events

The primary to secondary leak rate during single and multiple tube ruptures is a function of primary to secondary differential pressure. The differential pressure is minimized with reduced subcooling margin and by primary depressurization operating the RC pumps. Figure 1 illustrates that by changing from a 50°F subcooling margin (with pumps off) to a 25°F subcooling margin (with pumps on) a 50% reduction in the amount of RCS leakage is attainable. Reduced integrated leakage will, as a consequence, reduce the dose to individuals on and off site.

c. Overcooling Transients

During overcooling events a reduced subcooling margin provides an increased operating band making it easier for the operator to stay within the presssure temperature limits.

For all other transient and accident conditions, there is no reduction in the safety margin or consequences of an accident as described in the FSAR. Mitigation of LOCA, tube rupture and overcooling events is not dependent on subcooling margin as a signal to initiate automatic plant protection. Since HPI is not automatically initiated for any events analyzed in the FSAR besides LOCA, tube rupture and overcooling events; HPI throttling does not affect the consequences as analyzed in the FSAR (See Table 1).

IV. Conclusion

Maintaining a minimum of 25°F indicated subcooling margin assures that the RCS is subcooled during normal, transient and accident conditions. Therefore, HPI initiation and throttling may be based on 25°F subcooling margin without a reduction in plant safety. Furthermore, a reduction in subcooling margin from 50°F to 25°F reduces the primary to secondary leak rate, integrated leakage, dose rate and integrated dose resulting from a tube rupture event and, therefore, increases plant safety.

V. References:

1. NRC letter dated 23, 1979 "Meeting Minutes for October 12, 1979".
2. Letter from Warren J. Hall to Darrell G. Eisenhut dated March 31, 1982, Question 1.13.

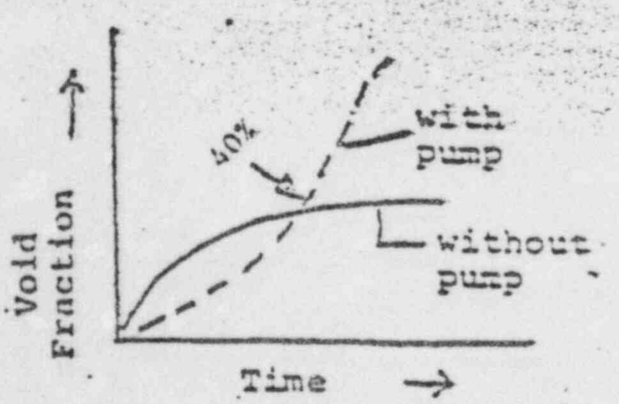
RCP Trip

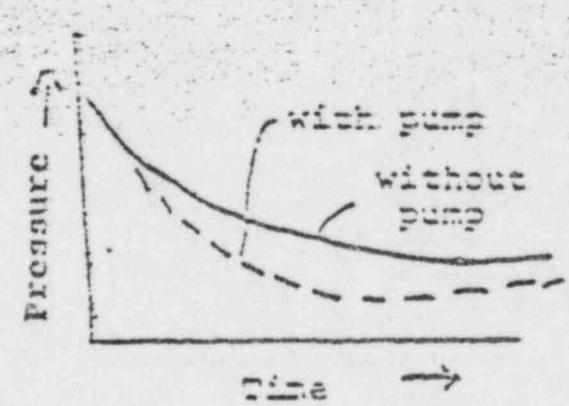
I. Background

Based on initial analyses received from PWR vendors, NRC concluded in NUREG 0623 that delayed trip of reactor coolants pumps during a small break LOCA can lead to predicted fuel cladding temperatures in excess of current licensing limits. B&W examined what would happen if the reactor coolant pumps were tripped at some time into the accident when the system void fraction was high. They arbitrarily assumed that the pumps were tripped when the system void fraction was 90%. At the time of pump trip the liquid that was previously dispersed around the primary system through pumping action now collapsed down to low points of the primary system such as the bottom of the vessel and steam generators. This resulted in significant uncovery of the reactor core, due to an insufficient amount of liquid being available to provide acceptable core cooling. Due to design features as well as temporal behavior of system void fraction, B&W concluded that unacceptable consequences would result from delayed reactor coolant pump trip only for a range of small breaks (.025 to 0.25 ft^2) and a range of trip delay times after accident initiation. Based on these findings, a meeting of utility vendors and owners was held with NRC in September 1979. At this meeting it was agreed that the 1600 psig ESAS signal provided timely Control Room indication for manual action to prevent possible voiding scenarios.

II. Analysis

In a recent B&W's analysis, various RCP tripping schemes were investigated. They included saturation margin, coincidence ESAS/Tsat, low low pressure and void fraction. The saturation margin scheme was chosen by GPUN since this signal results in fewer pump trips during overcooling events and if the saturation margin is suitably low, in no pump trips during design basis tube rupture events or very small break LOCA's. The results of the analysis centered around a review of void fraction for pumps on/off conditions.





The above schematics illustrate that the system will initially be less voiced as well as at a lower pressure with pumps running. These results occur because the continued operation of the RC pumps keeps the coolant circulating throughout the loops providing better steam generator heat transfer and lower hot leg temperatures. The lower system pressure with the pumps running during the initial phases of the transient results in a decreased leak flow and thus a lower void fraction. However, the continuous operation of the RC pumps results in lower quality discharge through the break which eventually offsets the decreased pressure effect on the leak flows. Thus, the fluid in the primary system ultimately evolves to a high void fraction for certain break sizes as a result of the continued RC pump operation. The studies done by B&W show that the crossover point between the pumps on and off cases occurs at 40% system void fraction independent of the break size.

Loss of subcooling margin in the hot leg occurs well before the RCS void fraction can become large enough to threaten core uncovery. Therefore, the use of the subcooling margin is an acceptable alternative to 1600 psig ESAS.

III. Discussion

Since the fall of 1979, analyses performed by GPUN and B&W have demonstrated that Reactor Coolant Pump trip on subcooling margin accomplishes the original objective of tripping RCP's without decreasing safety margin for the three main events of interest.

a. Small Break LOCA

The change in parameters from low pressure ESAS actuation to loss of subcooling margin accomplishes the original objective of tripping the RCPs for small break LOCAs. For the break sizes of concern, a loss of 25°F subcooling margin will occur slightly before low RCS pressure actuation of ESAS. The operator has essentially the same time to trip the pumps at the onset of saturation as with the current ESAS actuation criteria. A review of the SB LOCA analysis indicates that the basis for RCP trip was 20% void fraction.

b. Steam Generator Tube Rupture Events

During Steam Generator Tube Ruptures in which minimum subcooling margin is maintained, continuous RC pump operation assures expeditious cooldown with a minimum primary to secondary differential pressure. This change in criteria for RCP trip will allow RCP's to be operated for a greater spectrum of tube ruptures (including ruptures beyond the design basis) and to reduce the offsite doses for those events.

c. Overcooling Transients

For overcooling events in which the pressurizer does not empty, the subcooling margin does not drop below 25°F even though RCS pressure is below the ESAS initation setpoint (1600 psig). When combined with our proposed RCP trip criteria, the RCP's will remain operational, thereby precluding void formation in the hot legs and minimizing formation and duration of voids in the reactor vessel head. Furthermore, RCP operation allows continued use of Main Feedwater in lieu of Emergency Feedwater and

the use of pressurizer spray to control RCS pressure during recovery from the overcooling transient. Table 1 illustrates that the 25°F subcooling margin is not lost for any event in which forced RC flow is required for event mitigation. Therefore, the operator would not be forced to terminate forced flow when it had previously been taken credit for in FSAR analysis.

IV. Alarm

In addition, a Control Room alarm will be adjusted to annunciate if either subcooling margin monitor indicates less than 25°F. The plant computer also independently computes pressure and temperature saturation margin for logging, trending and alarm.

V. Conclusion

The change in RC pump trip from low pressure ESAS actuation to loss of subcooling margin:

o ensures RC pumps are turned off when required which assures no decrease in safety.

o permits RC pump operation for some overcooling events which increases plant control.

o permits RC pump operation for more tube rupture events (including those beyond design basis) which increases safety by decreasing leakage and expediting plant cooldown.

VI. Reference

1. "Evaluation of Transient Behavior for Small Reactor Coolant System Breaks In 177 FA Plants", dated May 7, 1979.

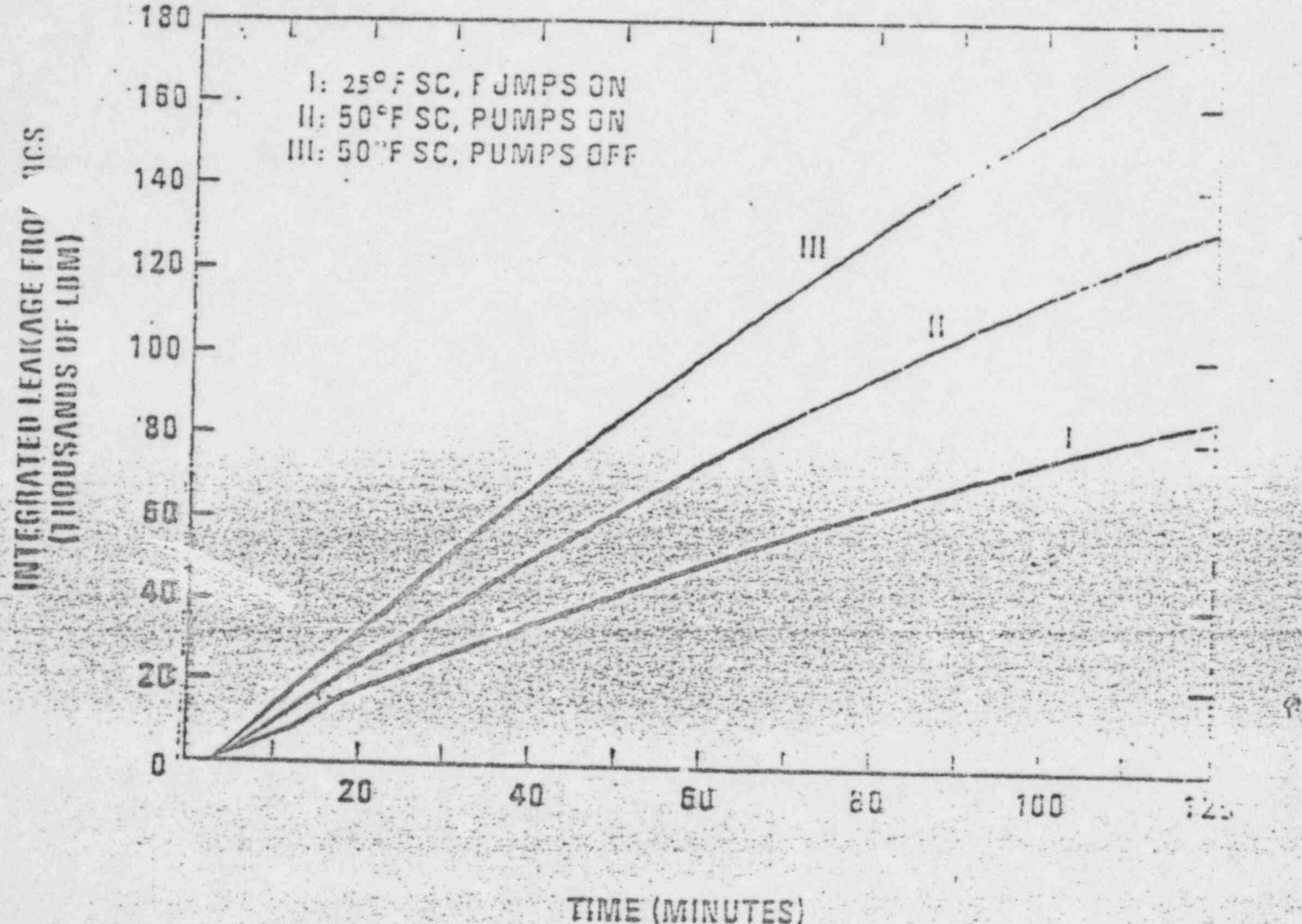
TABLE 1

Accident or Transient	HPI For Event Mitigation	Forced Flow Assumed in FSAR	25°F SCM Reached During Event
Rod Withdrawal			
Power	No	Yes	No
Startup	No	Yes	No
Boron Dilution	No	Yes	No
Cold Water Addition	No	Yes	N/A
Loss of Flow	No	No	N/A
Dropped Rod	No	Yes	No
Loss of Elec. Load	No	No	N/A
Blackout	Yes	No	N/A
Steamline Failure	Yes	*	See Discuss. (Encl. 1, III.c)
Tube Rupture	Yes	Yes	No
Fuel Handling	No	N/A	N/A
Rod Ejection	Yes	Yes	Yes
Feedwater Line Break	No	No	No
Waste Gas Decay Tank Rupture	No	N/A	No
SB LOCA	Yes	See Discuss.	See Discuss.
Large Break LOCA	No	No	Yes

*Analyzed with and without RCP operation.

FIGURE 1

Effect of RC Pump Trip Criterion on Integrated System Leakage for Single Ruptured Tube



SC - Subcooling

RC Pump Operating Criteria

1. RCP Operations - Trip

A. Set points for RCP Trip

1. Forced Flow

Table 1 of enclosure 2 provides an accident/transient summary matrix for which forced flow is assumed. Note, specifically, that RCS flow is assumed for design basis tube ruptures and that for a 25°F subcooling margin trip setpoint RCP trip does not occur. Further, tripping RC pumps on 25°F subcooling margin reduces trips for non LOCA events for which continued RC pump operation is desirable.

2. Voided System

By tripping pumps on 25°F subcooling margin, operation of RC pumps in a voided system is precluded.

3. PORV Challenges

TMI-1 will use a manual operator RCP trip which avoids inadvertent trips by automatic systems. Experience in the utility industry since the TMI-2 accident has shown that inadvertent operator initiation has a very low probability of occurrence. Tripping RCP's on 25°F subcooling margin reduces spurious RCP trips, thereby reducing challenges to the PORV for non-LOCA events since pressurizer sprays is available to control RCS pressure.

4. Hot Stagnant Fluids

The addition of 5°F margin to the instrument error calculation summarized in enclosure 1 of this letter provides sufficient margin to preclude saturation conditions in the RCS due to physical location of the sensors. Current plant emergency procedures discuss operation in a voided condition and removal of voids that result from flashing. Operator training specifically addresses these procedures.

5. RCP Services

As described in section 2.1.1.5 of the TMI-1 Restart Report injection water to the RC pumps is capable of being restored following containment isolation. In the event that the cooling water to the pumps is lost, the injection water provides adequate cooling for the seals and the pump can be operated indefinitely if the seal injection is functioning normally.

The saturation margin monitor which is part of the ICC Instrumentation system will be used for indication of 25°F subcooling margin for RCP trip.

B. Justification for Manual RCP trip

1. Conformance with 10CFR 50.46

A generic analysis has been performed by B&W which envelops TMI-1. This analysis is summarized in Section II of enclosure 1.

2. Most Probable Best Estimate

Since there is no substantial change in time to trip RCP's for the worst case SB LOCA under the 1600 psig criteria or the 25°F subcooling margin and in the time for the operator to respond to the initiating signal, this analysis is not considered necessary.

C. Other Considerations

1. Instrumentation

The saturation margin monitor and alarm are addressed in section 2.1.16 of the TMI-1 Restart Report. This instrumentation will be upgraded to safety grade during the Cycle 6 refueling.

2. Pump Restart

Small break LOCA and other emergency procedures will be updated to reestablish the RCP restart criteria from 50°F to 25°F.

3. Training

Training on RCP operation during transients and accidents is integral to the training program on emergency procedures which includes simulator training.

II. Summary of 10CFR 50.59 Evaluation

1. The probability of occurrence or the consequences of an accident or malfunction of equipment important to safety previously evaluated in the Safety Analysis Report has not increased. Enclosures 1 and 2 provide a summary analysis of those events of concern and Table 1 address all accidents evaluated in the FSAR Chapter 14. In fact, by tripping RC Pumps on 25°F subcooling margin, greater control and reduced consequences occur. No additional equipment is added by this change nor affected which would lead to a malfunction.

2. The possibility for an accident or malfunction of a different type than any evaluated previously in the Safety Analysis Report is not created. All credible events analyzed are enveloped by existing FSAR events and no new unanalyzed events are created.

3. The margin of safety as defined in the basis of any Technical Specification is not reduced. RCP trip and pressure temperature limits

Tech Spec bases have been carefully evaluated as indicated in Enclosures 1 and 2 with no resulting reduction in safety margin. For certain events the safety margin has been increased.

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

March 4, 1983

Docket No. 50-289

Mr. Henry D. Hukill
Vice President
GPU Nuclear Corporation
P. O. Box 480
Middletown, Pennsylvania 17057

Dear Mr. Hukill:

The purpose of this letter is to inform you of (1) the staff's conclusions regarding your analysis of LOFT Test L3-6, (2) the continued acceptability of your ECCS evaluation model for predicting small break LOCAs with Reactor Coolant Pump (RCP) operation and (3) criteria for resolution of TMI Action Item II.K.3.5, "Automatic Trip of Reactor Coolant Pumps."

We have completed our evaluation of your analyses of LOFT Test L3-6 and conclude that the evaluations acceptably predict the test results. Therefore, we find the currently approved B&W evaluation model for small break LOCAs in continued conformance with Appendix K to 10 CFR 50 for the case of limited RCP operation after reactor trip and for the range of licensed B&W reactor designs.

We have reviewed industry analyses and performed our own analyses to determine whether RCP trip is necessary during LOCAs, and evaluated the desirability of continued RCP operation during non-LOCA transients and accidents, including steam generator tube ruptures. We have concluded that there is a wide range of transients and LOCAs where it is beneficial for the operators to maintain forced circulation cooling and mixing through operation of the RCPs. However, some of the calculations show that for certain small break LOCAs, primarily those with only one of the two High Pressure Safety Injection (HPSI) Pumps assumed available, continued operation of the RCPs or continued operation of the RCPs followed by delayed RCP trip could lead to core damage.

Some uncertainty in these conclusions remains. Specifically, there is a complex interrelationship among break size, break location, RCP trip delay time, available safety systems, and peak cladding temperature (PCT) for each type of NSSS design. Moreover, although the staff's and each vendor's calculational models adequately predicted LOFT test L3-6, there appear to be subtle differences embedded in the computer models which, when applied to large, commercial, PWR designs, yield differing results regarding the necessity for RCP trip during small LOCAs.

Because of this, we place substantial weight on the views of the reactor designers and the utilities which are almost unanimous in asserting that for some small LOCAs with less than the maximum available HPSI flow, delayed RCP trip could lead to core damage. Some utilities indicated their preference to keep the RCPs running for all events; however, this view appeared to be based solely on the desire to maintain forced circulation and did not consider the consequences of delayed RCP trip.

While acknowledging the industry's general conclusion that the RCPs should be tripped for small LOCAs, both the staff and the industry recognized that there are other accident sequences of much higher probability than the small LOCA where the absence of forced circulation makes the operator's job more difficult and can increase the likelihood of operator errors. For this reason, we believe that a balance should be struck between the competing risks associated with tripping the RCPs early and leaving them running following transient and accident events.

Based on our discussions with both licensees and the reactor manufacturers, and our internal evaluations, we believe that appropriate pump trip setpoints can be developed by the industry that would not require RCP trip for those transients and accidents where forced circulation and pressurizer pressure control is a major aid to the operators, yet would alert the operators to trip the RCPs for those small LOCAs where continued operation or delayed trip might result in core damage.

In summary, we have concluded that the need for RCP trip following a transient or accident should be determined by each licensee on a case-by-case basis, considering the Owners Group input. However, the staff must ensure that whatever decision is made regarding pump operation, it will result in safe, reliable operation of reactors and will not adversely affect the ability of licensees to comply with the Commission's rules and regulations.

The enclosure to this letter provides guidance for the development of either (1) satisfactory setpoints for RCP trip or (2) the technical bases for allowing continued RCP operation in the event of a small LOCA at a licensee's facility. As stated in the enclosure, manual tripping of the RCPs for a LOCA can be allowed under certain conditions.

We recognize that possible differences exist between the requirements of 10 CFR 50.46, which assure ample core cooling capacity, and the approaches described in the enclosure which are based upon assuring proper operator/ system response under conditions that may be faced during accidents and transients. Accordingly, in such cases, we will consider a request for exemption from specific requirements of 10 CFR §50.46 pursuant to 10 CFR §50.12.

For the purpose of providing uniformity of setpoints and methods and for minimizing potential confusion that could arise because of diverse actions by individual licensees, we strongly urge that licensees work collectively with owners of similar plants (i.e., owners group) and propose setpoints and methods consistent with other licensees.

If a licensee elects to trip RCPs, when RCP trip setpoints are developed which are believed to substantially meet the guidance provided in the enclosure, we encourage licensees to begin implementation of these new setpoints at operating plant(s)*. We caution that careful judgment should be used when developing proposed methods and setpoints in accordance with the guidance in the enclosure. If RCPs are to be tripped, we recommend that the licensees utilize event trees to systematically evaluate RCP trip setpoints to minimize the potential for undesirable consequences due to a misdiagnosed event.

Specifically, we recommend the setpoints be evaluated for events where the RCPs could be tripped when it is preferable they remain operational. We further recommend the setpoints also be evaluated for the case when the RCPs are not tripped early in the event and for which a delayed trip may lead to undesirable consequences.

We are not requiring a formal submittal of the analyses which support either RCP trip setpoints or the decision to leave the RCPs operational for all events. However, once the technical bases for the decision are established, we intend to conduct inspections of individual licensees led by Regional personnel. During these inspections, we will examine the translation of the 10 CFR 50, Appendix K, and RCP operation mode evaluations into plant procedures. We would expect the evaluations to include consideration of the guidance contained in the enclosure to this letter. Copies of these evaluations should be made available to the staff at these inspections.

Alternatively, a licensee may choose to make either an individual submittal or reference a generic (i.e., owners group) submittal which provides the technical justification for treatment of RCPs during transients and accidents. In that case, an inspection would not be necessary.

The requirements set forth in this letter supersede the actions required in IE Bulletins 79-05C and 79-06C.

*Unless implementation entails a change to technical specifications or an unreviewed safety question, which require NRC approval prior to implementation.

Accordingly, within 60 days following receipt of this letter, please provide your plans and schedules for resolution of this issue for your facility. You should also indicate whether you desire to make a submittal concerning this issue. If you cannot respond within 60 days, you should indicate within 30 days when your schedule will be submitted. The information requested should be sent to Mr. D. G. Eisenhut, Director, Division of Licensing, Washington, D.C. 20555 pursuant to 10 CFR §50.54(f).

This request for information was approved by the Office of Management and Budget under clearance number 3150-0065 which expires May 31, 1983. Comments on burden and duplication may be directed to the Office of Management and Budget, Reports Management, Room 3208, New Executive Office Building, Washington, D.C. 20503.

If you believe further clarification regarding this issue is necessary or desirable, please contact Dr. B. Sheron (301-492-7460).

Sincerely,

Darrell G. Eisenhut, Director
Division of Licensing

Enclosure:
Resolution of TMI Action
Item II.K.3.5

cc w/enclosure:
See next page

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RESOLUTION OF TMI ACTION ITEM II.K.3.5

The NRC, its licensees, and the PWR vendors have been evaluating the reactor coolant pump (RCP) trip issue since the accident at TMI. The technical understanding of the industry and the requirements of NRC on this issue have changed twice in that period. As a result, there have been extensive studies to better understand the dynamic response of all classes of PWRs to small break LOCAs. Although some confirmatory information is still to be received concerning some models, we conclude that the analytical models are sufficiently reliable to be used by licensees to choose their own best method for RCP operation upon indication that a LOCA has occurred.

In developing methods for RCP operation (i.e., trip or leave running) during all transients and accidents, we recommend addressing the following items that have been identified by the staff as part of our review of this issue.

We have separated these items into two groups: Those associated with RCP operation criteria which could result in RCP trip during transients and accidents, and those associated with pump operation criteria which allow the RCPs to remain running during transients and accidents, including small break LOCAs.

I. Pump Operation Criteria Which Can Result in RCP Trip During Transients and Accidents

The staff has concluded, that, if sufficient time exists, manual action is an acceptable means for tripping the RCPs following a LOCA. We have based this conclusion in part upon our own probabilistic assessment. It

showed that the failure of a designated operator to trip the RCPs within five minutes following receipt of a RCP trip signal is approximately six times more likely than is the failure of an automatic trip. Our probabilistic assessment was limited by a lack of comprehensive information about the complex interrelationships among break size, break location, RCP trip delay time, available ECC systems, and peak cladding temperature (PCT) for each type of NSSS. A complete map of this interrelationship for each design would be prohibitively expensive to generate (tens of computer runs for each design at thousands of dollars per run and hundreds of hours of analyst time). Without such a map, we cannot accurately define the bounds of the region where unacceptable consequences might result from delay in RCP trip. However, based on our understanding of the phenomena in question, analyses performed by the NSSS vendors, limited independent analyses performed by the staff, tests performed in both Semiscale and LOFT, and our probability assessment, we conclude that allowing manual RCP trip is acceptable provided certain conditions are satisfied. Our guidelines for RCP trip setpoints and methods are set forth below. In developing RCP trip setpoints and methods, there are two potential problems with RCP trip that continue to show up in reactor operations. The first problem is caused by the fact that the loss of pressurizer sprays upon RCP trip for transients and for small break LOCAs results in a need in some plants to use power operated relief valves (PORVs) for primary system pressure control. Despite extensive testing of prototypes and improved reliability engineering, these valves continue to show a high propensity for failing to close. Although the question of PORV functionality has been better characterized by the EPRI

valve testing program since the accident at TMI, there does not appear to be significant progress in improving the overall operational reliability of PORV systems. A second problem associated with RCP trip is that it tends to produce a stagnant region of coolant in the upper elevations of the reactor vessel. In a number of recent operational events, this hot, stagnant fluid has flashed and partially voided the upper vessel region during depressurization or cooldown situations. Despite wide dissemination of information about these operating events and the learning opportunites that they present, we still perceive that operators (1) are not completely familiar with the significance of a steam bubble in the upper head, (2) have difficulty controlling coolant conditions so as to avoid or control flashing where possible, and (3) may have a tendency to take precipitous actions when a steam bubble exists.

In developing your RCP trip setpoints and methods, the following guidelines should be considered:

1. Setpoints for RCP Trip

   a) The setpoints should be designed to assure that the RCPs will be tripped for all losses of primary coolant in which RCP trip is considered necessary. The setpoints should also ensure continued forced RCS flow during steam generator tube ruptures up to and including the design basis tube rupture. Safety analyses should be performed to demonstrate the achievement of these goals. The symptoms and signals used to alert an operator of the need to manually trip RCPs should be, to the extent possible, uniquely attributable to LOCAs and not other depressurizing transients and actions for which continued pump operation is desirable. In this regard, consideration should

be given to partial or staggered RCP trip schemes (e.g., in two loop, four pump plants, trip one pump per loop immediately and trip remaining pumps once the existence of a LOCA is confirmed). If selected pumps are tripped during the initial phase of the transients, licensees should assure that training and procedures provide direction for use of individual steam generators with and without RCPs in operation. Your evaluation should be capable of demonstrating and justifying that the proposed RCP trip setpoints are adequate for small LOCAs but will not result in RCP trip for other non-LOCA transients and accidents (e.g., steam generator tube ruptures).

b) The RCP trip setpoints should be selected so as to exclude extended RCP operation in a voided system (e.g., pump head degradation >10%) unless engineering analyses or tests are available to justify that RCP and RCP seal integrity will be maintained under those conditions.

c) If, for some transients and accidents within the current design basis, and with offsite power available, the setpoints selected will lead to RCP trip even though it is neither required nor desirable, it should be assured that these events will not result in challenges, either automatic or from the operators, to the PORVs to accomplish depressurizing actions normally accomplished by pressurizer sprays. Heated

auxiliary spray capability not derived from RCP discharge pressure could be considered as one possible means of eliminating this reliance on the PORVs. On the other hand, if PORV operation is continued to be recommended for use in depressurization, then a program for upgrading the operational reliability of the PORVs should be developed.

d) For any conditions which require or result in RCP trip and the establishment of a hot, stagnant, fluid region at high points in the primary system, emergency procedure guidelines and emergency procedures should specifically describe symptoms of primary system voiding due to flashing of stagnant regions of hot coolant. They should also contain specific guidance on detecting, managing and removing the coolant voids that result from flashing. Operator training programs should specifically address the significance of primary system voids under non-LOCA and LOCA conditions.

e) Transients and accidents which produce the same initial symptoms as a LOCA (i.e., depressurization of the reactor and actuation of engineered safety features) and result in containment isolation may result in the termination of systems essential for continued operation of the reactor coolant pumps (i.e., component cooling water and/or seal injection water). It was the intent of TMI Action Plan

Item II.E.4.2 to have licensees reevaluate essential and non-essential systems with respect to containment isolation. In particular, if a facility design terminates water services essential for RCP operation, then it should be assured that these water services can be restored in a timely manner once a non-LOCA situation is confirmed, and prevent seal damage or failure.

It should be confirmed that containment isolation with continued RCP operation will not lead to seal or pump damage or failure.

f) Parameters used to determine when RCPs should be tripped should provide unambiguous indicators of a LOCA. The inadequate core cooling instrumentation required by the Commission and described in NUREG-0737 should be factored into the emergency procedure guidelines where useful in indicating the need for RCP trip.

2. Guidance for Justification of Manual RCP Trip

Our review of this subject leads us to conclude that, when tripping the pumps is recommended by the licensees, it is preferable to manually (rather than automatically) trip the reactor coolant pumps where it is at all possible to justify it. However, our review indicates that there may be a few plants for which it is not possible to justify manual trip because of reliability considerations. The guidance stated below is intended to assist

those plants that can and should rely on manual trip to develop complete justification for and to clearly identify those few plants that may not be able to rely on manual trip.

a) Based on the RCP trip setpoints developed according to the guidance in item one above, analyses* should demonstrate that the limits set forth in 10 CFR 50.46 are not exceeded for the limiting small break size and location. For the purposes of showing compliance with 10 CFR 50.46, operator action to trip the RCPs should be assumed no earlier than two (2) minutes following the onset of reactor conditions corresponding to the RCP trip setpoint. Allowances should be made for instrument error.

b) If manual RCP trip is proposed, then for the limiting small break size(s) and location(s) identified from (a) above, a most probable** best estimate analysis of the amount of time available to the operator to trip the RCPs following the existence of the RCP trip signal should be performed. If this time is less than that recommended in Draft ANSI Standard N660, the acceptability of this time should be justified. An evaluation of operating experience data should

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*Generic analyses of general reactor types is acceptable in lieu of plant specific analyses. The generic analyses should be shown to bound plant specific evaluations.

**Each licensee should identify and justify the most probable plant conditions. Conservative estimates are acceptable in the absence of justifiable most probable plant conditions.

be included when addressing this justification. The consequences if RCP trip is delayed beyond this time should also be addressed. Contingency procedures should be developed and be available to the operator in the event the RCPs are not tripped in the preferred time frame. If the time available is in excess of the standard, no further justification is necessary.

3. Other Considerations

Although acceptance criteria in the following areas are not specified, assurance that they have been considered and good engineering practice has been followed will be required.

a) For the parameter(s) employed in the RCP trip setpoint, the level of quality for the instrumentation that will signal the need for RCP trip should be established. In particular, the basis for the following should be identified:

- The design features chosen for the sensing instruments (e.g., seismic and environmental qualifications, reliability, etc.).

- The degree of redundancy in the sensing instruments.

In general, credit may be taken for all equipment available to the operators and for which sufficient confidence in its operability, during conditions under which it is expected to operate, has been established.

b) It should be ensured that emergency operating procedures exist for the timely restart of the reactor coolant pumps when conditions which will support safe pump operation are established.

c) The training program should instruct operators in their responsibility for performing RCP trip in the event of a SBLOCA. In particular, the operators should be trained in prioritization of actions following engineered safety features actuation.

II. Pump Operation Criteria Which will not Result in RCP Trip During Transient and Accidents

It is recognized that an evaluation could lead to the conclusion that, based on competing risks, both the preferred and safest method of pump operation following a transient or accident event would be to have the pumps running. In order to substantiate this conclusion, the following evaluation guidelines should be considered:

1. Evaluation of Inventory Loss

The industry analysis model comparisons against LOFT test L3-6, while providing good agreement with the experimental data, require additional verification to support continuous pump operation for all transients and accidents, including small break LOCAs. These include:

- Completing evaluations of LOFT L3-6 through the ECCS recovery phase, if not already completed;

o Evaluating all modeling differences which are expected to exist between the LOFT prediction and the large plant analysis (e.g., for B&W plants, how does primary system geometry affect conclusions? Can smaller scale, two-phase, side entry pump performance data be confidently extrapolated to large, bottom entry pumps, in particular in the high void fraction regions?).

2. Pump Integrity

a) During periods of extended two-phase performance, pump integrity is a chief concern (during the TMI-2 accident, one of the operating RCPs was finally tripped due to excessive vibration). The evaluation should conclude why RCP seal and RCP structural integrity will be assured during extended two-phase flow performance. If RCP and/or RCP seal integrity cannot be assured, then the consequences of their failure should be considered in the analyses.

b) If continuous RCP operation is expected in the presence of a containment isolation signal, the ability for continuous RCP operation without essential water services should be addressed, or the capability to rapidly restore essential water services should be provided.

c) The ability of the RCPs to operate in the accident environment (e.g., containment temperature and humidity) should be addressed. If continuous operation in the accident environment cannot

be assured, then the consequences of failure at any time during the course of the accident should be addressed.

3. Acceptability of Results

Analyses should be performed which demonstrate that the ECCS acceptance criteria of 10 CFR 50.46 are met using an analysis model which complies with the requirements of Appendix K to 10 CFR 50. These analyses should assume (a) continuous RCP operation, and (b) assumed RCP trip at various times during the accident if continuous pump operation cannot be assured. If the analyses indicate compliance with the criteria of 10 CFR 50.46 cannot be achieved, the staff will consider a request for an exemption to the 10 CFR 50.46 requirements if (a) it is concluded that compliance with 10 CFR 50.46 would require operating the plant in a less safe condition, (this should be supported with risk/benefit analyses), and (b) it is concluded that design modifications (e.g., additional HPI capacity) would not be cost-effective to implement from a safety standpoint.

The risk-benefit analyses can take credit for all equipment for which there is confidence that this equipment will remain operational during the accident.