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July 8, 1988
C311-88-2087

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

Dear Sir:

Three Mile Island Nuclear Station, Unit 1 (TMI-1)
Operating Licensing No. DPR-50
Docket No. 50-289
GPUN Response to NRC Bulletin 88-04, "Potential Safety Related Pump Loss"

NRC Bulletin 88-04, entitled "Potential Safety Related Pump Loss" requested licensees to investigate and take the necessary corrective actions in response to two miniflow design concerns.

The first concern involves the potential for the dead-heading of one or more pumps in safety-related systems that have a miniflow line common to two or more pumps or other piping configurations that do not preclude pump-to-pump interaction during miniflow operation. The second concern involves the adequacy of the installed miniflow capacity including the operation of a single pump.

Currently GPUN has completed its evaluation of NRC Bulletin 88-04 except for the Decay Heat Removal (DHR) Pumps. Our response to each of the items requested in the bulletin are included in Attachment 1.

As a result of our evaluation to date, GPUN concludes that all TMI-1 safety-related systems with the minimum recirculation arrangement precludes any significant pump-to-pump interaction or situations in which a "strong" performing pump would dead-head a "weak" performing pump during parallel pump operation in minimum recirculation. We have also determined that all pumps in TMI-1 safety-related systems that we have evaluated to date, which have the minimum recirculation arrangement, currently have adequate minimum recirculation flow in accordance with the pump specifications. We intend to complete our evaluation of the DHR pumps by August 1, 1988.





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As requested in the bulletin, GPUN is contacting the respective pump vendors to document the specified minimum flow requirements and confirm our assessment that these requirements are acceptable. We are requesting a response from the manufacturers by September 11, 1988. However, we do not have schedule commitments at this time. If the information received from the manufacturers confirms our own evaluations and conclusions, we do not anticipate a separate submittal to report these confirmations.

We are continuing our evaluation of the DHR pumps and will report the results by August 1, 1988.

Sincerely,

H. D. Hukill
Vice President and Director, TMI-1

Attachments

HDH/MRK

cc: J. Stolz
R. Hernan
R. Conte
W. Russell

Sworn and subscribed to
before me this 8th
day of July, 1988.

Linda L. Ritter

LINDA L. RITTER, NOTARY PUBLIC
MIDDLETOWN BOROUGH, DAUPHIN COUNTY
MY COMMISSION EXPIRES FEB. 26, 1990
Member, Pennsylvania Association of Notaries

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Attachment 1

The following addresses each of the items requested in NRC Bulletin 88-04:

Item 1:

Licensees were requested to determine whether or not their facility has any safety-related system with a pump and piping system configuration that does not preclude pump-to-pump interaction during miniflow operation and could therefore result in dead-heading of one or more of the pumps.

GPUN Response to Item 1:

In accordance with Item 1, the following TMI-1 systems were evaluated: Emergency Feedwater (EFW Pumps), Decay Heat Removal (DHR Pumps), High Pressure Injection (HPI/Makeup Pumps), and Reactor Building Emergency Cooling (RR Pumps).

As a result of our evaluation, GPUN concludes that all TMI-1 safety-related systems (with pump minimum recirculation arrangement) preclude any significant pump to pump interaction or situations in which a "strong" performing pump would dead-head a "weak" performing pump during parallel pump operation in minimum recirculation.

Item 2:

If the situation described in Item 1 were determined to exist, licensees were requested to evaluate the system for flow division taking into consideration:

(a) the actual line and component resistances for the as-built configuration of the identified system;
(b) the head versus flow characteristics of the installed pumps, including actual test data for "strong" and "weak" pump flows;
(c) the effect of test instrument error and reading error; and
(d) the worst case allowances for deviation of pump test parameters as allowed by the ASME Code, Section XI, IWP-3100.

GPUN Response to Item 2:

GPUN has completed its evaluation in response to Item 1 and determined that the situation described is not applicable to TMI-1. Therefore, a response to Item 2 is not required because each of the safety related systems above are provided with protection against a "strong" performing pump from dead-heading a "weak" performing pump in parallel during simultaneous pump minimum recirculation. The following factors are considered appropriate protection:

1) The Decay Heat Removal and Reactor Building Emergency Cooling Systems are designed with completely separate pump minimum recirculation lines for each parallel pump.

2) Both the Emergency Feedwater and High Pressure Injection Systems do have portions of their pump minimum recirculation arrangement which are common to all parallel pumps. However, our evaluations have shown that the non-common portion of the pump minimum recirculation arrangement (with dedicated pressure reducing orifices) provides the significant portion of the pressure drop in the entire arrangement. Therefore, the backpressure at the entrance to the common pump recirculation line is low enough to preclude any significant affect on the other pumps in parallel.

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Item 3:

Licensees were requested to evaluate the adequacy of the minimum flow bypass lines for safety-related centrifugal pumps with respect to damage resulting from operation and testing in the minimum flow mode. This evaluation should include consideration of the effects of cumulative operating hours in the minimum flow mode over the lifetime of the plant and during the postulated accident scenario involving the largest time spent in this mode. The evaluation should be based on best current estimates of potential pump damage from operation of the specific pump models involved, derived from pertinent test data and field experience on pump damage. The evaluation should also include verification from the pump suppliers that current miniflow rates (or any proposed modifications to miniflow systems) are sufficient to ensure that there will be no pump damage from low flow operation. If the test data do not justify the existing capacity of the bypass lines (e.g., if the pump supplier does not verify the adequacy of the current miniflow capacity,) the licensee should provide a plan to obtain additional test data and/or modify the miniflow capacity as needed.

GPUN Response to Item 3:

We have completed our evaluation for the Emergency Feedwater System (EFW Pumps), the High Pressure Injection System (Makeup Pumps), and the Reactor Building Emergency Cooling System (RR Pumps) and find that an in-depth analysis to predict pump damage and verify pump minimum flow requirements is not necessary for following reasons:

1) Inservice Testing (IST), per ASME Code Section XI, is performed on each system. Each pump in each system is tested. Degradation will be observed, trended and appropriately corrected.

2) In all the above safety-related systems, the amount of minimum recirculation flow and duration in which a pump is in minimum recirculation is consistent with our understanding of vendor requirements.

We are continuing our evaluation of the DHR Pumps and will report the results of our evaluation by August 1, 1988.

Also, in accordance with the request of the bulletin, we are contacting the respective pump vendors to verify the specified minimum flow requirements and our assessment that these requirements are acceptable.

Item 4:

The licensee is requested to provide a response within 60 days of receipt of NRC Bulletin 88-04 that:

(a) Summarizes the problems and the systems affected,
(b) Identifies the short-term and long-term modifications to plant operating procedures or hardware that have been or are being implemented to ensure safe plant operations,
(c) Identifies an appropriate schedule for long-term resolution of this and/or other significant problems that are identified as a result of this bulletin, and
(d) Provides justification for continued operation particularly with regard to GDC 35 of 10 CFR 50 Appendix A and 10 CFR 50.46.

GPUN Response to item 4:

4a) A review of the Emergency Feedwater (EFW) System, The Decay Heat Removal (DHR) System, the High Pressure Injection (HPI) System, and the Reactor Building Emergency Cooling (RR) System shows that the concern raised in item 1 and 2 of this bulletin is not applicable to TMI-1.

Our review of the EFW, HPI, and RR Pumps under Item 3 also indicate there are no concerns with minimum recirculation flow capability. We are still reviewing Item 3 for the DHR Pumps.

4b) As a result of our internal reviews, no long term or short term changes have been identified at this time due to the concerns expressed in NRC Bulletin 88-04.

4c) A schedule for corrective actions is not applicable at this time.

GPUN will report the results of our reviews on the DHR Pumps as well as any additional requirements for these pumps under Items 4(b) or 4(c) by August 1, 1988. Also we are contacting the manufacturer to document the specified minimum flow requirements and confirm our assessment that these requirements are acceptable.

4d) GPUN has no reason to believe that TMI-1 is not within its licensing basis. Currently no problems have been identified, and no changes or corrective actions are planned.

Evaluations for each system are provided in Attachment 2.

Item 5:

Within 30 days of completion of the long-term resolution actions, licensees were requested to provide a written response describing the actions taken.

GPUN Response to Item 5:

No long-term actions have been identified for TMI-1 in response to NRC Bulletin 88-04.

Item 6:

Licensees are requested to maintain the evaluations of actions in response to NRC Bulletin 88-04 at the plant site for a minimum of two years. The evaluation should, as a minimum, address the piping system configuration in accordance with Item 1, each of the four factors discussed in Item 2, pertinent test data and field experience on minimum flow operation, and verification of the adequacy of current minimum capacity by the pump manufacturer.

GPUN Response to Item 6:

This information will be available at the TMI-1 site as requested.

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Attachment 2

Emergency Feedwater System

Reference: Calc C-1101-424-5360-042

Item 2:

The concerns raised in Item 1 of NRC Bulletin 88-04 do not apply to the TMI-1 EFW System. To reinforce these conclusions, parts a and b of Item 2 are addressed as follows:

a) The EFW System has one 100% capacity turbine driven pump and two 50% capacity motor driven pumps in parallel. Each pump has a dedicated pressure reducing orifice in a non-common minimum recirculation piping section. These non-common piping sections connect to a common header which is routed to the "B" condensate tank. Although all three pumps share a portion of the pump recirculation arrangement, the pressure drop across the common piping section is negligible when compared to the pressure drop across the non-common piping sections containing the dedicated orifices. Therefore the backpressure at the entrance to the common pump recirculation piping is not enough to effect other pumps in parallel. The dedicated orifices hydraulically protect each pump from significant pump-to-pump interaction and a "strong" performing pump from dead-heading a "weak" performing pump.

b) The motor driven pumps do provide a greater discharge pressure than the turbine driven pump (3250 ft vs 3000 ft) at minimum recirculation conditions. However the dedicated orifices will prevent the motor driven pumps from dead-heading the turbine driven pump. In addition the dedicated orifices will prevent a "strong" motor driven pump from dead-heading a "weak" motor driven pump.

During surveillances both motor driven pumps are in minimum recirculation at the same time only during the performance of Surveillance Procedure 1303-11.42. This procedure ensures that full flow can be delivered from the condensate tanks to the steam generators. This procedure is performed each refueling outage or if the plant has been in cold shutdown more than 30 days. At no time during this surveillance are the 3 EFW pumps in minimum recirculation simultaneously.

Inservice Testing (IST) in accordance with ASME Code Section XI, Subsection IWP is conducted on these pumps in minimum recirculation on a monthly basis (Surveillance Procedures 1300-3F and 1300-3G A/B). Degradation of a pump at its minimum recirculation conditions will be observed, trended, and appropriate corrective action taken. During these surveillances it is prohibited to operate more than one EFW pump in minimum recirculation simultaneously.

Although more than one EFW pump may be in minimum recirculation while the system is in operation during a plant transient, the pumps are hydraulically protected from each other, and events of this nature are expected to occur infrequently.

Item 3:

An evaluation of the effects of cumulative operating hours in the minimum flow mode over the lifetime of the plant (including postulated accident scenarios) is unnecessary to verify that the current minimum flow requirements are preventing pump damage.

The minimum pump recirculation requirements were recommended by the manufacturer (Worthington). These requirements are 174 gpm (19% of best efficiency capacity) and 84 gpm (18% of best efficiency capacity) for the turbine driven and motor driven pumps respectively. The actual and measured recirculation flows are approximately 190 gpm and 90 gpm respectively.

Surveillance Procedures 1300-3F and 1300-3G A/B test these pumps individually at minimum recirculation conditions monthly. Degradation in discharge pressure, bearing temperature, and vibration would be observed, trended and appropriate corrective action taken. In addition Surveillance Procedure 1303-11.42 tests these pumps individually under full flow conditions. This surveillance is performed each refueling or if the plant has been in cold shutdown for more than 30 days.

Conclusion

In conclusion the 3 EFW pumps are hydraulically protected from significant pump-to-pump interaction and a "strong" performing pump from dead-heading a "weak" performing pump. In addition the three EFW pumps are not operated in minimum recirculation at the same time during surveillance, and infrequently during actual transients. Although the two motor driven pumps are at times (during surveillance) simultaneously operated under minimum recirculation, each pump is hydraulically protected by dedicated orifices. Pump dead-heading cannot occur during any mode of system operation.

## High Pressure Injection System

1. The HPI/MU (Makeup) pumps have a configuration in which pump-to-pump interaction may be possible during miniflow operation. However, all 3 Makeup pumps have separate flow restricting orifices on the discharge piping.

2. The flow resistance during miniflow operation is mainly in the restriction orifice (2813 psi at 105 gpm). The piping resistance in the miniflow line is relatively small (less than 25 psi at 105 gpm). This will prevent pump-to-pump interaction since the pressure downstream of the orifice will be low and allow sufficient flow from each pump.

3. Per the vendor, the Makeup pumps can operate in the miniflow mode for 30 minutes without damage at the originally specified 40 gpm. However, Makeup pumps at TMI-1 have recirculation flow of about 105 gpm and the pumps can operate at this recirculation flow for several hours without damage. The operation and testing of these pumps is described below:

   (a) During normal operation one pump is inservice and the remaining two pumps are in standby. The normal flow consists of minimum recirculation flow (approximately 105 gpm), seal injection flow (approximately 38 gpm) and makeup flow (variable). Thus, the pump does not operate normally in miniflow mode.

   (b) During plant startup, the pump operates in the minimum flow mode (approximately 105 gpm) for several minutes per Procedure 1104-2. Similar conditions will exist during shutdown.

   (c) During quarterly testing of the pumps, the flow rate consists of minimum flow and seal injection flow per Procedure 1300-3H A/B. (For the current test conditions, this represents a total flow of approximately 143 gpm).

   (d) During Engineered Safeguards Actuation, HPI valves MU-V16A/B/C/D open and flow is injected into the RCS. At this time minimum flow recirculation valves close automatically. The operation of HPI throttling (Procedure 1210-10) requires opening of the minimum flow valves when HPI is manually throttled below 400 gpm per pump.

4. Based on past experience these pumps do not operate at minimum flow for extended periods. No damage has been reported due to minimum flow operation. Based on the review of operating practices, no modifications or changes in operating procedures are required for these pumps.

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Reactor Building Emergency Cooling System

1. The Reactor Building Emergency Cooling Water Pumps (RR-P1A/B) have independent minimum recirculation flow paths. The concern for Item 1 is not applicable for these pumps.

2. Item 2 is not applicable for the same reason as discussed above.

3. These pumps are functionally tested under minimum recirculation mode every 92 days during normal plant operation. These pumps operate under this mode at least 30 minutes during the surveillance test. IST results indicate the pumps are operating within acceptable ranges. The pumps are functioning properly. Engineering calculation indicates that the as installed pump miniflow path has capability to provide 690 gpm. This flow rate exceeds the minimum required flow of 500 gpm. Therefore, the installed miniflow path is adequate for pump operation at recirculation flow condition.