PHILADELPHIA ELECTRIC COMPANY

NUCLEAR GROUP HEADQUARTERS

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July 12, 1990

Docket Nos. 50-352

License No. NPF-39

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, D.C. 20555

SUBJECT: Limerick Generating Station, Unit 1
Status of Resolution Action Items in Response to NRC
Bulletin No. 88-04, "Potential Safety-Related Pump Loss"

Dear Sir:

NRC Bulletin No. 88-04, "Potential Safety-Related Pump Loss," requested licensees to investigate two potential design concerns involving safety-related centrifugal pumps. The two broad NRC concerns discussed in the Bulletin included:

1) the potential for a pump to dead-head when it is operating in the minimum flow recirculation mode in parallel with another pump (pump-to-pump interaction), and

2) the adequacy of the minimum flow capacity.

Philadelphia Electric Company's (PECo's) understanding of these two concerns is as follows.

1) Pump-to-Pump Interaction

When the minimum flow lines from two or more pumps join at some point to form a common line, there is a potential for interaction between the pumps. If the pump unique performance characteristics were not considered in the design of the piping configuration, the pump with the higher discharge pressure (stronger pump) could reduce the flow through the pump with the lesser discharge pressure (weaker pump) to the point where it is inadequate for long-term integrity.

If each individual pump's minimum flow line is orificed (back-loaded) upstream of the junction with the common line, and if the

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common line has a large enough flow area such that its resistance is a relatively small part of the overall hydraulic resistance, there should be little adverse pump-to-pump interaction. The parallel pumps can be expected to operate individually or in unison with adequate minimum flow.

However, if the minimum flow lines are not individually orificed, interaction between the two pumps may occur. The severity of the degradation of minimum flow through a pump depends on the shape of the pump characteristic head-flow curves and the mismatch between the pumps. If the characteristic curve is such that a small change in flow results in a relatively large change in developed head (i.e., moderate to high flow conditions), it is probable that little operational difficulty would result from an undesirable piping configuration. However, if a relatively large change in flow resulted in only a small change in developed head (i.e., low flow conditions), some problems could be expected in satisfying the minimum flow requirements.

2) Adequacy of Minimum Recirculation Flow

The original design basis for sizing the minimum flow recirculation lines for the safety-related pumps at Limerick Generating Station (LGS), Units 1 and 2, both Boiling Water Reactors (BWRs), was to provide sufficient flow to avoid overheating the pumps due to low flow. However, more recent pump vendor's guidelines for minimum flow are based on avoiding hydraulic instability in addition to avoiding pump overheating, which has resulted in higher recommended minimum flow values than those used in original system design. Hydraulic instabilities can occur at low flow rates due to flow separation across the impeller vane, which can lead to asymmetrical shaft and bearing loads in addition to pump and piping vibration. Since the pump vendor guidelines are only applicable for "continuous" or "intermittent" operation, there are no new guidelines which specifically address low flow limits for infrequent operation, as is the case of Emergency Core Cooling System (ECCS) Pumps.

By letter dated June 30, 1988, we responded to Bulletin 88-04 and, as was requested, both short and long-term resolution action items were provided.

The status of the actions to resolve the two concerns raised by the subject Bulletin at LGS, Unit 1, is presented below.

I Pump-to-Pump Interaction

As discussed in our original response, this concern only applies to the Core Spray pumps.

During the summer of 1988, ultrasonic flow meters were used to obtain minimum flow rates for each of the Core Spray pumps with both pumps in a loop operating. The Core Spray system at LGS has two loops with two pumps in each loop. The test results showed that some slight pump-to-pump interaction was occurring. Upon evaluation of the test data, we concluded that the Core Spray system was acceptable as designed with respect to the pump-to-pump interaction since both pumps in a loop were operating on their characteristic head-flow curves without any one pump running in a dead-headed condition. However, the test results also showed that the actual minimum recirculation flow of the "weaker" pump in the 'B' loop of the Core Spray system was very close to the pump manufacturer's recommended value, and confirmed our June 30, 1988 response based on calculated minimum flow. In order to increase the minimum flow of the weaker pump and, at the same time, eliminate any pump-to-pump interaction which was occurring, a modification to remove the orifice in the common minimum flow line in each loop of the Core Spray system and install an orifice in each individual Core Spray pump's minimum flow line was evaluated. This modification was approved for LGS, Unit 1, in July 1989. A similar modification was performed on LGS, Unit 2, in April 1989, prior to licensing. In January 1990, additional testing was performed to support this modification to the Core Spray system.

As a result of the evaluation of the original Unit 1 test data, the evaluation of the appropriate modification, the design of the modification, the additional Unit 1 testing, and the long lead time for material procurement, this modification will be completed prior to restart from the fourth refueling outage for LGS, Unit 1, scheduled to begin in March 1992. This revises a previous commitment in our June 30, 1988 response which indicated that, based on the results of the 1988 testing, the appropriate modification to the Core Spray system would be completed prior to restart from the third refueling outage.

Until this modification is installed, the interim measures established previously are adequate to promptly identify any adverse pump-to-pump interactions which could cause pump degradation. Continuous monitoring of Core Spray pump vibration, and routine maintenance and inspections provide early indication of any pump degradation. The minimum flow is checked quarterly during system operational testing in accordance with a surveillance test procedure to ensure that there is no significant pump interaction. Operation of both Core Spray pumps in a loop in minimum flow mode is administratively limited to 30 minutes. For long-term operation in the minimum flow mode (e.g., low pressure ECCS initiation while the reactor is at high pressure), the Emergency Operating Procedures instruct the operators to manually secure the Core Spray pumps until the reactor is

depressurized to the point where they are capable of injecting and vessel injection becomes necessary.

II. Adequacy of Minimum Recirculation Flow

For LGS, General Electric Company and the applicable pump vendors were contacted to determine whether their originally specified minimum flow rates for the ECCS and Reactor Core Isolation Cooling (RCIC) pumps have been revised upward since the original values and under what operating regimes any restrictions would apply.

Some pump vendors now suggest that in order to prevent undesirable hydraulic instability, noise, and vibration when operating for extended durations at low flow, the minimum flow for intermittent operation of these types of pumps should be significantly higher than the present minimum flow. These recommended minimum flows (approximately 35% to 40% of the pump rated flow) are intended as operating guidelines for continuous operation. Other guidelines (approximately 25% to 30% of rated flow) are suggested for intermittent operation, where intermittent operation is defined as less than two hours of minimum flow operation in any 24-hour period. For a plant design life of 40 years, this would allow operation in low flow for approximately 30,000 hours. We note that the actual time that the affected pumps are in the minimum flow mode is relatively insignificant. Typically, less than five minutes of minimum flow operation occurs during any normal ECCS operation (i.e., testing), as is the case at LGS. There are no new guidelines which specifically address flow limits for such infrequent operation.

For LGS, General Electric Company has informed us that the originally supplied minimum flow values are adequate to preclude any pump damage resulting from operation of these pumps in the minimum flow mode for short periods of time (i.e., pump start up during surveillance testing). For longer term operation in the minimum flow mode (e.g., low pressure ECCS initiation while the reactor is at high pressure), the Emergency Operating Procedures instruct the operators to manually secure the Residual Heat Removal (RHR) and Core Spray pumps until the reactor is depressurized to the point where they are capable of injecting and vessel injection becomes necessary. Therefore, no further corrective actions are necessary in response to this issue.

The Bulletin requested that within 30 days of completion of any long-term resolution action items, a written response describing those actions be provided to the NRC. A response, confirming our long-term action items, will be provided within 30 days of completion of the above described modification to the Core Spray system.

If you have any questions, please do not hesitate to contact us.

Very truly yours,

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G. A. Hunger, Jr.
Manager
Licensing Section
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cc: T. T. Martin, Administrator, Region I, USNRC
T. J. Kenny, USNRC Senior Resident Inspector, LGS