PHILADELPHIA ELECTRIC COMPANY

2301 MARKET STREET

P.O. BOX 8699

PHILADELPHIA. PA. 19101

(215) 841-4500

JOHN S. KEMPER SENIOR VICE-PRESIDENT - NUCLEAR

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Docket No. 50-353

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

> Subject: Limerick Generating Station, Unit 2. NRC Bulletin 88-04

Gentlemen:

NRC Bulletin 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:

- 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 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 design of the piping configuration has not considered the pump unique performance characteristics, the pump with the higher discharge pressure (stronger pump) could reduce the flow through the pump with the lesser discharge ; essure (weaker pump) to the point where it is inadequate for ht g-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 common line has a large enough flow area such that its

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However, if the minimum flow lines are not individually orificed, but the common line is orificed or contains no orifice, 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) was to provide sufficient flow to avoid overheating the pumps due to low flow. However, more recently, pump vendor's guidelines for minimum flow are based on avoiding hydraulic instability in addition to avoiding pump overheating, leading to 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 lad 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 BWR Emergency Core Cooling System Pumps.

By letter dated June 30, 1988, PECo responded to Bulletin 88-04; and, as was requested, both short and long-term resolution action items were provided. The Bulletin also requested that within 30 days of completion of any long-term resolution action items, a written response describing those actions be provided.

The actions we have taken to resolve the two concerns raised by the subject Bulletin at LGS Unit 2 are presented here:

I. Pump-to-Pump Interaction

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

During the fall 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 test results showed that some slight pump-to-pump interaction may have been occurring. In order to eliminate this concern, we have installed restricting flow orifices in each individual Core Spray pump's minimum flow line, and replaced the existing orifice in the common lines with a spacer ring. The installation of the flow orifices in Unit 2 was completed in April, 1989. Flow testing performed after installation was completed verified that there was no pump-to-pump interaction occurring.

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 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. It is to be noted that the actual time spent in the minimum flow mode is relatively insignificant. Typically, less than five minutes of minimum flow operation occurs during any normal, Emergency Core Cooling System (ECCS) operation, as is the case at LGS. There are no new guidelines which specifically address flow limits for such infrequent operation.

For LGS, General Electric Co. 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 RHR and Core Spray pumps until the reactor is depressurized to the point where they are capable of injecting and vessel injection becomes necessary. Should you have any questions or require additional information, $p\,\dot{}_{*}ease$ do not hesitate to contact us.

Sincerely,

Joh S. Rupe

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Attachment

Copy to: T. J. Kenny, LGS Unit 2 Senior Resident Inspector W. T. Russell, Region I Administrator R. J. Clark, LGS Project Manager