Southern California Edison Company

P. O. BOX 800

2244 WALNUT GROVE AVENUE

ROSEMEAD, CALIFORNIA 91770

M. O. MEDFORD
MANAGER OF
NUCLEAR REGULATORY AFFAIRS

TELEPHONE
(818) 302-1749

January 5, 1989

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

Gentlemen:

Subject: Docket No. 50-206
NRC Bulletin 88-04
San Onofre Nuclear Generating Station
Unit 1

References: 1) July 26, 1988 letter from M. O. Medford (SCE) to NRC, subject: Docket Nos. 50-206

This letter provides the Southern California Edison response for San Onofre Unit 1 to NRC Bulletin 88-04, "Potential Safety-Related Pump Loss." As requested in Action 1 of the Bulletin, a review was conducted of safety-related systems where pump-to-pump interaction could occur. This review was initiated for all safety-related pumps as a result of the Westinghouse notification letter (before the bulletin was issued). Preliminarily, it has been determined that corrective actions to the existing plant design and procedures are not necessary pending completion of the evaluation of the feedwater pumps as described below.

As a result of this review, a further evaluation of the feedwater pumps is necessary. At San Onofre Unit 1, the feedwater pumps are utilized in the safety injection system. The pumps and the associated miniflow were only evaluated in the feedwater mode. Data for the pumps in the safety injection miniflow mode is not available. To document the adequacy of the feedwater pumps miniflow in the safety injection mode, an evaluation will be performed by April 28, 1989. In the event a test of the feedwater pump safety injection miniflow is necessary, it will be performed during startup of the unit. If startup is delayed and the April 28, 1989 date is impacted, you will be notified of a rescheduled date. To date no pump degradation has been noted as determined by testing and trending in the normal feedwater mode.

In Reference 1, it was stated that SCE was evaluating the need to participate in a joint effort being formulated by the C-E Owners Group to

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address this issue. Due to the need for plant specific data, SCE decided to perform this effort and has completed the required evaluations.

Subscribed on this 5th day of January, 1989.

Respectfully submitted,

M. O. Medford
Manager of Nuclear Regulatory Affairs

Subscribed and sworn to before me this 5th day of January, 1989.

OFFICIAL SEAL
AGNES CRABTREE
Notary Public-California
LOS ANGELES COUNTY
My Comm. Exp. Sep. 14, 1990

Agnes Crabtree
Notary Public in and for the County of Los Angeles, State of California

My Commission expires Sep 14, 1990.

Enclosure

cc: C. M. Trammell, NRR Project Manager, San Onofre Unit 1
J. B. Martin, Regional Administrator, NRC Region V
F. R. Huey, NRC Senior Resident Inspector, San Onofre Units 1, 2 and 3

NUCLEAR GENERATION SITE
INDEPENDENT SAFETY ENGINEERING GROUP
EVALUATION OF POTENTIAL SAFETY-RELATED PUMP LOSS
IN RESPONSE TO NRC BULLETIN 88-04, UNIT 1

NRC Action 1:

"Promptly determine whether or not its 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."

SCE Response:

All safety-related systems were reviewed to identify those with two or more pumps operating in parallel. All pumps that did not use miniflow lines were eliminated from the evaluation as not being within the scope of NRC Bulletin 88-04.

The design of the miniflow lines were then reviewed to determine if more than one pump shared miniflow lines. The pumps that did not share miniflow lines were eliminated from dead-heading concerns, but were evaluated for adequacy of miniflow capacity. One system, Residual Heat Removal, fits the criteria for pump interaction resulting in dead-heading and is discussed in Action 2 below. A second system, Main Feedwater in the safety injection mode, requires evaluation for miniflow adequacy. However, pump interaction is precluded due to orificed miniflow lines where essentially the entire pressure drop occurs at the orifice. This system is discussed in Action 3 below.

NRC Action 2:

"If the situation described in Item 1 exists, 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 American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code) Section XI, Paragraph IWP-3100."

SCE Response:

If multiple pumps share a miniflow line, the potential exists that interaction can cause one pump to run dead-head (zero flow) during miniflow conditions. This situation can occur when one pump provides more head to the discharge of the parallel pump. These conditions can occur at

very low flow rates (mini-flow) if there is little resistance between the discharges of the two pumps and there is inequality in pump performance.

Pumps supplying a common discharge header are discharging at a common pressure, except for frictional losses. Pump developed head decreases as flow increases. Thus, when two or more pumps discharge to a common point, the higher performing pump reduces flow from the lower performing pump. At low flows, when there is little margin in the head-flow curve, dead-heading of a pump can occur. At higher flows, the margin in the head-flow curve will only result in slightly reduced flow rates.

The design and operating modes of pumps with shared miniflow lines, including discharge headers were reviewed in detail, using P&IDs, System Descriptions, Pump Curves, and Operating Procedures. The In-Service Testing program and test data required by ASME Section XI was reviewed to determine proper pump performance.

Safety-related pumps at San Onofre Unit 1 that share miniflow lines or miniflow discharge headers have separate orifices for each pump's miniflow line. Reviews of the orifice designs confirmed that essentially the entire pressure drop for all miniflow lines occur at the orifices. Therefore, the resistive effects of the common lines are negligible with respect to those of the separate orifices and the systems behave as though they are separate miniflow lines discharging to a common tank. Interaction will not occur in such a design, because a single pump can not provide a significant pressure to the discharge of the parallel pump.

Based on the review of pumps at San Onofre Unit 1, only the RHR pumps have a shared miniflow line without separate orifices. A review of the RHR operating procedures determined that their operation is not conducive to interactions. One RHR pump is started manually and is used in miniflow for line warming. The other RHR pump is not started until the first pump is operating at greater than 800 gpm, which is 73% of rated flow. Therefore, each pump operates well above flow rates conducive to miniflow interaction when both pumps are operating. The main feedwater pumps have adequate flow division but lack adéquate documentation for the orifice design. This is discussed in Action 3 below.

NRC Action 3:

"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 operation 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 data do not come from flows comparable to the current capacity) or 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."

SCE Response:

A potential for inadequate miniflow can exist, even if interactions between pumps do not occur. If the design were improper, inadequate miniflow could occur and can result in overheating of thrust bearings, overheating of pump bearings, and excessive vibrations. Safety-related pumps are tested periodically, as part of the ASME Section XI Program, for bearing temperature rises and vibrations. During these tests, the pumps operate on miniflow for extended periods of time (approximately 30 minutes). Pump test records were reviewed to determine if excessive vibration or temperature rises occurred during miniflow operation. The test records showed that vibrations and temperature rises were at acceptable levels during miniflow operation. The test records also showed that temperature and vibration levels were essentially constant during the test runs. This indicates that the pumps can be run on miniflow for durations even greater than those of the tests. Recent vibrations and temperature rise results were compared with those of earlier pump testing. The comparisons indicated no increase in vibration levels or temperature rise, further confirming the adequacy of the pump miniflow designs. A review of maintenance order histories showed no degrading trends. Miniflow designs were in accordance with vendor manuals or where not specified, consistent with good engineering practices.

During the evaluation, it was determined that the main feedwater pumps, when operated in the safety injection mode, have a shared miniflow path through individual orifices. Documentation was unavailable to confirm adequate flow through use or testing. The adequacy of the flow rate will be validated and documented. It is expected that the evaluation results will indicate the miniflow for the feedwater pumps in the safety injection mode is adequate. This is based on the fact that the miniflow line for the feedwater pumps in the feedwater mode are the same size as the safety injection miniflow and the testing done on the feedwater pumps in the feedwater miniflow mode has demonstrated it to be acceptable.

NRC Action 4:

"Within 60 days of receipt of this bulletin, provide a written response 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 General Design Criterion 35 of Appendix A to Title 10 of the Code of Federal Regulations (10 CFR 50), "Emergency Core Cooling" and 10 CFR 50.46, "Acceptance Criteria for Emergency Core Cooling System for Light Water Nuclear Power Reactors."

SCE Response:

a) Evaluation of the designs and operating modes of safety-related pumps with miniflow lines showed that there are no credible potentials for damage. The only system potentially affected are the Residual Heat Removal (RHR) system and main feedwater in the safety injection mode.

b) No short term or long term modifications to plant operating procedures are planned. Procedure SO1-4-9, Residual Heat Removal System Operation," was previously revised to identify dead-head conditions (<800 gpm) and required the stopping of one RHR pump if RHR flow is <800 gpm with 2 RHR pumps in operation.

c) Evaluation and/or testing will be performed on the Main Feedwater pump recirculation line in the safety injection mode to document miniflow adequacy.

d) No justification for continued operation was required.

NRC Action 5:

"Within 30 days of completion of the long-term resolution actions, provide a written response describing the actions taken."

SCE Response:

A report will document the adequacy of the miniflow line for the main feedwater pumps in the safety injection mode by April 28, 1989.

NRC Action 6:

"An evaluation of your actions in response to this bulletin should be documented and maintained at the plant site for a minimum of two (2) years. That evaluation should, as a minimum, address the piping system configuration in accordance with Item 1 above, 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 miniflow capacity by the pump manufacturer."

SCE Response:

The engineering evaluation for the actions taken have been documented and will be permanently maintained at Southern California Edison in the Corporate Document Management system.

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