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

ENCLOSURE 1

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION
RESPONSE TO NRC GENERIC LETTER NO. 82-28
INADEQUATE CORE COOLING INSTRUMENTATION SYSTEM
SOUTHERN CALIFORNIA EDISON COMPANY
SAN ONOFRE NUCLEAR GENERATING STATION UNIT 1
DOCKET NO. 50-206

1.0 INTRODUCTION

In a letter dated June 20, 1986 and at a meeting with the NRC on October 2, 1986, the licensee, Southern California Edison Company (SCE), requested relief from the staff requirements to install a Reactor Vessel Level Measurement System at San Onofre Nuclear Generating Station Unit 1 (SONGS-1). The SCE submittal (two volumes dated June 1986) includes a description of the existing ICC instrumentation, and extensive documentation of their justification for requesting exemption from level measuring instrumentation including a probabilistic risk assessment.

The staff's requirements are discussed in Generic Letter No. 82-28 "Inadequate Core Cooling (ICC) Instrumentation System" dated December 20, 1982.

2.0 EVALUATION

The licensee proposed the following as the basis for its exemption request:

1) adequancy of existing ICC instrumentation to meet the requirements of NUREG-0737, Item II.F.2, and
2) cost and benefit of a reactor vessel level measurement.

This evaluation will therefore review conformance of the existing instrumentation, including upgrade plans, with the requirements of NUREG-0737 Item II.F.2, and discuss the merits of the licensee's cost benefit study.

2.1 Subcooling Margin Monitoring (SMM)

The existing SMM consists of two independent channels with separate inputs, processors and displays. Power is supplied from Class 1E sources. Pressurizer pressure and hot leg RTD inputs located inside containment are environmentally qualified and use appropriate signal isolators. Core Exit Thermocouple (CET) inputs to the SMM are not environmentally qualified and are not isolated. Continuous display of each channel of the SMM is provided by gas-discharge analog bar indicators with a display range of -50 to +150° F margin to saturation. No recording of SMM information is provided and no SMM inputs to the plant computer are included. Four CET inputs are used (one from each core quadrant) for each channel, along with three hot leg RTD's to compute the subcooling margin. Selector modules automatically select the highest of the input temperatures and the lowest of the input pressures for the computation of margin to saturation. The CETs are also used for the flux mapping system through manual selector switches, but not simultaneously. An alarm is provided when the CETs are not in the SMM position. An alarm is also provided when the computed margin is 40° F or less. The processing equipment is Foxboro Spec. 200.

Our evaluation shows that the basic design of the existing SMM system satisfies the requirements of NUREG-0737, except for environmental qualification. The Core Exit Thermocouple system (CET) and the processing equipment outside containment are not presently qualified. NUREG-0737 requires that the system be environmentally qualified from sensor through display, including seismic resistance. The licensee's assertion that qualification is not required because the environment outside containment is not harsh is not acceptable. The system must be qualified for the conditions it is expected to see, whether they be harsh or relatively mild.

Chapter 11 of the submittal outlines plans to upgrade the CET wiring for environmental qualification, including appropriate signal isolation. The upgrade plans do not mention required channel separation of the CETs. This concern is stated in Enclosure 2 which is the staff's request for additional information.

2.2 Core Exit Thermocouple System (CET)

The present SONGS-1 CET system includes 35 type K thermocouples whose leads exit the reactor vessel closure head through five instrumentation ports. Only 28 of the installed CETs are currently operable. The signal transmission cabling and connectors are not environmentally qualified. The CET display is a Teleflex unit for core mapping which is not environmentally qualified or safety related. A second display is in the Technical Support Center using a Foxboro computer, also not environmentally qualified. No signal isolation is provided. Both displays provide for continuous, trend, and record capabilities. The display range is from 100 to 2200° F. Proposed upgrade modifications include:

1. Replacing the core exit thermocouple in-containment cabling and connectors with types which meet safety related quality and environmental qualification requirements.

2. Replacing the display and recording units for the core exit thermocouples with qualified units.

3. Providing isolation for the core exit thermocouple channels so that the signals can be utilized for safety related or nonsafety input to instrumentation.

4. Developing a procedure using the CETs to address loss of recirculation cooling following a loss-of-coolant accident.

The following is our evaluation of SONGS-1 CET system.

The SONGS-1 CET system differs significantly from larger plants in that only 35 thermocouples are used in the smaller core compared to 50 or more in a typical larger plant. The SONGS-1 vessel has no bottom penetrations.

In the current configuration, the SONGS-1 CET system does not meet the requirements for cable and connector qualification, equipment qualification, signal isolation, channel separation, or display qualification. Although not described in detail, the plant computer and the Technical Support Center displays may satisfy the primary CET display requirements of NUREG-0737. The upgrade plans listed above may satisfy the additional requirements, but are not described in sufficient detail to determine conformance. Questions for SCE regarding conformance are listed separately in the staff's request for additional information.

Performance and conformance of the SMM and CET systems become especially important if exemption from level measurement requirements is to be considered.

2.3 Reactor Vessel Level Instrumentation System (RVLIS)

SCE has requested relief from the requirement to install a RVLIS at SONGS-1 based upon unique plant design, plant response to transients, and offsite dose considerations.

In comparison to larger and more modern plants, SONGS-1 has a smaller core (1347 Mwt) resulting in a smaller source term. The margin between operating pressure (2085 psi) and the PORV setpoint (2190 psi) is the same (100 psi). The margin between normal operating temperature and the saturation temperature for the RCS is about 10° F greater. Due to its smaller RCS volume (6940 ft^3) compared with large plants (10,600 ft^3) and high capacity injection pumps, SONGS-1 is claimed to be less susceptible to small break LOCAs.

SCE evaluated the Westinghouse differential pressure (dp) RVLIS and the Combustion Engineering (CE) Heated Junction Thermocouple (HJTC) systems for

their applicability to SONGS-1. The Westinghouse RVLIS in its generic design cannot be installed in SONGS-1 due to the lack of a bottom vessel penetration. SCE claims that the pressure vessel head penetrations and reactor internals would require extensive modification and corresponding hydraulic and stress analyses in order to accommodate HJTC probes, resulting in very high cost. Their value-impact assessment was done using the estimated costs associated with installing the HJTC system (this cost is two to three times higher than the average cost). SCE claims to have considered a modified Westinghouse dp system which would measure only from the hot leg to the vessel head, but did no serious cost estimates for this alternative. The alternative head-to-hot leg design was deemed less desirable because of its limited measurement range, which is essentially the same as the HJTC system, and its inoperability when primary coolant pumps are running. No mention was made of the possibility of using pump power monitoring to detect voids when the pumps are running.

SONGS-1 is the smallest of five Westinghouse plants that are in the range of 0.4 to 0.5 times the size of the modern four-loop Westinghouse plant. Only one, Yankee Rowe, is smaller (600 Mwt) and it has been granted relief from installing a RVLIS. Yankee Rowe, which is located in a remote area, is operating at 400 psi margin between operating pressure and the PORV setpoint and 25°F subcooling margin with upgraded SMM and CET systems. Haddam Neck and Ginna are the most similar to SONGS-1 due to the fact that they do not have reactor vessel bottom penetrations. Ginna is installing a modified Westinghouse type RVLIS from head to hot leg and Haddam Neck is installing the CE HJTC system.

A considerable portion of the SCE submittal is devoted to evaluation of events potentially leading to inadequate core cooling and a probabilistic risk assessment to evaluate the risk of core damage due to ICC with the existing SONGS-1 design. Although the study has merit, it involves essentially the same considerations used by the licensees and the NRC several years ago in determining if additional ICC requirements were needed. After due consideration of many analyses, the NRC determined that new requirements were needed and imposed those defined in NUREG-0737. The evaluation of the SCE

exemption request is therefore based on the differences in performance between SONGS-1 and larger plants that make ICC less likely to occur or the consequences less severe.

The principal difference noted by the scenarios presented in the submittal is that the smaller RCS volume of SONGS-1 leads to more rapid depressurization and early initiation of safety injection flow in the event of a small break. Safety injection flow can match the break flow for breaks smaller than 2.5 inches and core uncovery is not predicted. For larger breaks in the 2.5 to 5.2 inch range, less uncovery and lower peak clad temperatures are predicted than for larger plants. The report suggests that a 3.0 inch line break at SONGS-1 is comparable to a 4.0 inch line break at more typical larger reactors.

A probabilistic risk assessment focused on the risk associated with inventory threatening scenarios leading to inadequate core cooling. In a small break LOCA event, the safety injection system is designed to provide sufficient injection flow to prevent core damage. When this injection flow has depleted the Refueling Water Storage Tank, then the system must be realigned so that the normal charging system in conjunction with the containment recirculation pumps provide recirculation and injection to the reactor coolant system. The risk assessment utilizes event and fault trees to describe the sequence of events and failures which must occur for an inadequate core cooling condition to result. The fault trees include both equipment and human operator performance estimates for the existing plant configuration and instrumentation. The data input for the assessment were taken mostly from other studies. The validity of this data has not been confirmed, but the overall result appears reasonable in relation to the information given for other plants.

The risk assessment was then adjusted for an assumed incremental improvement which might result from the inclusion of RVLIS. It was assumed, however, that the RVLIS did not provide any new information of value, but was only redundant to the existing information so that the scenarios were virtually unaffected by

the addition of RVLIS Information. No procedural adjustments were made based on the availability of RVLIS. The only indication of approach to ICC in the existing system is elevated hot leg temperatures or elevated CET temperatures which respond only late in the event when the core is partially uncovered. The evaluation gives no credit for early detection of approaching ICC with vessel water level indication and the corresponding potential for corrective operator action. This is contrary to the conclusion reached by the staff based on other analyses which led to the establishment of the RVLIS requirements. The biased input assumption that RVLIS is of no value guarantees the PRA result obtained. For each of the assessments, it is stated that the uncertainty of the analysis was not calculated, but is assumed to be large.

The offsite consequence analysis submitted by SCE does not present a clear case for any less diligence in detecting and preventing ICC. Recent increase in population density in the vicinity of the plant appears to place SONGS-1 in a similar risk category as many other plants, all of which have installed ICC instrumentation as mandated. SONGS-1 has a small advantage due to its lower operating power and correspondingly smaller source term.

3.0 CONCLUSION

The licensee has not presented adequate technical justification for excluding a reactor vessel level measurement system from their instrumentation to detect inadequate core cooling. Other plants of similar size and design have installed an acceptable level measurement system (either a generically approved one or a modified one). Therefore, the licensee's request for relief from the requirement to install a reactor vessel level measurement system at SONGS-1 is denied. Enclosure 2 is the staff's request for additional information regarding a SONGS-1's alternative reactor vessel level measurement system and conformance of the SONGS-1 SMM and CET system to the requirements of NUREG-0737 Item II.F.2.

ENCLOSURE 2

REQUEST FOR ADDITIONAL INFORMATION ON SONGS-1 ICCI SYSTEM

1. Are the CETs providing signals to the SMM channel separated, environmentally qualified, and signal isolated from other displays?

2. Are all parts of the SMM system, including displays, seismically and environmentally qualified for the appropriate degraded environments?

3. Will recording of margin to saturation be provided?

4. Are all of the characteristics required of the primary CET display system, as delineated in NUREG-0737, Item II.F.2, provided by the upgraded system?

5. Are all of the CETs environmentally qualified and channel separated, including vessel connectors, other in-containment connectors, cables, containment penetrations, cold junction references, and isolation devices?

6. Are redundant independent channels provided for the backup display system which meet the single failure criterion and have Class 1E power sources?

7. Can sixteen CETs, four per core quadrant, be read in less than six minutes by the backup display system?

8. Are the qualified backup displays accessible to the operator isolated and independent of the primary display?

9. Has the availability of the SMM and CET systems been addressed in the Technical Specifications?

10. Has the use of SMM and CET information been integrated into emergency procedures and training?

11. Provide the schedule and details if available for proposed alternative reactor vessel level measurement system.