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

ENCLOSURE 1

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATING TO INSTALLATION MODIFICATIONS TO MEET THE REQUIREMENTS OF

NUREG 0737 ITEM II.F.2 "INADEQUATE CORE COOLING INSTRUMENTATION."

SOUTHERN CALIFORNIA EDISON COMPANY

SAN ONOFRE NUCLEAR GENERATING STATION, UNIT 1

DOCKET NO. 50-206

1.0 INTRODUCTION

On January 2, 1990, the Commission issued an order confirming Southern California Edison Company (SCE) commitment to implement the Sam Onofre Nuclear Generating Station, Unit 1, (SONGS 1) full - term operating license open items set forth in SCE's letter of October 2, 1989 (Ref. 1 and 2). The order requires SCE to install modifications to meet the requirements of NUREG 0737 Item II.F.2, "Inadequate Core Cooling Instrumentation." (Ref. 3 and 4)

The licensee committed to submit specific plans for implementation of the requirements of NUREG 0737 Item II.F.2 by December 1, 1990 and propose to install the reactor vessel level monitor system and upgrade the core exit thermocouples during Cycle 12 refueling outage.

By letter dated November 29, 1990, the licensee submitted specific plans for implementation of the SONGS 1 Inadequate Core Cooling Monitoring System (ICCMS) (Ref. 5). The staff reviewed this submittal and determined that additional information was required to complete the safety evaluation. Therefore, a request for additional information was sent to the licensee on July 10, 1991 (Ref. 6), and the licensee responded to this request for additional information by letter dated December 12, 1991 (Ref. 7).

2.0 BACKGROUND

The position of NUREG 0737 Item II.F.2 requires the licensee to provide: (1) a description of any additional instrumentation or controls proposed for the plant to supplement existing instrumentation, (2) a description of the functional design requirements for the system, (3) a description of the procedures to be used with the proposed equipment, the analysis used in developing these procedures, and (4) a schedule for installing the equipment. The design and qualification criteria for Accident Monitoring Instrumentation is contained in NUREG 0737 Appendix B and specifically for Pressurized Water Reactor reactor Incore Thermocouples, Attachment 1. Final design and qualification criteria is contained in Regulatory Guide (RG) 1.97.

On February 22, 1991 the NRC sent to the licensee the staff's evaluation of compliance to Regulatory Guide 1.97 (Ref.8). The Technical Evaluation Report by EG&G, which was included in the staff's safety evaluation report (SER), identified instruments associated with "Core Exit Temperatures" and " Coolant Level in the Reactor" and "Degrees of Subcooling" that were not evaluated. "The NRC has reviewed the acceptability of this [these] variable [s] as part of their review of NUREG - 0735, Item II.F.2." This SER will address the licensee conformance to RG. 1.97 in reference to these variables except as discussed below.

3.0 EVALUATION

The licensee's Inadequate Core Cooling Monitoring System (ICCMS) includes the Reactor Vessel Level Monitoring System (RVLMS), Core Exit Thermocouples (CET), and Sub-cooled Margin Monitor (SMM). The current SMM system is identified by the licensee as being a qualified system and will not be addressed in this safety evaluation report (SER) except its integration into the ICCMS which is designed to provide clear, concise information to the control room operators on the status of inadequate core cooling as determined by reactor level, core exit temperatures and subcooling.

The licensee has indicated that all instrumentation will conform to the requirements of NUREG 0737, Appendix B, "Design and Qualification Criteria For Accident Monitoring Instrumentation" as clarified in section II.F.2. However, there is no reference to Regulatory Guide (RG) 1.97.

3.1 Reactor Vessel Level Monitoring System

The SONGS 1 reactor is Westinghouse designed and manufactured. The Westinghouse (W) reactor vessel level indication system (RVLIS) is based on a differential pressure measurement with one tap at the reactor bottom. The SONGS 1 reactor does not have a reactor vessel bottom tap nor access available to install one, and would have to use a hot leg lower tap. The use of the hot leg lower tap design would lead to measurement uncertainties for several minutes because of reactor coolant pump coast down on turbine trip until the forced flow changed to natural circulation. Therefore, the licensee did not elect to use the W RVLIS, but rather evaluated a modified version of the Combustion Engineering Company (CE) Heated Junction Thermocouple (HJTC) System.

The CE HJTC modified system is based on a miniature version of the standard HJTC, which would be placed in an incore instrument thimble, and would require little or no modification to the reactor internal package. Although the

licensee considered the modified HJTC technically feasible, it was eliminated because of requalification, potentially long licensing exchanges, and unknown development costs. The licensee determined that SONGS 1 could be modified to accept the standard CE HJTC probe.

The heated junction thermocouple principle of operation is, an inconel heater located near one chromel-alumel thermocouple and a second chromel-alumel thermocouple located further away. When reactor coolant is present there is no temperature difference between the thermocouples; however, if the reactor coolant drop below the HJTC a differential temperature of several hundred degrees Fahrenheit is detected to indicate the level. Eight of these HJTC are spaced 360 degrees in a vertical direction within a probe assembly. Two independent probes will be secured in the reactor vessel upper internals between the upper core plate and the upper support plate. The spacing between each HJTC and their locations has not been finalized but the following is being proposed and is under evaluation by the licensee:

SENSOR	LOCATION FROM VESSEL FLANGE (in inches)	DISTANCE BETWEEN SENSORS (in inches)	VESSEL REGION BEING MONITORED
#1	+47.75		Vessel Head
#2	0.00	#1 TO #2 47.75	Vessel Flange
#3	-12.50	#2 to #3 12.50	Top of Lower Plenum
#4	-39.00	#3 to #4 26.50	Mid point between #3&#5
#5	-65.50	#4 to #5 26.50	Top of Hot Leg
#6	-82.50	#5 to #6 17.00	Center line of Hot Leg
#7	-99.50	#6 to #7 17.00	Bottom of Hot Leg
#8	-119.25	#7 to #8 19.75	Top of Upper Core Alignment Plate

The overall measuring range of the HJTC probe is 167 inches from the reactor vessel head to the upper core (fuel) plate. Sensor #8 is located 17.5 inches above the active fuel element. The indication of change from a covered sensor to uncovered sensor or vise versa will occur within plus or minus one inch of the design location (elevation) for that sensor. This inaccuracy is made up of about plus or minus one half inch each for dimensional tolerance and finite heater length.

The response time (time between actual level increase or decrease and indication) is eight to twenty six seconds. The delay time (the time interval between when heater power is turned on and the time the HJTC reading reach steady state) is less than thirty seconds. Although the power is normally provided to the HJTC probes any transient voltage removal should not provide an operational concern.

The Staff requested that the licensee provide a copy of the HJTC calibration procedures. The licensee has stated that the calibration procedures have not been developed yet, and will be developed upon completion of the Unit 1 ICCMS project using NUREG 2627, Section IV.C.7 for guidance on the HJTC operability verification. (Ref. 9)

The licensee stated in their November 29, 1990 submittal that "The CE HJTC technology has been successfully implemented at San Onofre Units 2 and 3 as well as over 20 other US nuclear facilities. Extensive qualification testing has been conducted on the HJTC technology and the application of this technology has been accepted and documented by the NRC in NUREG/CR-2627." (Ref. 9)

The staff requested information on any HJTC failures at San Onofre Units 2 and 3, the root cause for the failures, and the corrective action taken. A detailed root cause analysis of the failure mechanism has not been routinely performed

by the licensee because of the highly radioactive nature of the HJTC probes following reactor operation. In general the corrective action has been to replace the failed HJTCs when the available number of operable sensors is at or near the minimum number required by the plant Post Accident Monitoring Technical Specification. However, SCE does not propose to submit changes to the SONGS 1 Technical Specification to address the ICC instrumentation installation until approximately six months prior to the Cycle 12 refueling outage when the HJTC reactor vessel level monitoring system will be installed. SCE will provide the NRC a list of HJTC failures and the apparent failure mode by March 1, 1992.

Each of the two probe assemblies will have two power supplies. Each heater power supply will provide power for four heaters connected in series. The four HJTCs sensors supplied by one heater power supply will occupy alternating level positions; therefore, sensors 1,3,5 and 7 will be connected to one power supply and sensors 2,4,6 and 8 will be connected to the redundant power supply. The power to the Train A and Train B HJTC heaters will be supplied from Channel R and G 120 VAC safety related UPS respectively. The heater power requirements per train is 120 VAC, single phase, 3 ampere nominal, 5 amperes maximum.

The probe electrical leads exit through the reactor head with each HJTC electrical leads separately wired and terminated with electrical connectors in a transition panel which is located on the reactor head lift rig. The

electrical connectors permit assembly/disassembly during refueling operations and are qualified for post - accident conditions. The electrical leads between the transition panel and the containment penetration will be mineral insulated and organic insulated between the containment penetration and the control room panels. Electric cable trains will be separated in accordance with the requirements of Regulatory Guide 1.75.

The output of the HJTC probes are input into redundant micro processor cabinets located in the main control room. The output of the redundant micro processors are connected to redundant 1E displays. Outputs from the micro processors have inputs to isolation modules whose output are connected to the non-1E Integrated Plant Monitoring System (IPMS) , Safety Parameter Display System (SPDS), alarms, printers, and displays.

The HJTC system and it's components will be qualified in accordance with The Institute of Electrical and Electronics Engineers, Inc. (IEEE) standards 323 and 344 for specific seismic, environmental, and post accident conditions at SONGS 1.

3.2 Core Exit Thermocouples

The SONGS 1 was designed with 35 Core Exit Thermocouples (CET's) located uniformly across the top of the reactor core. As of November 29, 1990 only

28 CET's were operable (Ref. 5); however, information received by the licensee on December 12, 1991 (Ref. 7) indicates that two additional CETs have failed. Among the nine failed CETs, three were damaged during an instrument nozzle brazing repair performed by Westinghouse in 1978. Another CET was cut and capped, and terminated in the reactor head to read the head area temperature. The remaining five CET failures were considered random occurrences.

The licensee has indicated that a reasonable effort will be made to restore the inoperable CET's; however, if they are inoperable because of a broken guide thimble they cannot be made operable. The CET's will be segmented into two trains consisting of four quadrants per train to meet the requirements of NUREG 0737 II.F.2, Attachment 1 "Design and Qualification Criteria for Pressurized-Water Reactor Incore Thermocouples".

The existing CET's will be upgraded to post accident qualification as part of the ICCMS project. The CET components external to the reactor pressure boundary will be upgraded to post accident qualifications. The upgrade includes replacement of unqualified with qualified connectors and cables.

4.0 CONCLUSION

The staff concludes that the licensee's design of the Reactor Vessel Level Monitoring System and the modification of the Core Exit Thermocouples meets the requirements of NUREG - 0737 Item II.F.2 "Inadequate Core Cooling Instrumentation."

The licensee should provide a list of HJTC failures and the apparent failure mode by March 1, 1992, as committed to in their letter of December 12, 1991 (Ref.7), and inform the NRC the number of defective CETs that have been restored to operability.

5.0 REFERENCES

1.0 Letter from George W. Knighton, Director Project Directorate V , NRC to Harold B. Ray, VP, Southern California Edison Company, Order Confirming Licensee Commitments on Full - Term Operating License Open Items - San Onofre Nuclear Power Generating Station, Unit 1 (TAC No. 11232), dated January 2, 1990.

2.0 Letter from Harold B. Ray, VP, Southern California Edison Company to NRC, Responds to 89/08/17 letter reference full-term OL open items, dated October 02, 1989.

3.0 Letter from D.G. Eisenhut, NRC, to All Licensee of Operating Reactors.. "Supplement No. 1 to NUREG -0737 Requirement for Emergency Response Capability (Generic Letter 82-33)," dated December 17, 1982.

4.0 "Clarification of TMI Action Plan Requirements" NUREG -0737 November 1980.

"Clarification of TMI Action Plan Requirements, Requirements for Emergency Response Capability," NUREG -0737, Supplement No. 1, Dated January 1983.

5.0 Letter from F.R. Nandy, Manager Nuclear Licensing, Southern California Edison Company, to NRC, "TMI Action Plan Item II.F.2, Inadequate Core Cooling Instrumentation San Onofre Nuclear Generating Station, Unit 1 " dated November 29,1990.

6.0 Letter from George Kalam, Senior Project Manager, Project Directorate V, NRC, to Harold Ray Senior VP, Southern California Edison Company, "Request for Additional Information, Inadequate Core Cooling Monitoring System San Onofre Nuclear Generating Station, Unit 1," dated July 10. 1991.

7.0 Letter from R.M. Rosenblum, Manager of Nuclear Affairs, Southern California Edison Company, to NRC, "Response to NRC Request for Additional Information, Inadequate Core Cooling Monitoring System San Onofre Nuclear Generating Station, Unit 1, Dated December 12, 1991.

8.0 Letter from George Kalam, Senior Project Manager, Project Directorate V, NRC, to Harold Ray Senior VP, Southern California Edison Company, "San Onofre Unit 1 Conformance to Regulatory Guide 1.97," dated February 22, 1991.

9.0 "Inadequate Core Cooling Instrumentation Using Heated Junction Thermocouples for Reactor Vessel Level Measurement", NUREG/CR - 2627, ORNL/TM - 8268, Prepared by R.L. Anderson, J.L. Anderson, G.N. Miller, Oak Ridge National Laboratory for NRC, March 1982.

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

ENCLOSURE 2

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION
RELATING TO INADEQUATE CORE COOLING INSTRUMENTATION
SOUTHERN CALIFORNIA EDISON COMPANY
SAN ONOFRE NUCLEAR GENERATING STATION, UNIT 1
DOCKET NO. 50-206

1.0 INTRODUCTION

By letter dated November 29, 1990 (Ref. 1), Southern California Edison Company (SCE) submitted additional information relating to San Onofre Nuclear Generating Station, Unit 1 (SONGS 1) inadequate core cooling instrumentation (ICCI) system. The purpose of this submittal was to address the NRC Order issued January 2, 1990 (Ref. 2) which required that by December 1, 1990 the licensee shall submit specific plans for implementing the requirements of NUREG-0737 Item II.F.2 during the Cycle 12 refueling outage (about September 1992).

The SONGS 1 inadequate core cooling monitoring system (CCMS) will consist of the Reactor Vessel Level Monitoring System (RVLMS), Core Exit Thermocouples (CET), and Subcooled Margin Monitor (SMM). Currently, the SONGS 1 facility has a qualified SMM, nonqualified CET's and no RVLMS.

2.0 EVALUATION

In response to the NRC Order (Ref. 2), the licensee has submitted additional information (Ref. 1) to address its specific plans for implementing the requirements of NUREG-0737 Item II.F.2 as follows:

(1) During the Cycle 12 refueling outage SONGS 1 will provide operable and qualified SMMs, CETs and RVLMS, which will comply with the requirements of NUREG-0737 Item II.F.2.

(2) The SONGS 1 RVLMS will utilize two independent heated junction thermocouple (HJTC) probes developed and qualified by Combustion Engineering.

(3) Upgrade of the existing CETs to post accident qualification will occur as part of the ICCMS project.

(4) Six months prior to Cycle 12 refueling outage (i.e., about February 1992) SONGS 1 ICCMS Technical Specifications and details of the Integrated Plant Monitoring System (IPMS) and the Safety Parameter Display System (SPDS) will be submitted for staff review.

The staff has reviewed the SONGS 1 licensee's submittal for its inadequate core cooling monitoring system and has concluded as follows:

(1) The proposed design for the RVLMS is acceptable since the design proposal conforms to the Combustion Engineering generic description for a RVLMS employing HJTC probes which was generically approved by NRC.

(2) The proposed CET upgrade is acceptable since it will utilize the existing incore portion of the CET's as clarified in Regulatory Guide 1.97, and will be upgraded to post accident qualification for the CET components external to the reactor pressure boundary.

(3) The commitment to have operable and qualified ICCMS during the Cycle 12 refueling outage (about September 1992) and to provide Technical Specifications and details of IPMS and SPDS for staff review six months prior to Cycle 12 refueling outage (about February 1992) is acceptable.

3.0 CONCLUSION

With the commitment to have operable and qualified ICCMS during the Cycle 12 refueling outage, the staff concludes that Southern California Edison

Company's response to the NRC Order relating to San Onofre Nuclear Generating Station, Unit 1 ICCI system is acceptable. The staff final acceptance, however, is contingent on the resolution of the following open items.

(1) Emergency procedures and operator training in the use of the ICCI system have not been reviewed by the staff.

(2) Technical Specifications for the ICCI system have not been submitted and reviewed by the staff.

(3) An implementation letter report as required by Item II.F.2 of NUREG-0737 must be submitted by SCE (see attachment to this safety evaluation report, which provides the staff position for the final implementation for the ICCI System).

4.0 REFERENCES

1. Letter, F. R. Nandy (SCE), to USNRC, "Docket No. 50-206, TMI Action Plan Item II.F.2, Inadequate Core Cooling Instrumentation, San Onofre Nuclear Generating Station, Unit 1," November 29, 1990.

2. Letter, G. W. Knighton (NRC), to H. B. Ray (SCE), "Order Confirming Licensee Commitments on Full-Term Operating License Open Items - San Onofre Nuclear Generating Station, Unit 1," January 2, 1990.

ATTACHMENT

MILESTONES FOR IMPLEMENTATION OF

INADEQUATE CORE COOLING INSTRUMENTATION

1. Submit final design description (by licensee) (complete the documentation requirements of NUREG-0737, Item II.F.2, including all plant-specific information items identified in applicable NRC evaluation reports for generic approved systems).

2. Approval of emergency operating procedure (EOP) technical guidelines - (by NRC).

   NOTE: This EOP technical guideline which incorporates the selected system must be based on the intended uses of that system as described in approved generic EOP technical guidelines relevant to the selected system.

3. Inventory Tracking Systems (ITS) installation complete (by licensee).

4. ITS functional testing and calibration complete (by licensee).

5. Prepare revisions to plant operating procedures and emergency procedures based on approved EOP guidelines (by licensee).

6. Implementation letter* report to NRC (by licensee).

7. Perform procedure walk-through to complete task analysis portion of ICC system design (by licensee).

8. Turn on system for operator training and familiarization.

9. Approval of plant-specific installation (by NRC).

10. Implement modified operating procedures and emergency procedures (by licensee).

- System Fully Operational -

*Implementation Letter Report Content

(1) Notification that the system installation, functional testing, and calibration is complete and test results are available for inspection.

(2) Summary of licensee conclusions based on test results, e.g.:

   (a) the system performs in accordance with design expectations and within design error tolerances; or

(b) description of deviations from design performance specifications and basis for concluding that the deviations are acceptable.

(3) Description of any deviations of the as-built system from previous design descriptions with any appropriate explanation.

(4) Request for modification of Technical Specifications to include all ICC instrumentation for accident monitoring.

(5) Request for NRC approval of the plant-specific installation.

(6) Confirm that the EOPs used for operator training will conform to the technical content of NRC approved EOP guidelines (generic or plant specific).