June 15, 2001

MEMORANDUM TO: Steve Dembek, Section Chief
Project Director Section IV-2
Project Directorate IV
Division of Licensing Project Management, NRR

FROM: Evangelos C. Marinos, Section Chief ***(/RA by ECMarinos)***
Instrumentation and Controls Section
Electrical & Instrumentation and Controls Branch Division of Engineering

SUBJECT: LICENSE AMENDMENT REQUEST TO INCREASE SAN ONOFRE NUCLEAR GENERATING STATION UNITS 2&3 REACTOR POWER FROM 3390 MWt TO 3438 MWt

Plant Name: San Onofre Nuclear Generating Station Units 2&3
Licensee: Southern California Edison Company
TAC No: MB1623, MB1624
Docket No: 50-361, 50-362
Operating License: NPF-10, NPF-15
Project Directorate: PD VI-2
Responsible PM: J. Donoghue
Review Branch: EEIB
Review Status: Complete

By letters dated April 3, 2001, April 23, 2001, May 11, 2001, May 25, 2001, and May 31, 2001, Southern California Edison Company (SCE) requested NRC approval to increase the full core thermal power rating of San Onofre Nuclear Generating station (SONGS) Units 2 and 3 by 1.42% from 3390 MWt to 3438 MWt. This power uprate is based on CE Nuclear Power topical report CENPD -397-P-A which documents the Crossflow Ultrasonic Flow Meter's ability to achieve increased accuracy of flow measurement, and is generically applicable to nuclear power plants. The Electrical & Instrumentation and Controls Branch (EEIB) approved topical report CENPD-397-P-A in a March 2000 safety evaluation report (SER).

Attached is the EEIB safety evaluation of the SONGS Units 2 and 3 core thermal power measurement capability for the proposed 1.42% power uprate using the Crossflow

Ultrasonic Flow Meter (UFM) to measure feedwater flow. The staff finds that the Crossflow-assisted core thermal power measurement uncertainty is limited to 0.58% of actual reactor thermal power and, therefore, can support the proposed 1.42% uprate of the SONGS Units 2 and 3 licensed thermal power. This completes EEIB action on TAC Nos. MB1623 and MB1624.

Attachment: As Stated

CONTACT: I. Ahmed, EEIB/DE
301-415-3252

Ultrasonic Flow Meter (UFM) to measure feedwater flow. The staff finds that the Crossflow-assisted core thermal power measurement uncertainty is limited to 0.58% of actual reactor thermal power and, therefore, can support the proposed 1.42% uprate of the SONGS Units 2 and 3 licensed thermal power. This completes EEIB action on TAC Nos. MB1623 and MB1624.

Attachment: As stated

<u>DISTRIBUTED</u>
JCalvo
JDonoghue
EEIB R/F

ADAMS ACCESSION No.:ML011650467

OFFICE	EEIB:DE:NRR	SECY/EEIB:DE:NRR	SC/EEIB:DE:NRR
NAME	IAhmed	BParham	ECMarinos
DATE	06/14/01	06/14/01	06/14/01

OFFICIAL RECORD COPY

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION
REQUEST TO INCREASE REACTOR POWERFROM 3390 MWt TO 3438 MWt
SOUTHERN CALIFORNIA EDISON COMPANY
SAN ONOFRE NUCLEAR GENERATING STATION UNITS 2&3
DOCKET NO. 50-361, 50-362

1.0 INTRODUCTION

By letter dated April 3, 2001 (Reference 1), Southern California Edison Company (SCE) submitted a license amendment request to change the operating license and Technical Specifications (TSs) for San Onofre Nuclear Generating Station (SONGS) Units 2 and 3. The proposed change is to increase the full-core thermal power rating of each SONGS unit by 1.42% from 3390 MWt to 3438 MWt. The SCE's request is based on a reduced measurement uncertainty of core thermal power due to the installation of the Crossflow Ultrasonic Flow meter (UFM). The licensee's submittal referenced Topical Report CENPD-397-P-A,"Improved Flow Measurement Accuracy Using Crossflow Ultrasonic Flow Measurement Technology," and provided a description and an evaluation of the proposed changes. The CENP topical report was approved by the staff in March 2000 (Reference 2) and SCE's response to the staff's request for additional information (RAI) on the plant-specific justification for the proposed 1.42% power uprate was provided in letters dated April 23, 2001 (Reference 3), May 11, 2001(Reference 4), May 25, 2001(Reference 5), and May 31, 2001(Reference 6). Following is the staff's evaluation of the plant-specific justification for the proposed power uprate.

2.0 BACKGROUND

Nuclear power plants are licensed to operate at a specified core thermal power and the uncertainty of the calculated values of this thermal power determines the probability of exceeding the power levels assumed in the design basis transient and accident analyses. In this regard, Appendix K to 10 CFR Part 50 requires loss-of-coolant accident (LOCA) and emergency core cooling system (ECCS) analyses to assume that the reactor has been operating continuously at a power level at least 102.0% of the licensed thermal power to allow for uncertainties, such as instrument error. The phrase "such as" suggests that the 2% power margin was intended to address uncertainties related to heat sources in addition to the instrument measurement uncertainties. Later, the NRC concluded that, at the time of the original ECCS rulemaking, the 2% power margin requirement was solely based on the considerations associated with power measurement uncertainty. This development could justify a reduced margin between the licensed power level and the power level assumed in the ECCS analysis and, therefore, a power uprate.

In order to reduce an unnecessarily burdensome regulatory requirement and to avoid unnecessary exemption requests, the Commission published the final rule in the June 1, 2000, *Federal Register.* This final rule allows the licensees the options of justifying a smaller margin for power measurement uncertainty by using more accurate instrumentation to calculate the reactor thermal power or maintaining the current margin of 2% power. Licensees may apply the reduced margin to operate the plant at a level higher than the licensed power or use the margin to relax ECCS-related TSs. The final rule, by itself, does not allow licensees to increase the licensed power level without the NRC staff approval. Since the licensed power level of a nuclear power plant has a TS limit, the proposals to raise the licensed power level must be reviewed and approved under the license amendment process. The license amendment request should include a justification for the reduced power measurement uncertainty to support the proposed power uprate.

3.0 EVALUATION

Neutron flux instrumentation is calibrated to the core thermal power, which is determined by an automatic or manual calculation of the energy balance around the plant nuclear steam supply system (NSSS). This calculation is called “secondary calorimetric” for a pressurized water reactor (PWR) and “heat balance” for a boiling water reactor (BWR). The accuracy of these calculations depends primarily upon the accuracy of feedwater flow and main steam and feedwater temperature and pressure measurements. Feedwater flow is the most significant contributor to the core thermal power uncertainty. An accurate measurement of these three parameters will result in an accurate determination of core thermal power and an accurate calibration of the nuclear instrumentation.

The instrumentation used for measuring feedwater flow is typically an orifice plate, a venturi meter, or a flow nozzle. These devices generate a differential pressure proportional to the feedwater velocity in the pipe. Of the three differential pressure devices, a venturi meter is most widely used for feedwater measurement in nuclear power plants. The major advantage of a venturi meter is a relatively low head loss as the fluid passes through the device. The major disadvantage of the device is that the calibration of the flow element shifts when the flow element is fouled, which causes the meter to indicate a higher differential pressure and hence a higher than actual flow rate. This leads the plant operator to calibrate nuclear instrumentation high. Calibrating the nuclear instrumentation high is conservative with respect to the reactor safety, but causes the electrical output to be proportionally low when the plant is operated at its thermal power rating. To eliminate the fouling effects, the flow device has to be removed, cleaned, and re-calibrated. Due to the high cost of re-calibration and the need to improve flow instrumentation uncertainty , the industry assessed other flow measurement techniques and found the Crossflow UFM to be a viable alternative. The measurement uncertainties due to venturi fouling and instrumentation drift and calibration shifts are essentially eliminated when a Crossflow UFM is used. The crossflow UFM does not replace the currently installed plant venturi, but provides the licensee an in-plant capability for periodically re-calibrating the feedwater venturi to adjust for the effect of fouling. A unique advantage of the Crossflow UFM system is that it is installed external to the pipe in which flow is to be measured, thereby eliminating any possibility of compromising pressure boundary integrity.

The operation of a cross-correlation UFM is based on the fact that an ultrasonic beam traveling across fluid flowing in a pipe is affected (modulated) by the turbulence (eddies) present in the flowing liquid. When this modulated signal is processed, a random signal which is a signature of the flowing eddies can be obtained. In the Crossflow UFM, this operation is carried out by four ultrasonic transducers mounted on a metal support frame which is clamped on the feedwater piping. There is one upstream and one downstream transducer station, each station consisting of one transmitting and one receiving transducer. The Crossflow UFM calculates the time a unique pattern of eddies take to pass between the two ultrasonic transducer stations, and divides this known distance by the calculated time to obtain the flow velocity. This measured velocity is not an average velocity (highest velocity is at the center of the pipe) and should be multiplied by the "Velocity Profile Correction Factor" (VPCF) to obtain the average velocity of the fluid flowing in the pipe.

The Crossflow UFM system consists of a Mounting/Transducer Support Frame with ultrasonic transducers, a signal conditioning unit (SCU), and a data processing computer (DPC). The DPC receives a feedwater flow signal from the SCU and smoothed values of flow and temperature of main feedwater, main steam, and blowdown for each loop from the plant computer. Using the plant computer inputs and a built-in signal processing algorithm, the Crossflow DPC compares the ultrasonically-determined average flows and temperatures with the existing process measurements and produces correction factor. The DPC software validates each correction factor and if the expected accuracy is achieved, a "good" flag is generated; if the signals deviate from the expected accuracy, a "bad" flag is generated. The Crossflow- calculated mass flow is periodically compared to the venturi-measured mass flow to determine an adjustment of the venturi flow coefficient for obtaining the corrected mass flow signal. This corrected mass flow is used in calculating core thermal power and thereby calibrating nuclear instrumentation in accordance with the plant Technical Specification requirements.

ABB-CE Topical Report CENPD-397-P-A (previously approved by the staff) describes the Crossflow UFM system for the measurement of feedwater flow and provides a basis for the proposed 1.42% uprate of the licensed reactor power. The topical report includes a typical feedwater loop (straight pipe, fully developed flow) Crossflow measurement uncertainty calculation which established that the Crossflow UFM system is able to achieve an uncertainty of 0.5% or better with 95% confidence. The topical report provides specific guidelines and equations for determining uncertainty values of the Crossflow input parameters (VPCF, inside diameter, transducer spacing, feedwater density, and Crossflow time delay) . The plant-specific uncertainties are determined when the meter is installed, using the guidelines and equations provided in the topical report. The topical report stated that a trained CENP representative will install the hardware and software of the Crossflow UFM. Since the Crossflow measurement uncertainty is affected by temperature change, the topical report recommended improving the accuracy of temperature instrumentation.

Currently in SONGS design, the main feedwater is measured by an earlier version of Crossflow system which lacks the required upgraded component for achieving the accuracy needed for the proposed power upgrade. This instrumentation has been used only, to periodically verify the accuracy of the feedwater flow venturi and to calibrate the main steam flow venturi and does not meet the requirements of Topoical Report CENPD 397-P-A. Additionally, the existing feedwater temperature and steam generator blowdown flow and temperature instrumentation uncertainty was such, that installing Crossflow only in the feedwater line, would not sufficiently improve the secondary calorimetric power uncertainty to support the proposed power uprate. Therefore, to support the proposed power uprate, the SCE will install a new improved Crossflow UFM system and an Advanced Measurement Analysis Group(AMAG) high-accuracy ultrasonic temperature measurement (UTM) system on the main feedwater and the steam generator blowdown pipes. This new Crossflow UFM will replace the existing old version of the Crossflow system on the main feedwater system and will be located where the brackets for the existing UFMs are installed. This location meets Topical Report CENPD-397-P-A requirements. The licensee's submittal in reference four indicates that the Crossflow UFM and the AMAG-UTM measurements of feedwater flow and temperature and steam generator blowdown flow and temperature provide a four to five fold decrease in the instrument uncertainty. This will bring down the total secondary calorimetric power uncertainty from 2% with flow venturis to less than 0.58% with the Crossflow UFM and UTM. Like the Crossflow UFM, the UTM will have its own set of transducers and mounting frame and will use the ultrasonic signal transit time to determine the temperature of the process fluid. Flow and temperature data will be transmitted to the plant process computers called “Plant Monitoring System(PMS)” and “Core Operating Supervisory System(COLSS) Backup Computer System(CBCS)” for calculating reactor power. The CBCS is run as a backup channel and is typically used only when PMS is not available. The PMS and CBCS receive correction factors and quality flags from the Crossflow DPC. If the quality flags are “good” and the plant is above a minimum power level, the COLSS programs in each computer multiply the flow and temperature signals by their associated correction factors. The COLSS uses these corrected values of flow and temperature to calculate reactor thermal power and allows uprate operation of the power plant. If the quality flags become “bad,” both computers alarm and the COLSS continues using the last good quality correction factors up to a predetermined time. If the quality flag can not be restored to “good” during this interval, the correction factors will be changed to conservative default values.

The staff SER on ABB-CE topical report CENPD-397-P-A included four additional requirements to be addressed by a licensee requesting power uprate. SCE’s submittals addressed each of the four criteria as follows:

1. “The licensee should discuss the development of maintenance and calibration procedures that will be implemented with the Crossflow UFM installation. These procedures should include processes and contingencies for an inoperable UFM and the effect on thermal power measurement and plant operation.”

   In Reference 1, SCE stated that calibration and maintenance of the Crossflow UFM and UTM will be performed using SONGS maintenance and calibration procedures, which will be developed from vendor information and SONGS-specific experience, or will be performed by a combination of vendor procedures and SONGS procedures. The current software was verified and validated under CENP’s Verification and Validation Program and a periodic online monitoring of the Crossflow system will verify that the SCU, DPC, and software remain within the stated accuracy. The licensee stated in reference 6 that the vendor or another qualified calibration facility will calibrate the timer and amplifiers in the UFMs and UTMs based on the vendor’s recommendations.

   In response to the staff’s request for additional information (RAI), the licensee stated in reference 6 that the instrument calibration, software control, and hardware configuration will be performed to the same standards as the existing instrumentation and are subject to the requirements of Code of Federal Regulations 10CFR50.59. The SCE described its programs for the calibration of UFMs, UTMs, and all other instrumentation whose measurement uncertainties affect the plant power calorimetric uncertainty. Reference 6 lists the plant instrument calibration procedures that are applicable to these instruments. The licensee stated that each instrumentation and control (I&C) loop is calibrated following its applicable calibration procedure. If the output of the loop is found acceptable, no further calibration of individual loop component is performed. If the loop output is not acceptable, individual components are calibrated according to their applicable calibration procedures. The licensee also listed and described the SCE's procedures for performing corrective actions, reporting deficiencies to the manufacturers, and receiving and addressing manufacture deficiency reports on these instruments. The staff believes that the licensee's plant procedures can sufficiently assure instrumentation capability to provide acceptable power calorimetric uncertainty for the proposed power uprate.

As described in the licensee's submittals, the UFM system is inoperable when "sufficiently valid for use" correction factors are not produced and the correction factor quality flag changes from "good" to "bad" alarming in the plant computer system. The Crossflow correction factors are anticipated to be updated every four minutes under the automatic update conditions. With an inoperable Crossflow system the plant operation will continue at the uprate power level for an allowed outage time of 31 days using the most recently generated "good " correction factors. If the Crossflow system remains inoperable in excess of the allowed outage time, reactor power will be reduced to the currently licensed rated thermal power of 3390 Mwt. Continued operation of the COLSS programs with a "bad" quality flag does not affect safety since the COLSS programs will continue using the "good" correction factor. The allowed outage time of 31 days is currently used and based on the worst case drift of the existing instruments affecting power calorimetric uncertainty. The staff finds the licensee's actions for an inoperable Crossflow system in accordance with the amended ECCS rules and, therefore, acceptable.

2. "For plants that currently have Crossflow UFM installed, the licensee should provide an evaluation of the operational and maintenance history of the installed UFM and confirm that the instrumentation is representative of Crossflow UFM and bounds the requirements set forth in Topical Report CENPD-397-P-A."

The licensee stated in reference 1 that since 1997, an earlier version of the Crossflow UFM has been successfully used at SONGS to measure feedwater flow rate. This UFM was used to verify the feedwater flow signal and calibrate the steam flow signal used by the COLSS program for power calorimetric calculation to operate the plant closure to its licensed power limit of 3390 Mwt. Considerable experience has been gained in setting up and tuning the equipment, as well as conducting measurements using the existing SONGS procedure. This experience will be directly applicable to the installation , calibration, tuning, and use of the upgraded Crossflow UFM.

3. "The licensee should confirm that the methodology used to calculate the uncertainty of the Crossflow UFM in comparison to the current feedwater flow instrumentation is based on accepted plant setpoint methodology (with regard to the development of instrument uncertainty). If an alternate methodology is used, the application should be justified and applied to both the venturi and the UFM for comparison."

In Reference 1, SCE stated that the methodology used to calculate the uncertainty of the Crossflow UFM in comparison to the current feedwater flow instrumentation is based on accepted plant setpoint methodology, with regard to the development of instrument uncertainty in Regulatory Guide 1.105 and ISA S67.04. The licensee confirmed that an alternate methodology was not used and

Westinghouse calculation for the SONGS units 2 and 3 site-specific installation found the Crossflow UFM uncertainty to be equal to or better than ±0.5% of rated feedwater flow and ±10% of rated blowdown flow. These uncertainties were statistically combined with other instrumentation uncertainties which affect the plant secondary calorimetric power uncertainty. The total secondary calorimetric power uncertainty with a margin for AMAG UTM out of service and future plant changes, was found to be in the order of ±0.58% of rated thermal power, thereby justifying the proposed 1.42% power uprate. The staff review found the licensee's calculation to be based on an accepted plant setpoint methodology and is, therefore, acceptable.

4. "The licensee of the plant at which the installed Crossflow UFM was not calibrated to a site-specific piping configuration (flow profiles and meter factors not representative of the plant- specific installation), should submit additional justification. This justification should show that the meter installation is either independent of the plant-specific flow profile for the stated accuracy or that the installation can be shown to be equivalent to known calibrations and plant configuration for the specific installation, including the propagation of flow profile effects at higher Reynolds numbers. Additionally, for previously installed and calibrated Crossfow UFM, the licensee should confirm that the plant-specific installation follows the guidelines in the Crossflow UFM topical report.

The licensee stated in Reference 1 that for SONGS, there will be no site-specific configuration calibration because the installation is equivalent to known calibration and plant configurations for the specific installation, including the propagation of flow profile effects at higher Reynolds numbers. The meter installations are located on long straight sections of piping and will be far enough from disturbances to conform to the proprietary installation requirements of the Topical Report CENPD-397-P-A.

The staff finds that SCE's response to these requirements has sufficiently resolved the plant-specific concerns regarding Crossflow UFM maintenance and calibration, hydraulic configuration, and procedures and contingency plans for an inoperable Crossflow. The licensee used an approved methodology to calculate the plant-specific Crossflow measurement uncertainty and the plant power calorimetric measurement uncertainty.

4.0 CONCLUSION

Based on the review of the licensee's submittals regarding the Crossflow UFM system measurement uncertainty and plant power calorimetric measurement uncertainty, the staff finds that the SONGS Units 2 and 3 thermal power measurement uncertainty using the Crossflow UFM is limited to ±0.58% of actual reactor thermal power and can support the proposed 1.42% thermal power uprate. The staff also found that the licensee adequately addressed the four additional requirements outlined in the staff SER on the Crossflow Topical Report.

5.0 REFERENCES

1. D. E. Nunn (SCE) letter to NRC,"Request for License Amendment Increase in Reactor Power to 3438 MWt," dated April 3, 2001.

2. Stuart A. Richards (NRC) letter to Ian C. Rickard (PSEG), "Acceptance for Referencing of CENPD-397-P, Revision-01-P," dated March 20, 2000

3. D. E. Nunn (SCE) letter to NRC,"Response to Request for Additiional Information," dated April 23, 2001.

4. D. E. Nunn (SCE) letter to NRC,"Response to Request for Additional Information," dated May 11, 2001.

5. D. E. Nunn (SCE) letter to NRC,"Response to Request for Additional Information," dated May 25, 2001.

6. D. E. Nunn (SCE) letter to NRC,"Response to Request for Additional Information,"

Dated May 31, 2001.

Principal Contributor: I. Ahmed, EEIB
301-415-3252

Date: 6/15/01