AFFIDAVIT OF LAURENCE E. PHILLIPS
AND SUPPORTING DOCUMENTS

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UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	
PACIFIC GAS AND ELECTRIC CO.	)	Docket Nos. 50-275 - OL
	)	50-323 - OL
(Diablo Canyon Nuclear Power	)	
Plant, Unit Nos. 1 and 2)	)	

AFFIDAVIT OF LAURENCE E. PHILLIPS ON CONTENTION 13 AND SUBJECT 13

I, Laurence E. Phillips, being duly sworn, state as follows:

1. I am employed by the U.S. Nuclear Regulatory Commission (NRC) as a Section Leader of the Thermal-Hydraulics Section in the Core Performance Branch, Division of Systems Integration, Office of Nuclear Reactor Regulation.

2. I have prepared the statement of Professional Qualifications attached hereto, and, if called upon, would testify as set forth therein.

3. Contention 13 and Subject 13.

Contention 13 NRC regulations require instrumentation to monitor variables as appropriate to ensure adequate safety (GDC 13) and that the instrumentation shall directly measure the desired variable. IEEE 279, 4.8, as incorporated in 10 C.F.R. 50.55a(h), states that:

> "To the extent feasible and practical protection system imputs shall be derived from signals which are direct measures of the desired variables."

> Diablo Canyon has no capability to directly measure the water level in the fuel assemblies. The absence of such instrumentation delayed recognition of a low-water level condition in the reactor for a long period of time. Nothing proposed by the Staff would require a direct measure of water level or provide an equivalent level of protection. The absence of such instrumentation poses a threat to public health and safety.

The Board Concluded:

This contention raises an issue which is clearly TMI-related, and is included in NUREG-0737 (II.F.2) as an action item. As presented, the contention lacks specificity, as there is no argument among the parties that a water level indication will be required. During discussion of the contention (Tr. 258-252) it was revealed that the Intervenor's concern was that installation of the indicator would not be required until January 1, 1982, rather than before fuel loading and low power testing. With that understanding, the Board accepts Contention 13 as a litigable issue. Prehearing Conference Order at 23 (February 13, 1981).

Subject 13. Whether the licenses should issue prior to installation of PG&E of a reliable and unambigous method of measuring reactor vessel water level.

A. Whether PG&E's proposed system to measure water level in the reactor vessel is adequate for all conditions, including level swell, 2-phase flow, flow blockage and system dynamics. (SER, Supp. 10, p. II.F-9)

The Board Concluded:

Although lacking the basis and specificity required for an allowable contention, the subject is essentially the same as Joint Intervenors contention 13, which the Board has accepted. Governor Brown may, therefore, participate in litigation of this issue in the form in which the Joint Intervenor's contention was accepted. Prehearing Conference Order at 35 (February 13, 1981).

4. The basis of the contention is GDC 13 and 10 C.F.R. 50.55a(h). The intervenors contend that a direct measure of water level in the reactor core is needed to ensure adequate safety during fuel loading and low power testing and that an equivalent level of protection will not be provided by other instrumentation which will be available.

5. The most direct measure of inadequate core cooling would be fuel temperature, but instrumentation for this purpose is not available or practical in commercial light water reactors.

6. Alternate measurements which would be indicative of an inadequate core cooling condition are water level within the core and temperature of the coolant extracting heat from the fuel. Water level provides evidence of a condition indicative of core cooling adequacy while coolant temperature is dependent on and is an indicator of the fuel temperature.

7. All parties agree that the displays provided for Diablo Canyon do not indicate water level to the operator. Joint Intervenors and Governor Brown admitted this in Item A-1 of the NRC Request for Admissions. Water level may be deduced by post-event analysis of the available data.

8. The Staff does not agree with the Joint Intervenors' contention that TMI experience shows the core exit thermocouples to be unreliable indicators of inadequate core cooling. The deficiency at TMI was that the display went off-scale above 700°F (Ref. 1) and the operators believed that the indication was faulty. Later in the event, portable instruments were used to read the full range of thermocouple output. The core exit thermocouples then became the principal means of monitoring core cooling conditions, including blockage, and the progress of recovery from the accident.

9. For Diablo Canyon, the core exit thermocouple displays extend to 1650°F (Ref. 2), well above the 1200°F (Ref. 2) level which is considered to be a clear and definitive indication of an inadequate core cooling condition.

10. The Joint Intervenors and Governor Brown, in their response to Item A-4 of the NRC Request for Admissions, concede that core exit thermocouples provide an indication of the fluid temperature above the core at a "few" positions, but contend that they do not provide a direct indication that the core is "covered" or "uncovered."

11. The core exit thermocouples are actually distributed over the full core at 65 radial locations and provide an indication of superheat when the two phase froth level drops below the top of the core (Ref. 3).

12. As demonstrated at TMI-2, the core exit thermocouples were able to show both that the core was covered and that superheat persisted in some regions of the core due to blockage or core damage (Ref. 1). Since the most direct measure of inadequate core cooling is fuel temperature, measurement of the temperature of fluid exiting from the fuel provides a signal which is directly and closely associated with the parameter of interest.

13. The Joint Intervenors and Governor Brown in response to Item A-12 of the NRC Request for Admissions, argue that identified instrumentation available at Diablo Canyon for indication of inadequate core cooling does not provide direct indication. The Staff agrees but the water level instrumentation also would not provide direct indication.

14. Regulation 10 C.F.R. 50.55a(h) applies only to protection systems. Reactor water level instrumentation, when installed, will be used for monitoring and operator actions only and will not provide input to protection systems.

15. The Joint Intervenors and Governor Brown, in response to Items A-8 and A-9 of the NRC Request for Admissions, filed on February 24,

1981, agree that the high pressure and low pressure safety injection systems are initiated on low pressure signals to reflood the primary coolant system for those transient and accident conditions which result in low coolant inventory.

16. In response to Item A-10 and A-11, they do not refute the position that reactor vessel water level is not a necessary input to the safety injection system, although they argue that the signal could be used or may eventually be used as an input for makeup and/or safety systems.

17. Since the Staff and Joint Intervenors agree that the water level signal will initially be used only as an aid to the operator and not as a protection system input, the basis for Contention 13 is invalid and the contention should be dismissed.

18. The Joint Intervenors and Governor Brown in response to Items A-24 and A-25 agree that greater time is available to correct malfunctions in case of an accident during low power testing as compared to an accident during full power operation because the decay heat level is substantially reduced (at least 20 times less). For example, scoping calculations performed by the Staff indicate that the minimum time (adiabatic heat up) to increase the fuel temperature from 550°F to 1350°F following shutdown from full power for an uncovered and uncooled core would be 90 seconds compared to

3500 seconds (a factor of 39) for a core initially at 5 percent power.

19. The additional time for operator response after a core becomes uncovered following operation at 5 percent power provides a greater margin for operator response than does the advance warning given by water level instrumentation for a reactor operating at full power.

20. The Staff, therefore, concludes that water level instrumentation is not needed for low power testing and that the time available for operator response to inadequate core cooling is long enough to diagnose and mitigate potential severe accident sequences.

Laurence E. Phillips

Laurence E. Phillips

Subscribed and sworn to before me this 1st of April 1981

Marilyn Williamson

Notary Public

My Commission expires: July 1, 1982

REFERENCES

1. Pages 485, 486, 504, and 660, Three Mile Island, Volume II Part 2, A Report to the Commissioners and to the Public, by M. Rogovin and G. T. Frampton, Jr.

2. PG&E response to Item II.F.2 (Proprietary Submittal) from Mr. Crane (PG&E) to Mr. Miraglia (NRC) dated February 6, 1981.

3. Diablo Canyon Safety Evaluation Report, Supplement No. 14, Section II.F.2, Attachment B.

Laurence E. Phillips

CORE PERFORMANCE BRANCH
DIVISION OF SYSTEMS INTEGRATION
U. S. NUCLEAR REGULATORY COMMISSION

PROFESSIONAL QUALIFICATIONS

I am employed as a Section Leader of the Thermal-Hydraulics Section in the Core Performance Branch of DSI.

I graduated from the University of Cincinnati with a Chemical Engineering degree in 1954. After serving two years as an officer in the United States Army, I have been continuously employed in the nuclear engineering profession since January, 1957. I received a M.S. degree with nuclear physics major from Union College of Schenectady, N. Y., in 1961. I am a registered Professional Engineer, Certificate #E-026547, in the state of Ohio.

In my present work assignment at the NRC, I have supervisory responsibility for the review of the reactor core thermal-hydraulic design submitted in all reactor construction permit and operating license applications. In addition, my section participates in the review of analytical models used in the licensing evaluation of the core thermal-hydraulic behavior under various operating and postulated accident transient conditions. The latter responsibility includes technical review of the functional requirements for core monitoring systems to provide capability for detection and response to inadequate core cooling conditions.

Prior to joining the NRC staff in December, 1974, I was employed by NAI Corporation as a Senior Associate. In this capacity, I was responsible for the development and application of computer codes for analysis of nuclear reactor cores. I acted as a consultant to nuclear operating utilities in the use of these codes for analysis of their operation, and in the solution of general nuclear engineering problems. My tenure at NAI was from 1967 through 1974.

From 1962 to 1967, I was employed by Allis Chalmers Mfg. Co. My assignments during that period included supervisory responsibility for the safety analyses and licensing of the LaCrosse Boiling Water Reactor.

From 1958 to 1962, I was employed by Alco Products where I was project manager for the design, development, and fabrication of heat exchange equipment for nuclear liquid metal projects. Prior to that I was with the Nuclear Division of the Martin Company.

indication. The applicant has committed to add the level indication on the Post Accident Monitoring Panel.

We will condition the full power license to require installation of the containment water level monitor, meeting the requirements of NUREG-0737, by January 1, 1982. Based on our evaluation and the above cited condition to the license, we conclude that the containment water level monitoring system is acceptable.

In regard to position (6), the applicant has stated that two mutually redundant hydrogen monitors have been delivered to the Diablo Canyon Site. They are to be mounted outside of the containment with sample lines from two widely separated points inside the containment. They are capable of monitoring a range 0-10% hydrogen to an accuracy of ±2% of full scale. The readouts are mounted in the post-LOCA sampling room. In addition, recorders are mounted on the Post-Accident Monitoring panel (PAM-1). They will not normally be running, but can be energized and operated within 30 minutes.

The instrumentation has been procured and will be operational by the required implementation date. We will condition the full power license to require installation of the hydrogen monitors meeting the requirements of NUREG-0737 by January 1, 1982. We conclude, based on our evaluation and the license condition cited above, that the hydrogen monitors are acceptable.

II.F.2 Inadequate Core Cooling Instruments

Position

Licensees shall provide a description of any additional instrumentation or controls (primary or backup) proposed for the plant to supplement existing instrumentation (including primary coolant saturation monitors) in order to provide an unambiguous, easy-to-interpret indication of inadequate core cooling (ICC). A description of the functional design requirements for the system shall also be included. A description of the procedures to be used with the proposed equipment, the analysis used in developing these procedures, and a schedule for installing the equipment shall be provided.

Changes to Previous Requirements and Guidance

(1) Specify the "Design and Qualification Criteria" for the final ICC monitoring system in section, "Clarification" (items 7, 8, and 9), Attachment 1, and Appendix A.

(2) Specify complete documentation package to allow NRC evaluation of the final ICC monitoring systems to begin on January 1, 1981.

(3) No preimplementation review is required but postimplementation review of installation and preimplementation review before use as a basis for operator decisions are required.

(4) Installation of additional instrumentation is now required by January 1, 1982.

(5) Clarification item (6) has been expanded to provide licensees/applicants with more flexibility and diversity in meeting the requirements for determining liquid level indication by providing possible examples of alternative methods.

Discussion and Conclusions

In its February 6, 1981 response to NUREG-0737 requirements the applicant provided a proprietary submittal "PG&E Response to Item II.F.2 Instrumentation for Detection of Inadequate Core Cooling."

The existing instrumentation in the Diablo Canyon facility for detection of inadequate core cooling (ICC) consists of redundant wide range reactor coolant pressure, wide range coolant temperature sensors (total 8 RTD's, one for each hot leg and one for each cold leg in each loop), 65 core exit thermocouples, and a Combustion Engineering subcooling margin monitor which has temperature input from each of the reactor coolant system hot legs (4 RTD's) and from six core exit thermocouples, and pressure input from two pressure measurements from hot legs.

PG&E is adding a reactor vessel level instrumentation system (RVLIS), designed by Westinghouse, to supplement existing instrumentation in determining the existence of ICC. The description of the RVLIS in the applicant's February 6, 1981 submittal, including hardware description, microprocessor system, resistance temperature detectors, RVLIS valves and transmitters, hydraulic isolators, and sensors are being reviewed by the staff.

The staff has not approved the generic Westinghouse revised analysis and guidelines required by Task Action Plan item I.C.1(3) and clarified in NUREG-0737. Therefore, the pilot monitoring discussed in item I.C.8, Pilot Monitoring of Selected Emergency Procedures, was conducted using interim guidelines that have been approved by the staff. The adequacy of the vendor provided guidelines was discussed in a meeting with PG&E personnel on November 3 and 4, 1980. The draft procedures we reviewed for I.C.8 reflected the Westinghouse analysis of small-break LOCAs and inadequate core cooling in accordance with a license requirement and Task Action Plan (NUREG-0660) item I.C.1. However, on November 10, 1980 the Westinghouse Owners' Group provided additional guidelines for the mitigation of inadequate core cooling. The staff has not completed its review of these guidelines. The changes made to the draft procedures and any additional changes that may result from our review of the November 10, 1980 guidelines must be made and the Diablo Canyon operators must be trained on the changes and their bases prior to operation above 5% of the rated power level. The Office of I&E will verify that these requirements are satisfied.

Based on our review of the emergency procedures and our observation of the procedures being implemented on the simulator and in the plant walk-through, we have concluded that when the required changes have been made to the procedures as specified in Section I.C.8, the Diablo Canyon emergency operating procedures will be acceptable for operation at power levels up to 100 percent of rated power. Future actions required by Task Action Plan items I.C.1.a(3), Transients and Accidents and I.C.9, Long-Term Program Plan for Upgrading of Procedures may require future revisions to the emergency procedures.

In response to a staff request for additional information to supplement the February 6, 1981 submittal, the applicant has provided additional information

on March 19, 1981 including an evaluation of the subcooling meter and documentation required by NUREG-0737 Section II.F.2.

The subcooling margin monitoring system is environmentally qualified in accordance with Regulatory Guide 1.89 except for the backup analog recorder which is not subject to a harsh environment and the incore thermocouple inputs which are being upgraded and will be completed during the first refueling outage. No single failure will prevent the operator from determining the subcooling margin. All components are redundant except for the calculator itself. Should the calculator fail, the operator will monitor the loop temperature and pressure and then determine the degree of subcooling using steam tables and procedures specifically provided for this function. The monitor is powered by a Class IE power source. The staff has reviewed and found it to be acceptable. However, we will require that the upgrade of the incore thermocouple display system shall be completed by January 1982.

In the February 6, 1981 submittal the applicant has addressed the conformance of the incore thermocouples to the requirement of Appendix B, "Design and Qualification Criteria for Accident Monitoring Instrumentation," provided in NUREG-0737, "Clarification of TMI Action Plan Requirements." The incore thermocouple systems will satisfy these requirements by the required implementation date except for the following:

(1) The finalized system will be seismically and environmentally qualified in accordance with requirements of the criteria. The applicant has proposed replacement of the incore thermocpuple in-containment connectors and junction boxes with environmentally qualified equipment during the first refueling outage since the material will not be available by the required implementation date. We will require that the qualified equipment be installed during the first extended plant outage following component availability. All other aspects of the seismic and environmental qualifications will be completed by the required January 1, 1982.

(2) The 65 incore thermocouples (TCS) will be separated into two groups (one covering 32 TCS and one covering 33 TCS) with separate readout indicators

to provide redundant indication as backup displays with readout ranging from 200°F to 2300°F. Also all thermocouples signals are routed to the plant computer for the core mapping function as a primary operator display. The qualification criteria requires that the transmission of signals for other use should be through isolation devices that are designated as a part of the monitoring instrumentation and meet the provisions of Regulatory Guide 1.75. The applicant has noted that the computer has input isolation; however, it does not satisfy the requirements to be classified as Class 1E and conform to more stringent isolation requirements. Since the computer is a common element of this redundant indication system, full conformance to the isolation criterion has not been provided. Therefore, we will require that the applicant provide additional analysis to justify that the plant computer is not a source of common failure for the redundant indication of core region outlet temperatures, or that there is a low probability that such a failure could occur and that if it did, appropriate action could be taken to restore the indication system to an operable status. We will pursue this matter further and effect a resolution prior to the required implementation date for this upgrade in inadequate core cooling instrumentation.

Prior to January 1, 1982 the applicant has committed (1) to install the RVLIS, (2) to complete the reactor coolant pressure transmitter relocation, and (3) complete upgrading the incore thermocouple readouts for both the primary operator displays and the backup displays. The primary operator displays utilize an alphanumeric display located remotely from the computational system which can display all thermocouple temperatures. All readings (ranging from 200°F to 2300°F) can be printed out on a hard copy printer.

The applicant has also committed in the March 19, 1981 letter to provide additional submittals with respect to the report on the results of the portions of ongoing RVLIS test programs which are scheduled to be completed by November 1981 and the in-situ calibration document prior to January 1982, and a summary of key operator actions consistent with current procedures by April 15, 1981.

The staff has reviewed the applicant's commitments stated above and has concluded that they are acceptable, except for issues on the applicant's proposed schedule for completing the upgrade incore thermocouple wiring and the analysis for isolation devices which we require to be resolved by January 1982.

The staff has performed an acceptance review of the documentation which was submitted on February 6 and March 18, 1981. Based on the results of our review, we conclude that the description of the instrumentation for detection of ICC for Diablo Canyon Facility meets the documentation requirements of NUREG-0737, Section II.F.2, and is acceptable for full-power operation. We will condition the full-power license to require that, prior to January 1982, the issues on the isolation devices used to isolate redundant core region outlet thermocouples at the plant computer be resolved. Further, the completion of the upgrading of the incore thermocouple wiring, shall be completed during the first extended outage following component availability; and that prior to operating above 5% of rated power the applicant must make certain procedural revisions, train the operators on these revisions, and submit these procedures for staff review. The ICC system will be reviewed for acceptability after installation, testing, and calibration of the reactor vessel level instrumentation is complete.

II.K.2 Commission Orders on Babcock and Wilcox Plants

II.K.2, Item 13, Thermal-Mechanical Report

The Westinghouse Owners Group, of which PG&E is a member, will address the NRC requirements of detailed analysis of the thermal-mechanical conditions in the reactor vessel during recovery from small breaks with an extended loss of all feedwater. This program is scheduled to be completed and documented to the NRC by January 1, 1982 and will consist of analyses for generic Westinghouse PWR plant groupings.

Following the completion of this generic program, PG&E has committed to supply a plant specific analysis based on the generic analysis, if required. This schedule is consistent with the requirements of NUREG-0737, and we find the PG&E commitment acceptable.