UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	
TEXAS UTILITIES ELECTRIC COMPANY, et al.	)	Docket Nos. 50-445 50-446
	)	
(Comanche Peak Steam Electric Station, Units 1 and 2)	)	(Application for Operating Licenses)

AFFIDAVIT OF EDWARD ALARCON REGARDING K_{eff} AND BORON CONCENTRATIONS

My name is Edward Alarcon. My business address is Comanche Peak Steam Electric Station, P. O. Box 2300, Glen Rose, Texas 76043. I am the section head of Results Engineering for Comanche Peak Steam Electric Station ("CPSES"). In that capacity, I am responsible for initial fuel loading activities, precriticality testing, and other initial startup testing. A statement of my educational and professional qualifications is attached to Applicants' Motion for Authorization to Issue a License to Load Fuel and Conduct Certain Precritical Testing filed on August 7, 1984.

The purpose of this Affidavit is to respond to the Licensing Board's request for additional information concerning K_{eff} and boron dilution, and to identify the systems and procedures relevant to fuel loading and precritical testing as set forth in the Board's "Memorandum (Request for Evidence Relevant to Fuel Loading)" dated August 24, 1984.

Calculations Regarding K_{eff}

The Licensing Board requested "evidence concerning the maximum K_{eff} to be permitted during precritical testing that analysis suggests that may be achieved during precritical testing if all control rods were inadvertently removed while the boron concentration was 2000 ppm . . . ." Board Memorandum at p. 2.

In response to the Board's first question, the maximum K_{eff} permitted during precritical testing is established by Technical Specifications as .990 during cold shutdown (coolant temperature less than or equal to 200°F) and .984 at elevated temperatures (greater than 200°F). (It should be noted that as the coolant temperature increases, K_{eff} decreases). Reactivity control requirements during refueling are based on boron concentration. Specifically, in accordance with Technical Specifications, the boron concentration must be maintained sufficient to assure that the more restrictive of the following reactivity conditions is met: (1) K_{eff} of .950 or less, or (2) boron concentration of greater than or equal to 2000 ppm. For the initial fuel loading at CPSES, the limit of 2000 ppm boron concentration is the more restrictive limit and provides substantial conservatism as discussed below.

During fuel loading, CPSES will maintain the boron concentration in the reactor coolant system at greater than or equal to 2000 ppm as required by CPSES Technical Specifications. The fuel designer has provided design information and curves related to the initial fuel design. This information was developed using methodologies descibed or referenced in Section 4.3 ("Nuclear Design") of the FSAR. The minimum boron concentration required to maintain K_{eff} less than or equal to .950 with all rods inserted is 1275 ppm. Therefore, the requirement for 2000 ppm is extremely conservative. During precritical testing, again the boron concentration will also be maintained at greater than or equal to 2000 ppm. This conservative administrative control exceeds the requirements of the CPSES Technical Specifications during these modes of operation.

Using conservative assumptions, the maximum K_{eff} expected during precritical testing (either hot or cold) was calculated to be .984. The conditions associated with this calculation are a boron concentration of 2000 ppm, a coolant temperature of 68°F and the most reactive control rod bank withdrawn.

In response to the Board's second question regarding the K_{eff} which may be achieved assuming a 2000 ppm boron concentration and <u>all</u> control rods fully withdrawn, I would like to first state that the likelihood of all control rods being simultaneously fully withdrawn is virtually nonexistent. Except during specific tests on the rod control, rod drive, and reactor trip systems, these systems will be deenergized, precluding inadvertent rod withdrawal. Also, during testing of these systems, all control rod movement will be tightly controlled by detailed step-by-step test procedures. These procedures also require increased monitoring of nuclear instrumentation and rod position indication to preclude unauthorized rod configurations or inadvertent reactivity additions during control rod movements. Finally, following those tests which require control rod withdrawal, positive restoration steps are taken to prohibit further control rod motion. These steps include opening the reactor trip breakers and deenergizing the rod control motor generators to remove power from the control rod drive mechanisms and thereby preclude rod withdrawal.

In any event, even if all control rods were fully withdrawn at the worst case coolant temperature of 69°F, using conservative calculations K_{eff} would be only .932, still well below the Technical Specifications limit of.990. Indeed, conservative calculations reflect that assuming a coolant temperature of 68°F and all control rods fully withdrawn, the boron concentration could drop to 1390 ppm and K_{eff} would still be below .990.

Maintaining Boron Concentrations

The Licensing Board requested evidence "that non-borated water will never be injected into the core, substantially diluting the boron below 2000 ppm." Board Memorandum at p. 2. This will provide the evidence requested.

Makeup water to the Reactor Coolant System ("RCS") is provided either from the volume control tank of the Chemical and Volume Control System ("CVCS") or from the Refueling Water Storage Tank ("RWST"), a large tank normally containing several hundred thousand gallons of borated water. (Highly borated water, approximately 7000 ppm, is also available from the boric acid tanks in the CVCS). Prior to fuel loading, the CVCS and RWST, as well as the Reactor Coolant System, are borated to at least 2000 ppm.

Immediately prior to commencement of the fuel loading sequence, the boron concentration of the RWST is again established and then maintained greater than or equal to 2000 ppm as required by CPSES Technical Specifications. Also, as required by this test procedure, the Reactor Coolant System is sampled and analyzed for boron concentration at several places to assure uniformity of the 2000 ppm minimum boron concentration. Finally, also as a prerequisite to initial fuel loading, certain valves in the CVCS are closed and secured in the closed position. These valves block all flow paths that could allow unborated makeup water to reach the reactor coolant system. Therefore, any makeup which is required during refueling will be borated water supplied from the RWST.

It should be noted that once the proper boron concentration is verified immediately prior to commencement of initial fuel loading, a monitoring program is initiated and maintained throughout the initial fuel loading sequence to verify that the boron concentration remains at the desired level, at least 2000 ppm. This monitoring program requires sampling and chemical analysis of the boron concentration by a chemistry technician every four hours. The results of the analysis are reported to the control room for review by the operators and the initial startup test engineer on duty, who compares the results with the boron concentration that should be in the system. If the boron concentration decreases below 2000 ppm or the boron concentration deviates by 20 ppm or more between samples, test procedures require the operator to stop the initial fuel loading process and initiate investigative and corrective actions.

Upon completion of the initial fuel load, the precritical test sequence begins. During the precritical test sequence, the Reactor Coolant System will be restored to normal operation with the reactor vessel head reassembled and the CVCS in normal operation. The charging flow to and letdown flows from the RCS are automatically controlled by the CVCS to maintain a constant RCS coolant inventory. Also, within the CVCS, a boric acid blend system is available to allow the operator to match the makeup water's boron concentration to that of the RCS during normal charging.

Prior to the commencement of the actual testing, the RCS boron concentration is sampled and analyzed to verify a boron concentration of at least 2000 ppm. As stated earlier, this requirement of 2000 ppm during this test phase is extremely conservative, exceeds the requirements of the CPSES Technical Specifications and provides a substantial shutdown margin. A monitoring program is initiated and maintained on a frequency of one per shift (i.e., every 8 hours) to ensure that the boron concentration of the reactor coolant system remains greater than or equal to 2000 ppm. If the boron concentration decreases below 2000 ppm, all activities which could add positive reactivity to the core are halted and the boron concentration is restored to at least 2000 ppm.

Prevention, Detection, and Mitigation of An Inadvertent Boron Dilution

The CPSES Final Safety Analysis Report, section 15.4.6 addresses the causes and automatic actions associated with an inadvertent boron dilution event. Some of that information is summarized here along with some pertinent remarks concerning initial fuel loading and precritical testing.

As previously stated, during fuel loading, the boron concentration is established and continuously maintained at greater than or equal to 2000 ppm. Most importantly, all potential sources of unborated water are isolated from the RCS by closing and securing closed certain valves in the CVCS. Any required makup during refueling will be borated water from the RWST which is maintained within strict Technical Specification requirements. Therefore, an uncontrolled boron dilution during the initial fuel loading is virtually impossible.

Although the above is true, the boron concentration is still monitored every four hours. Also, during this test sequence, the nuclear instrumentation, which has readouts in the continuously manned control room, and other special instrumentation will be closely monitored to detect and trend the reactivity in the core. Any unexpected reactivity changes would require the immediate suspension of initial fuel loading actions and the initiation of investigative actions as to the cause of such unlikely changes.

During the precritical test sequence, the RCS is established and maintained at a conservative limit of greater than or equal to 2000 ppm boron concentration. The only credible cause of an inadvertent boron dilution is described in FSAR Section 15.4.6 and involves a malfunction in the CVCS. Administrative and procedural controls have been established to effectively preclude inadvertent injection of unborated makeup water into the RCS from the CVCS due to operator error. Operation of the CVCS is performed in accordance with procedures which are step-by-step in nature, and which are performed under the direction of trained and licensed reactor operators.

The boron monitoring program on each shift will detect any changes in boron concentrations. Further source range neutron instrumentation level indication is continuously logged on strip charge recorders, so that the operator may detect trends, such as changes in source range level due to boron dilution. It should be noted that the source range channels in the control room also have audio indication. The audio indication is in the form of continuous "clicks" (such as a typical radiation detector) which increases or decreases in frequency based on neutron flux changes in the reactor core. Any significant change in boron concentration in the Reactor Coolant System would result in a substantial and very noticeable change in the "clicking" frequency.

Finally, FSAR Sections 7.6.11 and 15.4.6 describe the components provided to mitigate the consequences of an inadvertent boron dilution at CPSES. Briefly, in the unlikely event of an inadvertent boron dilution transient the source range nuclear instrumention will detect a doubling of the neutron flux by continuous comparison of the current source range flux to that of approximately ten minutes earlier. This flux-doubling system is a safety-related redundant system. Upon detection of the flux doubling, an alarm is sounded for the operator and valve movement to terminate the dilution and start boration is automatically initiated. No immediate operator action is required. These automatic actions are carried out to stop any approach to criticality and regain any lost shutdown margin.

In conclusion, based on the foregoing, in my professional opinion, it is a virtual impossibility for a boron dilution event to be initiated and continue until a K_{eff} of .990 is exceeded.

Selection of Relevant Systems
and Procedures

The Licensing Board requested information concerning the adequacy of QA/QC oversight activities on systems that may be called upon to function during fuel loading and precritical testing to protect public health and safety. The Board stated that at least four systems were included in this category, i.e.,

(1) boron addition and monitoring equipment, (2) reactor monitoring equipment, (3) fuel loading equipment, and (4) reactor protection systems. Board Memorandum at p. 2. In response to the Board's request, I conducted an evaluation of all plant systems to determine the systems that fell into the category specified by the Board, as noted above. The list of ten systems/equipment groupings attached to Mr. Vega's Affidavit reflects my determination of the CPSES specific systems requested by the Board, plus any other components or systems that might be required to function to mitigate any inadvertent event such as boron dilution. It should also be noted that the CPSES Technical Specifications will require additional equipment or systems to be operable depending upon the plant operational mode.

The Board also requested information regarding the "appropriate QA/QC procedures" needed for fuel loading and precritical testing (Board Memorandum at p. 2). In response to the Board's request, I conducted a review to determine which procedures fell into this category. Based on my review, these 21 initial startup (ISU) procedures identified in the attachment to Mr. Deviney's Affidavit are the major controlling documents requested by the Board. As noted in Mr. Deviney's Affidavit, other routine plant procedures may be referenced in these ISU procedures or may be used to support the activities of fuel load and precritical testing.

Edward Alarcon

Edward Alarcon

County of Somervell)

)

State of Texas)

Subscribed and sworn to before me this 13 day of September, 1984

Westy L. Barnett

Notary Public

My commission expires: 09/04/85

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CERTIFICATE OF SERVICE

I hereby certify that copies of the foregoing "Applicants' Supplement to Motion for Authorization Pursuant to 10 C.F.R. § 50.57(c)" in the above-captioned matter were served upon the following persons by hand delivery,* by overnight delivery,** or by deposit in the United States mail,*** first class, postage prepaid, this 13th day of September, 1984:

*Peter B. Bloch, Esq.
Chairman, Atomic Safety and Licensing Board
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

*Dr. Walter H. Jordan
881 West Outer Drive
Oak Ridge, Tennessee 37830

**Dr. Kenneth A. McCollom
Dean, Division of Engineering Architecture and Technology
Oklahoma State University
Stillwater, Oklahoma 74074

***Mr. John Collins
Regional Administrator, Region IV
U.S. Nuclear Regulatory Commission
611 Ryan Plaza Drive
Suite 1000
Arlington, Texas 76011

***Chairman, Atomic Safety and Licensing Appeal Panel
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

**Mr. William L. Clements
Docketing & Service Branch
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

*Stuart A. Treby, Esq.
Office of the Executive Legal Director
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

***Chairman, Atomic Safety and Licensing Board Panel
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

***Renea Hicks, Esq.
Assistant Attorney General
Environmental Protection
Division
P.O. Box 12548
Capitol Station
Austin, Texas 78711

***Lanny A. Sinkin
114 W. 7th Street
Suite 220
Austin, Texas 78701

**Mrs. Juanita Ellis
President, CASE
1426 South Polk Street
Dallas, Texas 75224

*Ellen Ginsberg, Esquire
Atomic Safety and Licensing
Board Panel
U.S. Nuclear Regulatory
Commission
Washington, D.C. 20555

Sanford L. Hartman

cc: John W. Beck
Robert Wooldridge, Esq.