TENNESSEE VALLEY AUTHORITY

CHATTANOOGA, TENNESSEE 37401
400 Chestnut Street Tower II

May 10, 1983

Director of Nuclear Reactor Regulation
Attention: Ms. E. Adensam, Chief
Licensing Branch No. 4
Division of Licensing
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Ms. Adensam:

In the Matter of the Application of	)	Docket No. 50-390
Tennessee Valley Authority	)	50-391

The Watts Bar Nuclear Plant (WBN) Safety Evaluation Report (SER), NUREG-0847, page C-21, specifies that TVA needs to provide additional justification for the position that the research and development work performed for Sequoyah Nuclear Plant (SQN) in the area of hydrogen control capabilities is directly applicable to WBN. The SER indicated that the request for this justification is based on the fact that the WBN containment is designed to withstand larger internal pressures than SQN and that the containment spray flow rate for WBN is 4000 gal/min compared to 4750 gal/min for SQN. Enclosed is the requested justification which shows that the research and testing results are independent of plant containment spray conditions or containment boundary pressure retaining capabilities.

If you have any questions concerning this matter, please get in touch with D. P. Ormsby at FTS 858-2682.

Very truly yours,

TENNESSEE VALLEY AUTHORITY

L. M. Mills

L. M. Mills, Manager
Nuclear Licensing

Sworn to and subscribed before me
this 10th day of May 1983

Paulette H. White

Notary Public
My Commission Expires 9-5-84

Enclosure
cc: U.S. Nuclear Regulatory Commission
Region II
Attn: Mr. James P. O'Reilly Administrator
101 Marietta Street, NW, Suite 2900
Atlanta, Georgia 30303

B001

ENCLOSURE

WATTS BAR NUCLEAR PLANT UNITS 1 AND 2
HYDROGEN CONTROL MEASURES
RESEARCH AND RESULTS

1. Igniter Testing - Because TVA will use the same kind of igniter (Tayco) at WBN that is used at SQN, the testing and results are directly applicable to WBN. This included cycling and endurance testing at TVA's Singleton Lab and small-scale combustion tests at Whiteshell.

2. Combustion Testing - The Whiteshell test program included intermediate-scale combustion testing using a 7.5 ft diameter sphere. The purposes of these tests were to investigate lean mixture combustion, rich mixture deflagrations, fan- and obstacle-induced turbulence, and compartmentalized geometry effects. All of the tests yielded favorable results which support the effectiveness of TVA's Permanent Hydrogen Mitigation System (PHMS). Of special interest are the results of the rich mixture deflagration tests in which no detonations were observed even at stoichiometric and higher concentrations of hydrogen which are classically considered to be detonable. The turbulence test results indicate that no unanticipated pressure effects result from forced turbulence, even at high concentrations of hydrogen. Also, the compartmentalized geometry effects were investigated by attaching a 20-ft long by 1-ft diameter pipe to the 7.5-ft diameter sphere. For all tests, no detonations occurred and no significant effects of propagating flames was observed.

   The Acurex test program included intermediate-scale combustion testing in a 17-ft high cylinder. The purposes of the tests were to study the effects of spray environments and igniter location during both quiescent and dynamic tests. The favorable pressure-suppressing effect of steam and turbulence induced by the spray were observed. In dynamic tests with sprays the maximum pressure increase was 5 lb/in^2g above the initial cylinder test pressure.

   The above described models and the results obtained from the testing are applicable to both Sequoyah and Watts Bar.

3. Hydrogen Mixing and Distribution - A series of large scale tests was conducted at the Hanford Engineering Development Laboratory (HEDL) Containment Systems Test Facility (CSTF). This facility has a vessel that is 67 feet tall with a diameter of 25 feet. The interior of the CSTF was modified to represent a divider deck, reactor cavity, refueling canal, the air return fans, and ice condenser lower inlet doors. For the purpose of these tests, geometric similarity was retained between the test compartment and the lower compartment of an ice condenser containment such as Sequoyah and Watts Bar.

   In evaluating the test results, as reported in Sequoyah SSER 6, the staff concluded that the formation of detonable pockets of hydrogen is precluded.

5. Detonations

TVA has concluded, and the staff has concurred in Sequoyah SSER 6, that hydrogen detonation is not a credible phenomenon because (a) there would be no rich concentrations of hydrogen throughout the containment because the distributed igniters would initiate combustion as the mixture reached the lower flammability limit and because effective mixing would occur, (b) there are no high-energy sources to initiate a detonation, and (c) there are no areas of the containment with sufficient geometrical confinement to allow for the flame acceleration necessary to yield a transition to detonation. The HEDL tests confirm that a well-mixed atmosphere will be present inside containment. Even given a local cloud of a high concentration of hydrogen, the igniter tests verified that there was not enough energy generated to initiate detonation. There are no other high energy ignition sources present in containment to initiate detonation before combustion is initiated by a local igniter. The tests at Whiteshell and further tests at McGill University and Sandia National Laboratory yielded results which support the conclusion that flame propagation necessary to yield a transition to detonation due to compartmentalized geometry effects is extremely unlikely. These tests are applicable to both SQN and WBN. WBN is geometrically similar enough to SQN to draw the same conclusions that transition to detonation is incredible. WBN has no areas with sufficient geometric confinement necessary for flame acceleration that yields a transition to detonation.

6. Comparisons

In addition, structural analyses of the SQN and WBN steel containment vessels have been performed by TVA (and verified independently by NRC) which demonstrated significant (factor of three and higher) margins in the actual vessel internal pressure retaining capacity above the 12 and 15 lb/in^2g design values, respectively. Therefore, given the available margin in the as-constructed containments and the relatively low calculated pressure rises induced by hydrogen burning, TVA concludes that the controlled combustion of hydrogen is an acceptable means of ensuring that containment integrity during an accident is maintained.

The only potentially nonconservative design differences between SQN and WBN that is of significance to degraded core containment analysis is the containment spray system flow rate which is 4750 gal/min per train at SQN and 4000 gal/min per train at WBN. The same design flow rate (15.2 gal/min) is supplied to each spray nozzle at SQN and WBN at the same design pressure (40 lb/in^2) so the same drop size distribution would result. The reduced total flow rate at WBN is due to the reduced number of nozzles. This difference in spray flow rate (about 15 percent) would only become an issue for events that led to combustion in the upper compartment. However, the latest analyses for SQN (submitted November 1981) showed that upper compartment burns did not occur for the base case or any reasonable sensitivity cases.

In addition, one of the sensitivity cases analyzed for the SQN submittal assumed that only one train of sprays (4750 gal/min or 50 percent) and one air return fan were operating. The containment pressure and temperature response for this case was virtually unchanged from the base case. Therefore, we believe that the previously submitted SQN analyses have demonstrated that the reduced containment spray flow rate at WBN would not signficantly affect the ability of the containment to mitigate hydrogen produced during a degraded core accident.

The PHMS igniters in the upper plenum at WBN are located relatively low and are alternated on opposite walls. This encourages more complete burning at lean concentrations of hydrogen and provides good spatial coverage. This was the preferred upper plenum arrangement at SQN in the original design but had to be modified due to the installation at SQN being an outage backfit instead of being done before operation. The SQN arrangement was justified to the NRC and accepted for use. There are no other significant differences between the SQN and WBN designs.

7. <u>Testing Summary</u>

Although all of TVA's research regarding hydrogen control has been submitted under the SQN docket, the tests were not so restrictive so as to apply only to SQN. The tests were conducted so as to gain a better understanding of (1) the validity of TVA's PHMS design philosophy, (2) to better understand the conditions under which hydrogen will combust, (3) to determine under what conditions hydrogen will detonate, and (4) how special effects such as spray, air turbulence, and geometry affect the way hydrogen combusts and the likelihood of detonation. The results of these tests are directly applicable to WBN. The SQN SSER 6 should be referenced for details regarding the conclusions NRC reached as a result of TVA's research and testing results.