TENNESSEE VALLEY AUTHORITY

CHATTANOOGA, TENNESSEE 37401

400 Chestnut Street Tower II

November 2, 1984

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	)	Docket Nos.	50-327
Tennessee Valley Authority	)		50-328

As required by the Sequoyah Nuclear Plant unit 1 operating license condition 2.C.(22).D.(2), TVA performed additional testing on the Tayco igniters. The required testing has been completed and the results are provided in the enclosed final report. Based on the information provided in the enclosure, we continue to believe that the design of the hydrogen mitigation system is acceptable and that the design of the igniter assemblies is adequate to ensure satisfactory igniter performance.

However, if the NRC believes that another level of conservatism is needed to ensure proper operation of the igniters in the upper compartment of containment while exposed to postulated turbulent conditions, TVA can modify the igniter design to add a cylindrical, perforated shield that has been tested as described in the enclosed report to resolve the issue of hydrogen combustion control for Sequoyah.

If you have any questions concerning this matter, please get in touch with Jerry Wills at FTS 858-2683.

Very truly yours,

TENNESSEE VALLEY AUTHORITY

L. M. Mills

L. M. Mills, Manager
Nuclear Licensing

Sworn to and subscribed before me
this 2nd day of Nov 1984

Paulette H. White

Notary Public
My Commission Expires 8-24-88

Enclosure
cc: U.S. Nuclear Regulatory Commission (Enclosure)
Region II
Attn: Mr. James P. O'Reilly Administrator
101 Marietta Street, NW, Suite 2900
Atlanta, Georgia 30323

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ENCLOSURE

FINAL REPORT ON TAYCO IGNITER TESTING
SEQUOYAH NUCLEAR PLANT

I. Background

There are presently ten igniter assemblies located in the upper compartment of each containment that could be exposed to the spray environment below the spray headers. These assemblies were all originally equipped with flat overhead shields to deflect any spray from above. In the latter part of 1982, the NRC verbally expressed concern to TVA that spray-induced turbulence in the upper compartment could entrain a sufficient amount of spray to bypass the overhead shield and cool the igniter below its ignition threshold. Although TVA did not believe that it was a significant problem, we immediately took steps to alleviate this concern by enlarging the overhead shields to protect the igniter from direct impingement throughout a 100-degree angle and by conducting a number of expedited tests at our Singleton Laboratory to study igniter spray performance. Our conclusion after enlarging the shields and completing the testing was that the modified igniter assemblies were satisfactory for operation in the upper compartment spray environment.

The bases for our conclusion were formally stated in a submittal from L. M. Mills to Ms. E. Adensam dated January 31, 1983, and are only summarized here. First, we have analytically demonstrated with the CLASIX computer code that it is highly unlikely that flammable mixtures would ever be present in the upper compartment due to probable burning in the lower compartment or ice condenser upper plenum. Second, the enlarged shield would protect the igniter from any spray droplets travelling at an angle up to 50-degrees from the vertical. It is our judgment that long-term spray-induced turbulence levels inside the upper compartment would not be great enough to cause significant prolonged spray impingement at greater than this severe angle (i.e., more horizontal than vertical) at all ten igniters simultaneously. This is because the igniter assemblies are located on walls far enough above the floor to avoid local turbulence from turning, far enough below the nozzles to avoid any horizontal component from the original trajectory, and far enough from each other vertically, radially, and circumferentially to avoid experiencing identical severe turbulence. Third, the igniters have been shown to be able to withstand some direct spray impingement without being overcooled. Therefore, TVA concluded that the modified igniter assemblies were satisfactory. However, NRC felt that additional testing was necessary and imposed the license condition stated above.

II. Description of Testing Program

After receiving the license condition, TVA began developing a purpose and scope for the testing program through discussions with a number of recognized testing organizations throughout the country. It was our judgment, based on these conversations, that it would be difficult to

conduct a reasonable scaled test that would verify ignition of hydrogen while simultaneously simulating the upper compartment turbulence. Therefore, TVA proposed, in another letter from L. M. Mills to Ms. E. Adensam dated January 31, 1983, to conduct small-scale combustion tests that would conservatively account for the turbulent spray conditions postulated in the upper compartment. These tests were strictly defined as combustion proof tests since they were not intended to be a broad research effort. After receiving interim NRC approval of this approach (final approval being reserved until completion of the program), TVA solicited and evaluated several proposals and then contracted with the Factory Mutual Research Corporation (FMRC), a recognized combustion testing organization, in May 1983. We submitted a detailed test plan to NRC in a letter from L. M. Mills to Ms. E. Adensam dated August 31, 1983, and commenced testing shortly thereafter. NRC requested additional information about the program in October 1983, and we responded in a letter from L. M. Mills to Ms. E. Adensam dated November 1, 1983.

As the program got underway, testing was carried out substantially as outlined in the test plan. However, as unshielded igniter testing progressed, FMRC found that the igniter quenched at a lower spray flux (flow rate/area) than expected based on the earlier Singleton data (which had been submitted in the first January 31, 1983, letter referenced above). This failure to reach the desired spray flux goal of 0.9 gal/min/ft^2 (based on averaging the total spray flow rate over the containment cross-sectional area) led us to redirect the testing toward extending igniter performance by enclosing it in a perforated cylinder that would shield it from spray in all directions. Several evolutionary shield designs with various hole sizes and percentages of open area were tested before settling on an optimum combination. Results of the completed testing program were informally submitted to NRC in a preliminary draft report in March 1984. The final FMRC test report is attached to support final resolution of the license condition. In addition to the submittals referenced above, frequent informal oral and written interactions took place between TVA and NRC throughout the program to ensure that it would meet its objectives.

III. Technical Conclusions

After the completion of the testing program, TVA was able to draw several conclusions about the program and its results. The entire program included more than 150 igniter tests carried out over a range of parameter values that encompassed postulated, worst-case upper compartment conditions. Because the tests were performed in a logical, sequential manner with careful attention given to control of conditions and data acquisition, the results were reasonable and self-consistent. Therefore, we have a high degree of confidence in the accuracy and reproducibility of the results. Those results indicate that the hydrogen concentration and the spray flux impinging on the igniter are the only parameters of real significance to igniter combustion performance in the spray environment. More importantly, the tests demonstrated that the proposed cylindrical shield by itself is very effective in maintaining an adequate igniter temperature even under the maximum spray flux of 1.8 gal/min/ft^2 (assuming all spray falls within the crane wall) while still allowing ignition at a lean

hydrogen concentration of 6.6 volume percent which is well below the 8 volume percent conservatively used as input for the licensing analyses with the CLASIX code. Further tests showed that the combination shield (consisting of the overhead shield currently installed and the additional cylindrical shield proposed here) was even more effective since it was capable of withstanding in excess of 1.8 gal/min/ft^2 spray flux while allowing ignition at a very lean hydrogen concentration of 5.5 volume percent. Thus, while the cylindrical shield by itself has been demonstrated to withstand the maximum spray flux while igniting at acceptable hydrogen concentrations, the combination shield has been demonstrated to be superior in both withstanding a higher spray flux and igniting at lower concentrations.

IV. Licensing Position

TVA continues to believe that the igniter assemblies are satisfactory as currently installed with the enlarged overhead spray shields. In addition to the justification stated previously in section I, an important new development has recently emerged from the EPRI-NRC large-scale hydrogen combustion tests conducted in Nevada. Originally, it was thought by some that top ignition and subsequent downward flame propagation leading to essentially complete combustion was only possible at hydrogen concentrations of 8 volume percent and above. However, several of the Nevada tests convincingly demonstrated that top ignition and complete combustion was possible in the presence of sprays at lean hydrogen concentrations such as 6 volume percent. This new information is very significant for the plant because there are four igniters (two each on separate trains) installed above the spray headers outside the spray environment. Based on the Nevada test results, these four top igniters would be effective at igniting lean hydrogen mixtures well below the 8 volume percent ignition limit used in the CLASIX analyses. The effective performance of these top igniters therefore makes the remaining upper compartment igniters superfluous and renders the spray performance issue moot. Thus, TVA believes that there is sufficient justification for the technical acceptability of the upper compartment igniter assemblies as currently installed.

However, if the NRC believes that another level of conservatism is needed to ensure proper operation of the igniters in the upper compartment of containment while exposed to postulated turbulent conditions, TVA can modify the igniter design to add a cylindrical, perforated shield that has been tested as described in the enclosed report to resolve the issue of hydrogen combustion control for Sequoyah.