TENNESSEE VALLEY AUTHORITY
CHATTANOOGA, TENNESSEE 37401
400 Chestnut Street Tower II

November 1, 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) Docket No. 50-327
Tennessee Valley Authority) 50-328

Enclosed is our response to your October 11, 1983 letter to H. G. Parris regarding the TAYCO Igniter Test Program required by the Sequoyah Nuclear Plant unit 1 operating license condition 2.C.(22).D.2. The test program is currently scheduled to be completed by the end of November 1983.

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

Very truly yours,

TENNESSEE VALLEY AUTHORITY

L. M. Mills, Manager
Nuclear Licensing

Sworn to and subscribed before me
this 1st day of Nov. 1983

Notary Public
My Commission Expires 4/8/84

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 30303

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ENCLOSURE

RESPONSE TO NRC LETTER DATED OCTOBER 11, 1983
FROM THOMAS M. NOVAK TO H. G. PARRIS

TAYCO IGNITER TEST PROGRAM
SEQUOYAH NUCLEAR PLANT
UNITS 1 AND 2

NRC Concerns

1) Characterization of Spray Environment.

Item A

TVA has proposed that the spray environment be characterized on the basis of scaled spray flux (gpm/ft^2). A spray flux value of 0.915 is specified for Sequoyah. However, no justification is provided for basing the spray flux on the containment diameter, rather than on the crane wall diameter. Also, since tests are planned at spray flux values of 0.9 and 1.8, it is not clear whether tests at the higher spray flux are intended to address any uncertainty in how to compute containment spray flux (in which case success at the higher spray flux is essential), or to demonstrate the effect of a factor of two increase in spray flux.

The staff believes that spray flux may not be the only important consideration in evaluating spray conditions; spray density should also be considered. Staff concern over the use of spray flux to describe the spray environment lies in the fact that should spray droplet velocity in the test be significantly greater than the terminal velocity, the test conditions will underestimate containment spray density. We, therefore, request that spray density be determined for each test and that additional tests be conducted, if necessary to adequately simulate the spray density expected in the upper compartment of Sequoyah.

Item B

Comparisons of droplet size distribution for the two test nozzles and the 1713A nozzle have been provided in terms of volume mean drop size. Similar comparisons should be provided in terms of volume mean and number mean droplet size at the pressure at which the nozzles will be tested.

TVA PESPONSE

Item 1-A

The spray flux value for the Sequoyah Nuclear Plant of 0.915 gal/min per ft^2 proposed in the test plan (Test Plans to Demonstrate Hydrogen Combustion Initiated by a Tayco Igniter in a Spray Environment, L. M. Mills to E. Adensam, August 31, 1983) was based on the spray falling through the entire containment cross-section instead of just inside the crane wall. This total area was used because the presumed high turbulence level would tend to distribute the spray throughout the upper compartment including outside the crane wall. We note that this assumption is consistent with the Safety Evaluation Report (SER) for another plant where the staff estimated the upper compartment spray flux as 0.65 gal/min per ft^2. Based on a nominal spray flow rate of 6800 gal/min, this yields an area of 10,226 ft^2 which corresponds to the entire cross-sectional area of containment, not just inside the crane wall.

The planned upper limit of the spray flux of 1.8 gal/min per ft^2 in the TVA tests was selected simply to provide a bound on the upper end of the proposed test matrix.

As stated on page 10 of the test plan, "the drop velocity anticipated to impinge on the igniter in the test enclosure should be only slightly higher than the terminal velocity." The spray density in the tests may be determined from the volumetric flow rate, the drop fall time, and the appropriate spray-swept test enclosure volume. The fall time may be determined from the drop velocity. An estimate of the drop velocity and the spray-swept test enclosure volume will be reported. As stated in the test plan, the volumetric flow rate will be measured and reported.

Item 1-B

As stated on page 7 of the test plan, "water spray distributions will be reported in the form of distribution plots along with the standard statistical parameters such as volume mean diameter." Number mean drop size measurements will also be available.

NRC Concern

2) Test Matrices.

Item A

TVA intends to investigate the effect of spray nozzle design and spray temperature in the ignitability test series only if these parameters are shown by separate effects testing to have a significant impact on igniter surface temperature. The staff believes that even if the arbitrary 50°F temperature differential go-no-go criterion is satisfied in separate effects testing (suggesting that additional ignition testing is not necessary), the insensitivity of combustion to spray temperature and spray droplet distribution will not have been demonstrated. Whether or not the TVA test program will meet the intended objective will then be strongly dependent upon the path taken in the decision tree for ignitability testing.

We request that TVA investigate the effect of spray nozzle design and spray temperature in ignitability tests regardless of the outcome of separate effects surface temperature tests. This is particularly important if combustion testing indicated reduced igniter effectiveness at low values of spray flux or density. An acceptable means for addressing these parameters would be to include an additional test for each at the stopping point in the ignitability test decision tree.

Item B

The ignitabilty tests as presently planned will not serve to demonstrate reliable ignition since there is no provision for determination of margins, e.g., measurement of igniter surface temperature at ignition. We request, therefore, that the test procedure for the ignitability tests be modified to include a means for assessing margins such as transient igniter surface temperature measurements (using two thermocouples).

Item C

The present ignitability test matrix includes tests with hydrogen concentrations of 6 percent and 8 percent. The staff view is that lower concentrations should be used in these tests to confirm that upper compartment ignition will occur at a hydrogen concentration below that shown acceptable by CLASIX analysis. We consider the use of an 8-percent hydrogen mixture as an alternate mixture inappropriate for these tests for several reasons. Primarily, CLASIX analyses for Sequoyah, which resulted in upper compartment burns with acceptable consequences, assumed combustion at a maximum hydrogen concentration of 6 percent, with a burn completion of 60 percent. Ignitability tests at 8-percent hydrogen concentration, if required, provide no margin for assessing the effect of upper compartment combustion. Furthermore, CLASIX analyses are based on an assumed flame speed of 6 ft/sec. The validity of this assumption at large scale has yet to be substantiated in tests simulating those conditions. In view of the uncertainties associated with upper compartment burns, we request that the ignitability tests be conducted with a 5-percent hydrogen mixture and a 6- to 7-percent mixture if necessary.

TVA Response

Item 2-A

The igniter surface temperature tests described in section 3.2 of the test plan are not intended to demonstrate the "insensitivity of combustion to spray temperature and spray droplet distribution." As stated on page 10 of the test plan, these two parameters "are only important insofar as they may significantly affect igniter surface temperature," and would not appreciably affect the inherent ignitability of the gas mixture itself. The effect of spray temperature would have a second-order effect on gas mixture temperature which was shown on pages 8-10 of the test plan "to have only a minor effect on ignitability." The spray droplet distributions from the test nozzles consist of drops with volume average sizes of at least 385 microns. These distributions are much larger than the drop sizes shown to affect lower ignitability limits in Factory Mutual's tests reported in "The Effect of Water Fogs on the Deliberate Ignition of Hydrogen," (EPRI NP-2637). These two parameters are to be examined in the igniter surface temperature tests instead of the ignitability tests because the noncombustion tests are safer, easier, and cheaper to perform.

Item 2-B

"Reliable ignition" will be demonstrated by the careful performance of well-instrumented, repeatable tests and not by the "determination of margins." Although not required for the purpose of the tests, which is "to demonstrate that the igniters will initiate combustion in a spray environment such as that expected in the upper compartment of an ice condenser containment," the igniter surface temperature will be measured as described on page 5 of the test plan. There is no requirement for "measurement of igniter surface temperature at ignition" such as has already been performed and reported by the Whiteshell Nuclear Research Establishment (WNRE) for the Tayco igniter.

Item 2-C

The spray tests are being conducted to demonstrate igniter operability in a spray environment as quoted in response 2-B and not to determine lower ignition limits of hydrogen mixtures. Igniter operability tests were satisfactorily performed at Fenwal in 1980 with hydrogen concentrations of 6-8 v/o. Lower ignition limits for the Tayco igniter were determined in WNRE tests which showed that 6 v/o mixtures should be flammable if they are relatively dry and turbulent. Therefore, although we expect the 6 v/o tests at Factory Mutual to successfully ignite when the igniter surface temperature is high enough, the 8 v/o concentration was specified just to provide a backup way of ensuring that a flammable mixture is available. As stated previously, the purpose of the tests is to demonstrate igniter operability in a spray environment and not to provide margin for assessing the effects of upper compartment combustion or to substantiate the validity of an assumed flame speed of 6 ft/sec at large scale.

The reason for "CLASIX analyses for Sequoyah which resulted in upper compartment burns with acceptable consequences assumed combustion at a maximum hydrogen concentration of 6 percent, with a burn completion of 60 percent" was to investigate the effect of upper compartment combustion by arbitrarily lowering the flammability limit there below the other regions to force combustion to occur. The 6-percent/60-percent assumption was not selected as a limiting case for upper compartment burns. In fact, a recent CLASIX analysis indicated that for a forced upper compartment burn at conditions of 8-percent ignition and 85-percent completeness, 8-second burn time, two trains of containment spray and standard heat sinks, the upper compartment pressure did not exceed 27 lb/in^2g. Therefore, we believe that an 8 v/o hydrogen concentration is appropriate as a backup mixture in the ignitability tests.