August 23, 2004

Mr. Karl W. Singer
Chief Nuclear Officer and
Executive Vice President
Tennessee Valley Authority
6A Lookout Place
1101 Market Street
Chattanooga, TN 37402-2801

SUBJECT: REQUEST FOR ADDITIONAL INFORMATION FOR THE REVIEW OF THE BROWNS FERRY NUCLEAR PLANT, UNITS 1, 2 AND 3, LICENSE RENEWAL APPLICATION (TAC NOS. MC1704, MC1705 AND MC1706)

Dear Mr. Singer:

By letter dated December 31, 2003, Tennessee Valley Authority (TVA) submitted an application pursuant to 10 CFR Part 54, to renew the operating licenses for the Browns Ferry Nuclear Plant, Units 1, 2 and 3, for review by the U.S. Nuclear Regulatory Commission (NRC). The NRC staff is reviewing the information contained in the license renewal application (LRA) and has identified areas where additional information is needed to complete the review. Those areas are stated in the enclosed requests for additional information (RAIs), specifically from Sections 3.1, 3.2, 3.3, and 3.4, related to aging of mechanical systems during extended outage of Browns Ferry Unit 1.

Based on discussions with Mr. Gary Adkins of your staff, a mutually agreeable date for your response to the RAIs is within 30 days of the date of this letter. If you have any questions regarding this letter or if circumstances result in your need to revise the response date, please contact me at (301) 415-1594 or by e-mail at yks@nrc.gov

Sincerely,
/RA/

Yoira K. Diaz Sanabria, Project Manager
License Renewal Section A
License Renewal and Environmental Impacts Program
Division of Regulatory Improvement Programs
Office of Nuclear Reactor Regulation

Docket Nos.: 50-259, 50-260 and 50-296

Enclosure: As stated

cc w/encl: See next page

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BROWNS FERRY NUCLEAR PLANT, UNITS 1, 2 AND 3
LICENSE RENEWAL APPLICATION
REQUEST FOR ADDITIONAL INFORMATION (RAI)
AGING OF MECHANICAL SYSTEMS DURING EXTENDED OUTAGE
SECTIONS 3.1, 3.2, 3.3 AND 3.4

The license renewal application (LRA) states that there were no additional aging effects and, consequently, there is no need for additional aging management as a result of the extended outage on Unit 1. However, the aging of the mechanical systems is highly dependent upon the environment that was maintained during the extended outage. In order to determine whether 1) there was additional or more severe aging during the extended outage, 2) any additional aging has been properly identified, evaluated, and managed, and 3) the proposed aging management can distinguish the aging during the extended outage from the aging during future operation, the staff needs the following additional information:

<u>Questions applicable to all Mechanical System Groups (3.1. 3.2, 3.3, and 3.4)</u>

RAI 3.0-1 LP

Describe the process that was used to maintain equipment in a wet lay-up condition. The Evaluation of the Browns Ferry Nuclear (BFN) Unit 1, Lay-up and Preservation Program (Reference 2) states that the systems were maintained with flowing, demineralized, air-saturated water, and indicates that the water chemistry program was used to maintain the water quality. Describe the water parameters that were maintained for the various systems and discuss the differences from the water chemistry that exists during plant operation. What flow rates were maintained (and how) for the various systems in wet lay-up, including the low flow portions of those systems. In particular, discuss the following:

a. Discuss the differences between the chemistry program(s) implemented during the lay-up period and the chemistry aging management program (AMP) to be implemented during the period of extended operation.

   Discuss the bases for concluding that the chemistry AMP is sufficient to manage the aging effects listed in the aging management review (AMR) if the chemistry program(s) implemented during the period of extended operation is not consistent with the Generic Aging Lesson Learned (GALL) report AMP XI.M2.

b. Discuss the criteria (e.g., guidelines) used to maintain the chemistry of the fluid in the lay-up systems, the chemistry parameters monitored, and the frequency of the monitoring/trending. Discuss the results of the monitoring/trending. Describe the corrective actions, including any inspections, for conditions where the water chemistry failed to meet acceptance criteria. Provide information on the following attributes for each system (in RCS, ESF, Auxiliary Systems, and SPCS) maintained wet lay-up:

   (1) Temperature of the water

   (2) Existence of any stagnant conditions

(3) Water chemistry maintained (i.e., P_H, conductivity, corrosion inhibitors, concentrations of aggressive chemicals, etc.)

(4) Reactor Coolant System (RCS only) Any additions of hydrogen

(5) (RCS only) Measurement of Electro Chemical Potential (ECP) of the reactor coolant which will provide information on the oxidizing nature of the RCS water. The susceptibility of the corrosion is directly proportional to the oxidizing nature of the RCS water.

c. Because of the potential differences in water temperature and chemistry, and the potential effect of stagnant flow condition in portions of the Unit 1 wet lay-up components, discuss the possibility of incurring more severe aging degradations to these wet lay-up components than could have occurred during the plant operation. Also, discuss the potential for latent effects, and provide the basis for not performing additional inspections (i.e., startup inspections) for potential aging effects.

RAI 3.0-2 LP

For the systems covered by Table 1, the applicant stated that during lay-up, the systems were maintained in dehumidified air (60% relative humidity) and no additional aging effects were identified for the lay-up condition.

NRC Inspection Report 50-259/87-45 reported that in 1987 an acceptable program for monitoring the relative humidity of all pipe environments had not been finalized and the extent to which all parts of each system was being continually purged with dry air had not been established. For example, the standby liquid control system contained moisture in portions of the system and procedures did not require the system to be monitored for dryness. Although inadequacies in the program were later resolved, it appears that the moisture concerns existed for an extended period of time.

Also, industry documents such as Electric Power Research Institute (EPRI) NP-5106, "Sourcebook for Plant Lay-up and Equipment Preservation," Revision 1, identify the need to monitor the effectiveness of the lay-up practices. This document states that RH (relative humidity) can not be used alone as a lay-up surveillance technique to evaluate lay-up effectiveness.

Table 1 does not identify any additional inspections prior to restart to assess the condition of these systems, and it is not clear if inspections were performed in the lay-up condition. In light of the above inspection findings, the recommendations in the industry documents, and the possibility that parts of this system may not have been continually purged with dry air (such that the exact dryness of the surrounding air can not be ascertained), discuss any inspections planned before startup to address the potential aging during the extended outage, and whether these inspections target system low points where condensate and/or chemicals could accumulate. If inspections have been performed recently, discuss the results of the inspections.

If no inspections to verify the aging during the extended outage are planned, provide justification for not performing such inspections. Describe the process that was used to maintain equipment in a dry lay-up condition. Discuss how humidity was controlled and maintained below 60%, whether the 60% is relative to the coldest portion of the system, the results of any monitoring and trending of the air quality and humidity, and the corrective actions taken (including any inspections) for any conditions where the humidity criterion was exceeded (including corrective actions for the conditions identified in the above inspection report). Also, Table 1 identifies that future one-time inspections are planned. Discuss how the one-time inspections will differentiate between the rate of aging in the different environments (operation vs. shutdown), and discuss whether the one-time inspections will target locations that are susceptible to aging during normal operation or during shutdown.

RAI 3.0-3 LP

Industry documents such as EPRI NP-5106 indicate that all metals are susceptible to microbiologically influenced corrosion (MIC), especially in stagnant and low flow areas, and microbes in the system should be monitored by an adequate program at least every week and more often in outages. NRC Inspection Report 50-259/87-45 identified damage due to MIC had already occurred in the fire protection system and water samples in the demineralized water system were planned. Table 2 does not identify MIC as a corrosion mechanism (for example, in the reactor water cleanup (RWCU) and control rod drive (CRD) systems for systems intended for wet lay-up with demineralized water. Table 3 does not identify MIC as a corrosion mechanism for systems that had no water chemistry control (wet, non-lay-up) during the extended outage. Similarly, Table 4 does not identify MIC as a corrosion mechanism for components subject to a moist air environment for extended periods of time. Provide technical justification that MIC is not an aging mechanism applicable to the stagnant, low flow, and moist air portions of the mechanical systems. Alternatively, describe how inspections would detect loss of material caused by MIC at susceptible locations.

RAI 3.0-4 LP

For components in a lubricating oil environment, the LRA identified no aging effects requiring management. Discuss how the lubricating oil was maintained during the extended outage. Discuss whether testing was performed to verify the oil qualities, including moisture, that would effect aging. If the lubricating oil was drained, discuss the resulting environment and any applicable aging degradation. Discuss any planned inspections to verify that there was no significant aging during the extended outage.

RAI 3.0-5 LP

Tables 2 and 3 show that some components are exposed to an air/gas internal environment during normal operation, but state that this environment is not applicable during the extended outage. These tables state that, due to drainage and system isolation, portions of several systems may have been exposed to an internal environment of moist air. These tables also state that the evaluation for treated water encompasses the aging effects for a moist air environment in these systems. However, Tables 2 and 3 identify additional aging effects for moist air than they identify for treated water (for example, cracking in low points where condensation and chemicals can accumulate). Clarify the above discrepancy in Tables 2 and 3.

Also, since the rate of loss of material caused by a moist air environment during lay-up may be more severe than a flowing treated water environment, explain why the evaluation of the aging effects for the treated water environment would encompass that of the aging effects for a moist air environment in these systems. Tables 2 and 3 state that one-time inspections are planned for the components that are exposed to an air/gas internal environment. Discuss the plans for additional inspections before startup of Unit 1 to evaluate aging during the extended outage, or inspections that were performed during the extended outage. If no such inspections are planned or none have been performed, provide justification that they are not needed and discuss how the one-time inspection will distinguish between the rate of aging in the different environments.

RAI 3.0-6 LP

Table 3 of Reference 2 identifies several systems that were not incorporated into the Unit 1 wet lay-up program. These systems were exposed to treated (non-controlled) or raw water during the extended outage. Table 3 concludes that there are no additional aging management for these systems. In order to justify this conclusion, discuss the results of any water samples, including pH, oxygen levels, aggressive chemical species, biological activity, and corrosion product levels. Discuss whether the systems were stagnant or periodically flowed. Discuss the plans for prestartup inspections to determine the loss of material due to general, pitting, and crevice corrosion, MIC, dealloying, and galvanic corrosion, or provide justification that such inspections are not needed. Also, discuss inspections for the degradation of other materials, such as elastomers and other non-metallic materials.

RAI 3.0-7 LP

Notes 1 and 2 of Tables 2 and 4 indicate that inspections will be performed prior to Unit 1 restart for certain components where additional aging effects were identified for the extended shutdown. Examples include additional aging effects for copper alloy, cast iron, cast iron alloy, and stainless steel components in system locations where condensation could build up, and carbon and low alloy steel in an internal environment. No descriptions of the inspections were provided. Discuss the proposed inspections, including scope, method, procedure, parameters monitoring and trending, detection of aging effects, and acceptance criteria, in order to justify the adequacy of the inspections.

RAI 3.0-8 LP

The LRA and Reference 2 are not clear regarding the management of galvanic corrosion. There is the potential for galvanic corrosion during the extended outage for those systems that were maintained in wet lay-up, wet non-lay-up, or moist air such that condensation and pooling could occur. The LRA and Reference 2 state that galvanic corrosion is managed through use of the Chemistry AMP and the One-Time Inspection AMP; however, there were differences in water chemistry during the extended outage and the One-Time Inspection AMP does not cover galvanic corrosion. Describe how galvanic corrosion during the extended outage is managed. Also, discuss any inspections that are planned to determine the extent of galvanic corrosion during the extended outage.

Questions related to Reactor Vessel, Internals, and Reactor Coolant System (3.1)

RAI 3.1-1 LP

Reference 2 indicated that the internal environment of System 068 (RRS) is flowing, air saturated, demineralized water conforming to the Chemistry Program (CL-13.1). Define "flowing". Identify all components in the RV, RI and RRS that may not have contained flowing, air saturated, demineralized water conforming to the Chemistry Program (CL-13.1) which will not be replaced prior to restart. For each component that may have had stagnant conditions, provide a list of materials, degradation mechanisms, and aging management programs (AMPs) and describe why the AMPs will manage any aging effects resulting from stagnant conditions during wet lay-up.

RAI 3.1-2 LP

For all heat exchangers that will not be replaced:

a) Identify whether the reactor coolant side was subject to flowing or stagnant conditions during wet lay-up.

b) For each location that may have had stagnant conditions, provide a list of materials, degradation mechanisms, and AMPs and describe why the AMPs will manage any aging effects resulting from stagnant conditions during wet lay-up.

c) Identify the environment on the shell side during wet lay-up; the materials, degradation mechanisms, and AMPs; and describe why the AMPs will manage any aging effects resulting from lay-up.

RAI 3.1-3 LP

Describe any inspections, including results, of components in the RV, RI, and RRS that were performed during the lay-up period. Also list prestartup inspection plans for all RV, RI, and RRS components and describe why the wet lay-up inspections and prestart inspections are sufficient to ensure that any aging effects resulting from lay-up are being adequately managed.

The RI inspection program discussed should include the following locations:

(1) CRD Nozzle welds
(2) In Core Monitor (ICM) nozzle welds
(3) Standby Liquid Control (SLC) nozzle welds
(4) Core Shroud
(5) Access Hole Covers
(6) Top Guide
(7) Core Spray Piping and Spargers
(8) Jet Pump Assembly

In Section F.6 of the LRA, the licensee makes a commitment to perform preservice inspection of the RI using the referenced BWRVIP guidelines. Provide information of the extent of preservice inspection that each RI component will receive in accordance with the BWRVIP guidelines.

<u>**Questions related to Engineered Safety Features Group (3.2)**</u>

RAI 3.2-1 LP

In Table 1 of Reference 2, for high pressure coolant injection system (73) and core spray system (75), the Unit 1 lay-up components made of carbon and low alloy steel as well as cast iron and cast iron alloy were exposed to air/gas (internal) or inside air (external) environments, and are identified as being susceptible to loss of material due to general corrosion during the lay-up period. The same aging effect is also identified for the same components, in the supposedly same environments, during plant operation. Because of the possible uncertainty of the dryness of air environments, the applicant is requested to provide technical justification that the lay-up air environments (such as, air/gas, inside air, outside air, etc.) for these components are not any more aggressive than their counterparts in the plant operating environments. Consideration should be given, but not limited to, the oxygen level and moisture content of the air which are the source of electrolytic reaction that initiates the corrosion.

RAI 3.2-2 LP

In Table 1, for high pressure coolant injection system (73) and core spray system (75), the applicant identified One-Time Inspection Program as the AMP for carbon and low alloy steel components and cast iron and cast iron alloy components exposed to air/gas (internal) environments. One-time inspections are appropriate where degradation is at a negligibly slow rate in environments such as dehumidified air, but may not be appropriate for a moist air environment. Provide justification that the one-time inspections are appropriate for possible unintended moisture conditions in both systems during the lay-up period. Also discuss whether the one-time inspections will include areas susceptible to aging effects caused by the moist air lay-up condition as well as those areas susceptible during normal operation.

<u>**Questions related to Auxiliary Systems Group (3.3)**</u>

RAI 3.3-1 LP

Section 3.0.1 of the LRA describes the criteria for evaluating systems for aging during the extended outage. Systems that remain in operation for Unit 1 or in support of operation for Units 2 and 3 are not evaluated. However, based on the system descriptions, it appears that at least a portion of the following systems should have been evaluated (i.e., it appears that the system was idle or that only the main headers were needed to support operation of Units 2 and 3). Discuss the operation of the following systems during the extended shutdown, and explain why these systems were not evaluated for aging during the extended shutdown.

Residual Heat Removal Service Water System (023)
Control Air System (032)
Sampling and Water Quality System (043)
Emergency Equipment Cooling Water System (067)
Reactor Water Cleanup System (069)

Reactor Building Closed Cooling Water System (070)
Radioactive Waste Treatment System (077)
Neutron Monitoring System (092)

If it is determined that these systems, or portions thereof, met the criteria for evaluation, provide an evaluation of aging during the extended outage. Include a description of the environment, identification of AERMs, and proposed aging management. Also, discuss any inspections that are planned to determine the extend of aging during the extended outage.

RAI 3.3-2 LP

LRA Table 3.3.2.29 and Table 2 of Reference 2 state that many carbon and low alloy steel components in the Control Rod Drive System have an internal environment of raw water during normal operation. However, Table 2 states that this environment is not applicable during the extended outage. Clarify the environment during the extended outage, and discuss the implications of the environment on the aging of these components. Specify any applicable aging effects and the corresponding AMPs. Also, discuss whether any inspections are planned to determine the extent of aging during the extended outage.

<u>Questions related to Steam and Power Conversion Systems Group (3.4)</u>

RAI 3.4-1 LP

In Table 3, the applicant identified portions of several systems that were not incorporated into the Unit 1 wet lay-up program. For gland seal water system (37), containment (64), high pressure coolant injection system (73), and core spray system (75), the applicant identified various aging effects for carbon and low alloy steel, copper alloy, cast iron and cast iron alloy, stainless steel, nickel alloy, and aluminum alloy components in treated water (internal) and/or treated water (external) environments. To ensure that these components have not been subjected to aging degradation more severe than their Units 2 and 3 counterparts during plant operation, the applicant is requested to (1) describe the general environments associated with the above system components, which were not incorporated into the Unit 1 wet lay-up program; (2) provide a detailed description of the water chemistry of the treated water existing in the extended lay-up period, and discuss its differences from the water chemistry existing in the plant operation; (3) discuss any water chemistry monitoring that has been performed for the treated water during the lay-up period, and discuss how the aging effects/aging mechanisms were determined for each of the above components; (4) because of the potential differences in water temperature and chemistry, and the potential effect of stagnant flow condition in conspicuous portions of the Unit 1 lay-up components, discuss the possibility of incurring more severe aging degradations to these lay-up components than could have occurred during the plant operation; (5) discuss how the latent effect of the potentially more severe aging degradation occurring in the Unit 1 lay-up can be accounted for in their license renewal aging management review; and (6) justify the basis for not performing inspections for potential aging effects for these components prior to restart.

RAI 3.4-2 LP

In Table 3, the applicant indicated that, for condenser circulating water system (27), carbon and low alloy steel components and cast iron and cast iron alloy components were susceptible to loss of material due to general corrosion, crevice corrosion, pitting corrosion, biofouling, and MIC in raw water (internal) environments. Since the components were exposed to raw stagnant water for an extended period of time, portions of the components, especially those at low points, may have already been subject to aging degradation far more severe than their Units 2 and 3 counterparts in plant operation. The applicant is requested to justify the basis for not performing inspections for potential aging effects for the components prior to restart.

RAI 3.4-3 LP

In Table 3, the applicant indicated that, for condenser circulating water system (27), the cast iron and cast iron alloy components (valves, fittings, etc.) were exposed to raw water (internal) environments, and identified no aging effects due to selective leaching. It should be noted that in raw water environments, leaching in the form of graphitic corrosion could occur with loss of iron matrix from gray cast iron. In addition, gray cast iron can also display the effects of selective leaching in relatively mild environments. The applicant is requested to discuss why selective leaching is not identified as a potential aging mechanism for the components.

RAI 3.4-4 LP

In Table 3, the applicant indicated that, for gland seal water system (37), copper alloy components and cast iron and cast iron alloy components saw treated (condensate) water for an extended period of time. Similarly, cast iron and cast iron alloy components in HPCI system (73), and aluminum alloy components and cast iron and cast iron alloy components in core spray system (75) saw treated (torus) water for an extended period of time. The applicant identified loss of material due to general corrosion, selective leaching, crevice corrosion, and pitting corrosion as the aging effect requiring management. The applicant is requested to explain why galvanic corrosion is not identified as a potential aging mechanism for the above listed components, if they are galvanically coupled to a more cathodic materials.

RAI 3.4-5 LP

In Table 3, for main steam system (01), condensate system (02), and heater drains & vents system (06), Unit 1 lay-up components of carbon and low alloy steel, stainless steel, copper alloy, aluminum alloy, and cast iron and cast iron alloy, were identified as being susceptible to various forms of aging degradation in air/gas (internal) moist air environments that lacked moisture controls. These same Unit 1 lay-up components will be exposed to treated water (internal) environments after restart. The applicant identified the aging effects of loss of material due to various selective leaching, general corrosion, crevice corrosion, pitting corrosion, and galvanic corrosion, and of crack initiation/growth due to stress-corrosion cracking (SCC), for the extended period of operation. Since the rate of loss of material caused by a moist air environment during lay-up may be more severe than a flowing treated water environment, explain why the evaluation of the aging effects for the treated water environment would encompass that of the aging effects for a moist air environment in these systems, and justify the basis for not performing inspections of these affected system components prior to restart. Also, explain, specifically, why "galvanic corrosion" was identified for cast iron and cast iron alloys in the condensate system (02) during the Unit 1 lay-up, but not for the plant operation condition.

RAI 3.4-6 LP

In Table 4, for condensate system (02), copper alloy components were identified as being susceptible to loss of material due to selective leaching, crevice corrosion, and pitting corrosion. Copper alloys will preferentially corrode when coupled with more cathodic metals such as stainless steel, nickel-based alloys, titanium or graphite in an electrolytically conducive environment. The applicant is requested to explain why galvanic corrosion was not included as a potential aging mechanism in air/gas (internal) moist air and treated water (internal) environments.

References

1. Browns Ferry License Renewal Application, Dated December 31, 2003.

2. "Evaluation of the BFN Unit 1 Lay-up and Preservation Program," Enclosure to letter dated February 19, 2004.

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