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Subject: Arkansas Nuclear One - Unit 1
Docket No. 50-313
License No. DPR-51
License Renewal Application RAIs (TAC Nos. MA8054 and MA8055)

Gentlemen:

By letters dated April 17, 2000 (1CNA040004), April 25, 2000 (1CNA040006) and May 2, 2000 (1CNA050004), the NRC requested additional information concerning the Arkansas Nuclear One, Unit 1 (ANO-1) License Renewal Application (LRA). Attached are the responses to the requests for additional information (RAIs) pertaining to electrical and instrumentation and controls sections 2.5 and 3.7 of the ANO-1 LRA.

Also, by letter dated June 26, 2000 (1CAN060002), Entergy Operations provided the NRC additional information concerning the severe accident mitigation analysis (SAMA) performed to support the ANO-1 Environmental Report. Subsequent to the submittal of this information, the Staff verbally requested additional information supporting the response to RAI question number 9 of correspondence dated April 12, 2000 (1CNA040002). The following is additional information supporting the ANO-1 SAMA analysis. This information was used to calculate the replacement power costs used in the sensitivity analysis and in response to RAI question number 9.

- The CDF used in the baseline case for determining averted onsite cost estimate is 1.03E-05/rx yr
- Discount rate is assumed to be 7%
- Duration is 20 years

Averted Onsite Cost (AOSC), Maximum Attainable Benefit (Replacement Power only):
(U_{RP} * CDF)= $81,065.00

A001

Replacement Power Costs

Replacement power costs, U_{RP}, are not included in the onsite costs but are considered in a sensitivity analysis. These are calculated in accordance with the Regulatory Analysis Technical Evaluation Handbook", NUREG/BR-0184, January 1997. Since replacement power will be needed for that time period following a severe accident, for the remainder of the expected generating plant life, long-term power replacement calculations have been used. The present value of replacement power is calculated as follows:

$$PV_{RP} = \left(\frac{\$1.2E+8}{r}\right)\left(1 - e^{-rt_f}\right)^2$$

Where

PV_{RP} = Present value of the cost of replacement power for a single event.
t_f = years remaining until end of facility life.
r = Discount rate.

The \$1.2E+8 value has no intrinsic meaning but is a substitute for a string of non-constant replacement power costs that occur over the lifetime of a "generic" reactor after an event. This equation was developed for discount rates between 5% and 10% only.

For discount rates between 1% and 5%, a linear interpolation is appropriate between present values of \$1.2E+9 at 5% and \$1.6E+9 at 1%. So for discount rates in this range the following equation was used to perform this linear interpolation.

$$PV_{RP} = (\$1.6E+9) - \left(\frac{[(\$1.6E+9) - (\$1.2E+9)]}{[5\% - 1\%]} * [r_s - 1\%]\right)$$

Where

r_s = Discount rate (small), between 1% and 5%.

To account for the entire lifetime of the facility, U_{RP} was then calculated from PV_{RP}, as follows:

$$U_{RP} = \frac{PV_{RP}}{r}\left(1 - e^{-rt_f}\right)^2$$

Where

U_{RP} = Present value of the cost of replacement power over the life of the facility.

Again, this equation is only applicable in the range of discount rates from 5% to 10%. For lower discount rates, linear interpolations for U_{RP} are recommended between \$1.9E+10 at 1% and \$1.2E+10 at 5%. The following equation was used to perform this linear interpolations:

$$U_{RP} = (\$1.9E+10) - \left(\frac{[(\$1.9E+10) - (\$1.2E+10)]}{[5\% - 1\%]} * [r_s - 1\%] \right)$$

Where

r_s = Discount rate (small), between 1% and 5%.

Total Onsite Property Damage Costs

The total averted onsite damage costs is, therefore:

$$AOSC = F * (U_{CD})$$ (or

$$AOSC = F * (U_{CD} + U_{RP})$$ for the sensitivity including replacement power.

Where F = Annual frequency of the event.

Should you have any further questions, please contact me.

Very truly yours,

Jimmy D. Vandergriff
Director, Nuclear Safety Assurance

JDV/nbm
Attachment

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**Request for Additional Information Regarding ANO-1 LRA
Electrical Sections 2.5 and 3.7
Dated April 17, 2000 (1CNA040004), April 25, 2000 (1CNA040006),
and May 2, 2000 (1CNA050004)**

2.5.2-1 **Sections 2.1 and 2.2 of the application describe the scoping methodology and process at a system level, and Table 2.2-1 containing a list of site systems and identifies which of those systems are (and are not) in the scope of license renewal. Although electrical and instrument and control components and component types that are subject to an aging management review (AMR) are identified, the application does not contain a list of these electrical components/component types. To assist the staff in its review, provide a list of electrical and instrumentation and control components/component types (e.g., relay, breaker, fuse, motor...) for the systems identified in Table 2.2-1 and identify which of those components/component types are subject to an AMR. In addition, identify the components that are specifically part of fire protection.**

NEI 95-10, Appendix B provides a listing of typical structures, components, and commodity groupings that are applicable to an integrated plant assessment. The electrical, instrumentation, and control (EIC) components and component types identified in NEI 95-10, Appendix B are representative of the components at ANO-1 contained within the systems identified in Table 2.2-1, including the fire protection system. EIC components within the scope of license renewal at ANO-1 include:

- power supplies # $
- circuit breakers * # $
- switchgear #
- load centers
- motor control centers
- batteries * # $
- cables * # $
- connectors * # $
- terminal blocks * # $
- splices * # $
- relays * # $
- sensors
- electrical bus
- insulators
- transmitters # $
- meters
- diesel generators #
- indicators * # $

- switches * # $
- controllers * #
- detectors * #
- transformers # $
- battery chargers * # $
- lights * #
- annunciators # $
- inverters #
- motors * #
- solenoid operators * #
- alarm units
- converters # $
- isolators $
- signal conditioners # $
- recorders #
- transducers
- motor-generators
- heat tracing
- electric heaters

* - electrical component types included in the fire protection system
# - electrical component types included in the alternate AC system
$ - electrical component types included in the ATWS system

Those in-scope components that are passive are subject to an aging management review. At ANO-1, the only components requiring an aging management review are splices, connectors, terminal blocks, and cables. The *spaces* approach from the Department of Energy (DOE)/Sandia aging management guideline was employed to perform the aging management review for these component types at ANO-1. (Note: EIC components that perform a pressure boundary function are considered in the mechanical sections and structural components such as electrical panels and cabinets are considered in the structural sections.)

2.5.3-1 **Section 2.5.3 of the application describes the screening process used to identify the electrical structures and components subject to an AMR. NEI 95-10, Appendix B, provides guidance on long-lived, passive electrical and instrumentation and control components, or commodity groupings that require an AMR.**

a. Structures and components that are within the scope of the rule and that perform a pressure boundary intended functions without moving parts, or without a change in configuration or properties (passive),

and that are not replaced based on qualified life or a specified time period (long-lived) require an aging management review. The staff was unable to identify any discussion(s) involving the pressure boundary function for the following components: radiation monitors (including sensors and transmitters); elements; RTDs; sensors; thermocouples; transducers; and, heat tracing and heaters, in Section 2.5 of the ANO-1 LRA. Identify specifically where in the LRA or provide a justification as to why these components are not subject to an AMR.

Radiation monitors, pressure and flow transmitters and transducers are active components and are treated like other instruments in accordance with NEI 95-10, Revision 0, which lists them as active and not requiring an aging management review.

Reactor coolant system (RCS) resistance temperature elements (RTE) or sensors, often referred to as resistance temperature detectors (RTD), and thermowells are discussed in ANO-1 LRA Section 3.2.2 (pages 3-5 and 3-6). They have the pressure boundary intended function and are included in the appropriate piping component/commodity groupings in Table 3.2-1.

The RCS hot leg flowmeter assembly is shown with a pressure boundary intended function in the component commodity groupings in ANO-1 LRA Table 3.2-1 (page 3-25). Flow elements are shown with a pressure boundary intended function in the component commodity groupings in Table 3.3-2 (page 3-44) for the low pressure injection/decay heat removal system. Flow elements are shown with a pressure boundary intended function in the component commodity groupings in Table 3.3-3 (page 3-46) for the makeup and purification/high pressure injection system. Flow elements are included with a pressure boundary intended function in the piping component commodity grouping in Table 3.3-4 (page 3-47) for the reactor building spray system. Flow elements are shown with a pressure boundary intended function in the component commodity groupings in Table 3.4-10 (page 3-75) for the service water system. Flow elements are shown with a pressure boundary intended function in the component commodity groupings in Table 3.4-11 (page 3-77) for the penetration room ventilation system. Temperature element wells, also known as thermowells, are included with a pressure boundary intended function in the piping component commodity groupings in Table 3.5-4 (page 3-89) for the condensate storage and transfer system.

Steam generator shell thermocouples are indicated as not requiring an aging management review in ANO-1 LRA Section 2.3.1.7 (page 2-28) as they have no pressure boundary intended function. Additionally, no other thermocouples have a pressure boundary intended function.

As noted in NRC correspondence from C.I. Grimes to D. J. Walters (NEI), dated September 19, 1997, subject: Determination of Aging Management Review for Electrical Components, "Heat tracing performs its intended function through a change in state...[t]herefore, heat tracing is not subject to an aging management review."

Pressurizer heaters are shown on ANO-1 LRA Table 3.2-1 (page 3-30) and were evaluated in the aging management review for the pressure boundary intended function. Borated water storage tank heaters are shown on Table 3.3-2 (page 3-44) and were evaluated in the aging management review for the pressure boundary intended function. Alternate alternating current (AAC) diesel generator system lube oil subsystem heaters are shown on Table 3.4-5 (page 3-67) and were evaluated in the aging management review for the pressure boundary intended function. The AAC diesel generator system cooling water subsystem heaters are shown on Table 3.4-5 (page 3-68) and were evaluated in the aging management review for the pressure boundary intended function. Condensate storage tank heaters are shown on Table 3.5-4 (page 3-89) and were evaluated in the aging management review for the pressure boundary intended function.

b **Passive, long-lived components that are within the scope of the rule and that provide physical support or protection for safety-related electrical equipment are typically subject to an AMR. The staff was unable to identify any aging management discussion(s) involving instrument racks, frames, panels, and enclosures; and, electrical panels, racks, cabinets, and other enclosures, in Section 2.5 of the ANO-1 LRA. Identify specifically where in the LRA or provide a justification as to why these components were not subject to an AMR.**

Items physically supporting or protecting electrical equipment within the scope of license renewal are discussed in the structural sections of the LRA. For the in-scope battery racks, which are unique to the auxiliary building, refer to ANO-1 LRA Sections 2.4.3 and 3.6, and Table 3.6-4. Cabinets, electrical panels, and supports are considered bulk commodities (i.e., common to more than one in-scope structure) and are evaluated in Sections 2.4.6.2 and 3.6, and Table 3.6-8.

c. **On the basis of the information in 10CFR54.21, NEI 95-10, Appendix B, and Section 2.5.3.3 of the LRA, which identifies cables and connectors as being subject to an aging management review, more detail with respect to type and categorization of cables (such as power cable, instrument cable, control cable, communication cable, bare cable, and uninsulated ground conductors) in the scope of license renewal is needed for the staff to perform its evaluation. Identify**

specifically where in the LRA each specific cable type including connections (e.g., connectors, terminal blocks, and splices) is addressed in the ANO-1 LRA; or provide a justification as to why each specific type of cable within the scope of license renewal is excluded from an AMR.

The various types of cables and electrical connections at ANO-1 that are part of in-scope systems are subject to an aging management review. The cable types include power cable, instrument cable, control cable, communication cable, and uninsulated cable. Connection types include splices, connectors, and terminal blocks. While the LRA did not list the individual cable and connection types, an aging management review was performed for all types using the *spaces* approach from the DOE/Sandia aging management guideline. Table 3.7-1 of the LRA provides the results of this aging management review.

2.5.4-1 **Section 2.5.4 of the application describes the electrical SSCs that were determined not to be within the scope of license renewal because these SSCs are non-safety-related, are part of a larger complex assembly, or are active. The electrical SSCs identified below perform an intended function without moving parts, without a change in configuration or properties, and they are not subject to replacement on the basis of qualified life or a specified time.**

a. **Electrical Buses under Section 2.5.4.1 were generically excluded from the scope of license renewal based on the characterization that those buses were not safety-related. A component can not be excluded simply because they are non safety-related. Any component, including an electrical bus, that is non safety-related but whose failure could prevent satisfactory accomplishment of the function identified in 10CFR54.4(a)(2) or a(3), needs to be included within the scope of license renewal. On the basis of this discussion, provide a justification for excluding electrical buses discussed under Section 2.5.4.1 from the scope of license renewal.**

Entergy Operations has re-reviewed the electrical buses not included within the scope of license renewal and verified that these buses do not meet the criteria under 10CFR54.4(a)(1), 10CFR54.4(a)(2), or 10CFR54.4(a)(3).

b. **Insulators under Section 2.5.4.2 were generically excluded from an AMR on the characterization that they were "part of a larger complex assembly or not safety-related." A component can not be excluded from an AMR simply because it is part of a larger complex assembly. Therefore, if a complex assembly is within the scope of the rule, and a**

component within that complex assembly is determined to be passive and long-lived, that component should be subject to an AMR. In addition, any component that is non safety-related but whose failure could prevent satisfactory accomplishment of the functions identified in 10CFR54.4(a)(1), needs to be included within the scope of license renewal. If any non safety-related component within the scope of license renewal perform its function(s) without moving parts or without a change in configuration or properties, and are not replaced based on qualified life or specified time period, are subject to an AMR. On the basis of this discussion provide a justification for excluding the insulators discussed under Section 2.5.4.2 from an AMR.

At ANO-1, only the 500 kV system contains insulators that are considered to be separate components (i.e., not part of an active component assembly). As noted in RAI response 2.5.4-1(a), only the circuit breakers that provide an interface between the 500 kV system and other systems are within the scope of license renewal. None of the insulators in the 500 kV system are in the scope of license renewal since they are not safety-related and they do not meet the criteria of 10CFR54.4(a)(2) and 10CFR54.4(a)(3).

Many other components at ANO-1 contain parts that serve as insulating devices. However, all of these components, such as load centers, motor control centers, switchgear, and distribution panels, are active components and thus are not subject to an aging management review.

3.3.7.3.1-1 **Section 3.7.1, Table 3.7-1, and Section 3.2 of Appendix B of the ANO-1 LRA describes the aging management review activities including the identification of splices, connectors, terminal blocks, and cables as passive electrical components, the associated materials and environments of these components that may lead to accelerated aging, the applicable aging effects, and the proposed aging management programs for these components. Environmental conditions that should be evaluated include temperature, radiation, humidity, water, electrical, mechanical, vibration, chemical, electrochemical, and contaminants. The staff was unable to identify where the applicant addresses vibration and contaminant environmental conditions associated with electrical splices, connectors, terminal blocks and cables in Section 3.7.1, Table 3.7-1, or Section 3.2 of Appendix B, of the ANO-1 LRA. Identify specifically where the vibration and contaminant environmental conditions are addressed, and, if not, provide a justification for not considering these environments in determining the applicable aging effects and for excluding these aging effects from an aging management review.**

According to the DOE/Sandia aging management guideline, dirt, dust, and other types of contamination do not directly produce stress, but may intensify the effects of other stressors acting on cables and related components. The DOE/Sandia aging management guideline also notes that the combination of moisture and contaminants is considered to be the only stressor of any significance involving contaminants. The LRA discusses the cable aging effects due to moisture and humidity. The effects of contaminants are mentioned in ANO-1 LRA Section 3.7.6.

The DOE/Sandia aging management guideline does not consider vibration to be a significant and observable aging mechanism. The effects due to vibration are event driven and and are not age-related. Vibration induced effects are due to poor design or installation practices. At ANO, the corrective action process will detect and correct any problems associated with vibration. Operating experience does not show any adverse trends due to this condition. Therefore, vibration is not considered in the LRA.

3.3.7.3.1-2 **Identify where in the LRA is the AMR for the following electrical components:**

Electrical components whose bodies perform a pressure boundary function such as the following:

- **instrumentation racks, frames, panels and enclosures**
- **electrical panels, racks, cabinets and other enclosures**
- **selected cables**
- **electrical busses**
- **insulator**

The staff was unable to identify where the applicant specifically addresses these components in Section 3.7, Table 3.7-1, or Section 3.2 of Appendix B. Identify specifically how these electrical components will be addressed in Section 3.7 and Section 3.2 of Appendix B.

A similar question was asked during a conference call on March 30, 2000, relating to the review of Section 2.5 of the LRA. It was noted that some of these components may have been addressed in the structural portion of the application, but we were unable to definitively identify before the end of that telecommunication where in the LRA was the AMR for any of these components. Identify where the AMR for these components can be found in the LRA, submit an AMR for these components, or provide a justification for excluding these components from an AMR.

See RAI responses 2.5.3-1(a) and 2.5.3-1(b).

3.3.7.3.1-3 **Section 3.7.1, Table 3.7-1, and Section 3.2 of Appendix B of the ANO-1 LRA describes the aging management review activities including the identification of splices, connectors, terminal blocks, and cables as passive electrical components, the associated materials and environments of these components that may lead to accelerated aging, the applicable aging effects, and proposed aging management programs (visual inspection) for these components.**

a. Identify the means for monitoring the applicable aging effects for any inaccessible in-scope cables, splices, connectors, and terminal blocks.

Based on the aging management review of cables and connections at ANO-1, no unique aging effects for inaccessible cables or connections were found in comparison to accessible cables or connectors. The areas in the cable inspection program may contain both accessible and inaccessible

cables and connectors. Thus, the cables and connections in the accessible areas can be thought of as a sample, representative of all cables and connections. When an unacceptable condition or situation is identified for an accessible cable or connection, a determination will be made as to whether the same condition or situation is applicable to other accessible or inaccessible cables or connections and what additional actions need to be taken. Cables may be inaccessible due to the presence of fire wrapping material or due to the conduit or cable tray blocking access to the cable. For these situations, an evaluation will performed to ensure that the accessible cables in the same area are truly representative of the inaccessible cables.

b. Provide a discussion of the acceptance criteria and corrective actions when the acceptable criteria are not met for visual inspection of in-scope cables, splices, connectors, and terminal blocks.

EPRI TR-109619, Guideline for the Management of Adverse Localized Equipment Environments, will be used as guidance in implementing the inspection program. Cables and connections will be judged to be acceptable if there are no visual indications of cable and connection jacket surface anomalies (e.g., embrittlement, cracking, or discoloration) that suggest that conductor insulation degradation exists. Terminal blocks and pin type connectors will also be inspected for corrosion. The personnel performing the inspections will possess the qualifications and training necessary to adequately detect degradation. When the acceptance criteria are not met, further investigation will be performed on electrical cables and connections. Corrective actions may include, but are not limited to, testing, shielding or otherwise changing the environment, and relocation or replacement of the affected cable or connection. Specific corrective actions will be implemented in accordance with the ANO corrective action process that is administered under 10CFR50 Appendix B. When an unacceptable condition or situation is identified, a determination will be made as to whether the same condition or situation is applicable to other accessible or inaccessible cables or connections.

3.3.7.3.4.1-1 On October 2, 1999, the #2 component cooling water (CCW) pump tripped at the Davis-Besse Nuclear Power Station. The supply breaker tripped as a result of a phase-to-ground fault in a 3-phase safety-related Okonite cable. The cable consisted of three twisted 2/0 single conductors insulated with ethylene-propylene-rubber (EPR) with a bare #4 copper ground. The cable was installed in a 4-inch pvc conduit that runs partially underground from the switchgear room in the turbine building to the CCW pump room, and had been in service for about 23 years. Although a conclusive root cause has not been determined, it appears that the most likely aging degradation mechanism is intrusion of ground water into the cable over a period of time. Although the cable is water resistant, it is not water proof, and over time water can permeate through the EPR insulation by the process of osmosis. The NRC is interested in this cable failure because there are potential generic implications for cable failures caused by aging at other nuclear power plants. Provide a discussion relative to the applicability of this event to cables at ANO-1 and if appropriate, provide a discussion on how the aging of similar cables will be managed during the period of extended operation.

Underground cables that may be subject to this condition at ANO-1 (e.g., service water pump motor cables) will be included in the scope of the electrical component inspection program. As stated in the Safety Evaluation Report Related to the License Renewal of Oconee Nuclear Station, Units 1, 2, and 3 (NUREG-1723), the NRC staff is evaluating the root cause of this Davis-Besse cable failure event, as well as the results of related tests and experience, to determine whether any further actions are necessary or whether to pursue this matter as a generic safety issue. Based on the results of this evaluation, Entergy Operations will take additional action as necessary.