Mr. C. Randy Hutchinson
Vice President, Operations ANO
Entergy Operations, Inc.
1448 S. R. 333
Russellville, AR 72801

February 7, 2000

SUBJECT: ARKANSAS NUCLEAR ONE, UNITS 1 AND 2, PLANT-SPECIFIC SAFETY EVALUATION FOR USI A-46 PROGRAM IMPLEMENTATION (TAC NOS. M69426 AND M69427)

Dear Mr. Hutchinson:

Entergy Operations, Inc. (Entergy, the licensee) established its Unresolved Safety Issue (USI) A-46 program at Arkansas Nuclear One, Units 1 and 2 (ANO-1&2) in response to Generic Letter 87-02 through a 10 CFR 50.54(f) letter. The staff concludes that the licensee's USI A-46 implementation program has, in general, met the purpose and intent of the criteria in Generic Implementation Procedure, Revision 2, and the staff's Supplemental Safety Evaluation Report No. 2 for the resolution of USI A-46. The staff has determined that the licensee's corrective actions and completed physical modifications for resolution of outliers will result in safety enhancements which, in certain aspects, are beyond the original licensing basis, and, as a result, provide sufficient basis to close the USI A-46 review at the facility. The staff also concludes that the licensee's implementation program to resolve USI A-46 at the facility has adequately addressed the purpose of the 10 CFR 50.54(f) request. Licensee activities related to the USI A-46 implementation are subject to NRC inspection.

The licensee had committed to provide a summary report of resolution of equipment item outliers for each ANO unit to be included in the completion letter to the Nuclear Regulatory Commission subsequent to the last refueling outage (1R15), which was completed in the fall of 1999. In a letter dated November 18, 1999 (0CAN119901), the licensee indicated that all outstanding corrective actions associated with equipment issues related to Generic Letter 87-02, Supplement 1, have been completed for ANO-1&2.

This completes the staff's review and closes TAC Nos. M69426 and M69427.

Sincerely,

/RA/

M. Christopher Nolan, Project Manager, Section 1
Project Directorate IV & Decommissioning
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Docket Nos. 50-313 and 50-368

cc: See next page

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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION
FOR USI A-46 PROGRAM IMPLEMENTATION
ARKANSAS NUCLEAR ONE, UNITS 1 AND 2
OPERATING LICENSE NOS. DPR-51 AND NPF-6
DOCKET NOS. 50-313 AND 368

1.0 BACKGROUND

In December 1980, the Nuclear Regulatory Commission (NRC) designated "Seismic Qualification of Equipment in Operating Plants" as Unresolved Safety Issue (USI) A-46. The safety issue of concern was that equipment in nuclear plants for which construction permit applications had been docketed before about 1972 had not been reviewed according to the 1980-81 licensing criteria for the seismic qualification of equipment, such as Regulatory Guide (RG) 1.100 (Reference 1), Institute of Electrical and Electronics Engineers (IEEE) Standard 344-1975 (Reference 2), and Section 3.10 of the Standard Review Plan (NUREG-0800, July 1981) (Reference 3). To address USI A-46, affected utilities formed the Seismic Qualification Utility Group (SQUG) in 1982.

The NRC staff issued Generic Letter (GL) 87-02 “Verification of Seismic Adequacy of Mechanical and Electrical Equipment in Operating Reactors (USI A-46),” in February 1987, (Reference 4) to provide guidance for the resolution to USI A-46. The staff concluded that the seismic adequacy of certain equipment in operating nuclear power plants should be reviewed against seismic criteria not in use when these plants were being constructed. In 1987, SQUG, representing its member utilities, committed to develop a Generic Implementation Procedure (GIP) for implementing the resolution of USI A-46. SQUG requested a deferment of the 60-day response, as requested in GL 87-02, until after the NRC issued its final safety evaluation report (SER) on the final version of the GIP. In 1992, SQUG developed the “Generic Implementation Procedure (GIP) for Seismic Verification of Nuclear Plant Equipment,” Revision 2 (GIP-2, Reference 5).

On May 22, 1992, the NRC issued Supplement 1 to GL 87-02 including the staff’s Supplemental Safety Evaluation Report No. 2 (SSER-2, Reference 6), pursuant to the provisions of 10 CFR 50.54(f), which required that all addressees provide either (1) a commitment to use both the SQUG commitments and the implementation guidance described in GIP-2 as supplemented by the staff’s SSER-2, or (2) an alternative method for responding to GL 87-02. The supplement also required that those addressees committing to implement GIP-2 provide an implementation schedule as well as detailed information including the procedures and criteria used to generate the in-structure response spectra (IRS) to be used for the USI A-46 program.

By letters dated September 18, 1992 (Reference 7), January 28, 1993 (Reference 8), and March 26, 1993 (Reference 9), Entergy Operations, Inc. (EOI, the licensee), and a member of SQUG responded to Supplement 1 of GL 87-02. The response included a

commitment to implement GIP-2, including the clarifications, interpretations, and exceptions in SSER-2, and a clarification and identification of procedures used in generating the IRS. The staff's evaluation of EOI's response was issued in letters dated November 16, 1992 (Reference 10), and August 19, 1993 (Reference 11).

EOI conducted the USI A-46 program and submitted a summary report on May 31, 1996, (Reference 12). The summary report consists of two parts: one for Arkansas Nuclear One, Unit 1 (ANO-1) and the other for Arkansas Nuclear One, Unit 2 (ANO-2). The Nuclear Steam Supply System (NSSS) for ANO-1 is an 883 MWe pressurized water reactor (PWR) system designed by Babcock & Wilcox Company, while the NSSS system for ANO-2 is an 912 MWe PWR system designed by Combustion Engineering. Bechtel was the Architect/Engineer and constructor for both units. Commercial operation began in December 1974, for ANO-1 and March 1980, for ANO-2. The staff reviewed the summary report and issued a request for additional information (RAI) on May 7, 1998 (Reference 13). EOI responded to the staff's RAI on March 30, 1999 (Reference 14). The staff has completed its review of EOI's response.

This report provides the staff evaluation of the licensee's USI A-46 implementation program based on the staff's review of the summary report, supplemental information, and clarification provided by the licensee in response to the staff's RAIs.

2.0 DISCUSSION AND EVALUATION

The staff reviewed the summary report of the USI A-46 program implementation at ANO-1 and ANO-2 (ANO-1&2) (Reference 12) in accordance with the USI A-46 Action Plan, dated July 26, 1994 (Reference 15). The effort consisted of a screening of specific sections of the licensee's program, with emphasis placed on identification and resolution of outliers, i.e., equipment items which do not comply with all the screening guidelines provided in GIP-2. The report identifies a safe shutdown equipment list (SSEL) and contains the screening verification and walkdown of mechanical and electrical equipment. The report also contains relay evaluations and the evaluation of the seismic adequacy for tanks and heat exchangers, cable and conduit raceways, and the identification and resolution of outliers, including the proposed resolution schedule.

2.1 Seismic Demand Determination (Ground Spectra and In-structure Response Spectra)

The horizontal ground response values for the operating-basis earthquake (OBE) and safe-shutdown earthquake (SSE) at ANO-1&2 are 0.10g and 0.20g, respectively. The vertical ground response adopted is two-thirds of the horizontal value for both the OBE and SSE. The ground response spectrum (GRS) for ANO-1 is a Housner-type. The GRS for ANO-2 is a Newmark-type and was derived in accordance with the method provided in the ANO-2 Final Safety Analysis Report (FSAR).

The structures at the ANO-1&2 plants include the reactor buildings, reactor auxiliary buildings, turbine buildings, intake structure, and emergency diesel fuel storage vault. Most seismic category I structures at ANO-1&2 are founded on rock, therefore, there is no need to consider soil-structure interaction in the seismic modeling of the structures. All IRS for ANO-1 seismic category I structures were generated from artificial time histories developed so that their spectra enveloped the GRS. The rock founded

structures at ANO-1 were modeled with base springs representing the soil stiffness. The licensee developed IRS for appropriate levels of equipment damping for the reactor building-internal structure, reactor building-containment shell, auxiliary building, intake structure, attachment points to the primary coolant system, and the condensate storage tank foundation. The NRC staff reviewed these spectra and determined that they should be considered as "median centered floor response spectra for the purpose of ANO-1 USI A-46 evaluation" (Reference 11).

The licensee modeled the rock-founded structures at ANO-2 as fixed base structures. They developed IRS for appropriate levels of equipment damping for the reactor building-internal structure, reactor building-containment shell, intake structure, and attachment points to the primary coolant system. The NRC staff designated ANO-2 as a post-1976 operating license plant with non-Housner-type GRS and its GRS were by definition classified as "conservative design" spectra for the purpose of ANO-2 USI A-46 evaluation.

The IRS with the appropriate damping values shown in Table 2-1 of the ANO-1&2 USI A-46 summary report (Reference 12) were used as seismic input for the design, analysis, and evaluation of equipment and distribution systems within the structures.

The staff reviewed the original modeling performed by the licensee and determined that the modeling of the structures was acceptable and the resulting IRS could be used for the resolution of the ANO-1&2 USI A-46 program.

2.2 Seismic Evaluation Personnel

Several seismic review teams (SRTs) comprised of seismic capability engineers (SCEs) as defined in GIP-2 performed the screening verification, walkdown, and outlier identification for ANO-1&2. GIP-2 describes the responsibilities and qualifications of the individuals who implement this generic procedure. For a complete resolution of the USI A-46 issue, the seismic evaluation personnel should include individuals with sufficient expertise to identify safe shutdown equipment, perform the plant walkdown, and verify the seismic adequacy of equipment and cable/conduit raceway systems, and be able to perform the relay screening and evaluation. This involves a number of plant and engineering disciplines including structural, mechanical, electrical, system, earthquake, and plant operations.

The ANO-1&2 USI A-46 project included a joint engineering effort between the ANO design engineering staff and the consultant project staff (Stevenson and Associates), and Science Applications International Corporation. In addition to the project management and contract management work associated with the use of consultant resources, ANO design engineers were integrated with the consultant team in all aspects of the work. The principal areas where ANO design engineering participated include the reviews of all engineering packages completed for the project (such as SSEL development report, relay list development report, tank evaluation report) and participation as seismic walkdown team members during the screening walkdowns.

The licensee included resumes for the walkdown team members in Appendix A of the summary report (Reference 12).

Mr. Harry Johnson and Dr. Robert Budnitz performed the peer review for the USI A-46 project at ANO-1&2. Mr. Johnson's review covered all seismic evaluation portions of the project and included a review of the project plan, the draft report, a visit to the plant site for a sample walkdown, and a review of the documentation. Dr. Budnitz's review covered all systems aspects of the project and included a review of the project plan, the SSEL development documentation, the draft report, and review of the documentation.

The staff finds that EOI's seismic evaluation personnel qualifications meet the provisions of GIP-2 and the staff's SSER-2, and are, therefore, acceptable for use in the resolution of USI A-46 at ANO-1&2.

2.3 Safe Shutdown Path

GL 87-02 specifies that licensees should be able to bring the plant to, and maintain it in, a hot shutdown condition during the first 72 hours following an SSE. To meet this provision, in its submittal dated May 31, 1996 (Reference 12), the licensee addressed the following plant safety functions: reactor reactivity control, pressure control, inventory control, and decay heat removal. Primary and alternate safe shutdown success paths with their support systems and instrumentation were identified for each of these safety functions to ensure that the plant is capable of being brought to, and maintained in, a hot shutdown condition for 72 hours following an SSE. Figures 4-1 through 4-4 (Reference 12) provide the safe shutdown success paths. Appendix B to Reference 12 provides the SSEL.

The reactor decay heat removal function is accomplished by relieving steam via the main steam safety valves from the reactor by establishing natural circulation conditions through the steam generators (SGs) until such a time that the decay heat decreases to the point where atmospheric dump valves can be used. The operator would open the atmospheric dump valves to establish a plant cooldown. Makeup water to the SGs will be supplied by the emergency feed water (EFW) system which takes suction from the condensate storage tank (CST). Once the CST has been depleted, the other available source is the service water system which takes suction from Lake Dardanelle. These water supplies ensure sufficient capacity to cool down to low pressure injection (LPI) entry conditions and maintaining the plant in cold shutdown conditions.

The plant operations department reviewed the equipment listed in Appendix B to Reference 12 against the plant operating procedures and operator training, and concluded that the plant operating procedures and operator training were adequate to establish and maintain the plant in a safe shutdown condition following an SSE.

Based on the above, the staff concludes that the approach to achieve and maintain a safe shutdown for 72 hours following a seismic event is acceptable for the resolution of USI A-46 at ANO-1&2.

2.4 Seismic Screening Verification and Walkdown of Mechanical and Electrical Equipment

The staff's evaluation focused primarily on the licensee's identification and resolution of equipment outliers. GIP-2 screening guidelines are intended to be used as a generic

basis for evaluating the seismic adequacy of equipment. If an item of equipment fails to pass these generic screens, it may still be shown to be adequate by additional evaluations.

2.4.1 Equipment Seismic Capacity Compared to Seismic Demand

The licensee determined the seismic capacity of SSEL items using: (1) earthquake experience data with capacity defined in terms of the bounding spectrum (BS) (i.e., 1.5 times BS), or (2) equipment-specific seismic qualification data, or test data on similar equipment. Both ANO-1 floor response spectra (designated as "median-centered" spectra) and ANO-2 floor response spectra (designated as "conservative design" spectra) were compared to 1.5 times the BS defined in GIP-2 (Reference 5). Newer, upgraded equipment that had been seismically proof tested in accordance with the IEEE Standard 344, 1975 Edition (Reference 2) or later version, was accepted based on the IEEE 344-related documentation and was supplemented only by a seismic interaction review implemented by the SRT. The staff finds this licensee's approach adequate and acceptable for resolution of the USI A-46 program at ANO-1&2.

There were several equipment outliers identified at ANO-1&2 due to the reference spectrum not enveloping the IRS at approximately 12 Hz and higher. The licensee provided three technical justifications as the generic basis for resolving the outliers. The staff reviewed the licensee's justifications presented in Section 5.4.1 of the ANO-1&2 evaluation reports and found them, in general, acceptable. Method A of Table 4-1 of GIP-2 was used to address the seismic adequacy of equipment with a natural frequency above approximately 8 Hz, located below approximately 40-feet above the average grade of the ANO-1&2 seismic category I structures. Although comparisons of key licensing basis IRS, applicable to the reactor containment internal structure and the auxiliary building with 1.5 times the GRS, indicated exceedances of the IRS over the GRS (average ratios are on the order of 1.29 and 2.15 for ANO-1&2, respectively), because of the conservatism inherent in the development of the original design IRS, the staff finds that the licensee's application of Method A is consistent with the intent of applicable GIP-2 guidance. The staff finds that the licensee's approach for equipment seismic capacity-to-demand comparison as discussed above, acceptable for the resolution of the USI A-46 program at ANO-1&2.

2.4.2 Assessment of Equipment "Caveats"

In order to apply the experience-based approach and to use the equipment seismic capacity defined in GIP-2, the plant-specific equipment must meet some restrictions or caveats described in GIP-2. GIP-2 also allows engineers to verify whether the plant equipment conditions satisfy the caveats specified for a particular equipment class by judging whether these conditions meet the "intent of the caveats" even if they do not necessarily meet the exact words of the caveats.

The licensee stated in Reference 12, that no significant or programmatic deviations from GIP-2 were made while performing the walkdowns and seismic adequacy evaluations at ANO-1&2 for resolution of USI A-46. They made very few interpretations with respect to the specific wording of GIP-2 caveats versus the caveat's intent. In general, the judgments and the calculations performed meet the caveat requirements documented in

Appendix B of GIP-2. An example of a clarification used includes the 3g load check on yokes of motor-operated valves that do not meet the experience-based size and operator offset limits of Table B.8-1 of GIP-2. These issues are not specifically called out in Table 5-3 of the summary report (Reference 12) since the Appendix B wording allows these interpretations. The licensee lists five cases for ANO-1 and three cases for ANO-2 with interpretations, or measures taken to meet the intent of the GIP-2 caveat in Table 5-3 of Reference 12. All other equipment (not listed in this table) meet the caveat rules as stated in GIP-2. The staff finds EOI's approach for assessing the equipment "caveats" to be reasonable and acceptable for the resolution of the USI A-46 program at ANO-1&2.

2.4.3 Equipment Anchorage

The licensee adopted four main steps to evaluate the seismic adequacy of equipment anchorage at ANO-1&2 following the guidance provided in GIP-2. The four steps are: (1) anchorage installation inspection, (2) anchorage capacity determination, (3) seismic demand determination, and (4) comparison of capacity and demand. The anchorage inspection consists of visual checks and measurements along with a review of plant documentation and drawings, where necessary. The second step is to determine the allowable capacity of anchors used to secure an item of equipment. The licensee obtained the allowable capacity of anchorage by multiplying the nominal allowable capacities by the applicable capacity reduction factors. The nominal capacities and reduction factors are provided in Appendix C of GIP-2. The third step is to determine the seismic demand based on the in-structure floor response spectra or the GRS. For ANO-1, if the GRS was used for demand, the licensee applied a factor of 1.875 times the appropriate spectral acceleration, whereas, the licensee applied a factor of 1.5 for ANO-2 anchors because its IRS were designated as "conservative design" spectra. The fourth step is to compare the seismic demand to the anchor capacity to determine its adequacy. Equipment anchorages at ANO-1&2 are typically either welds to embedded steel, expansion anchor bolts, or cast in place bolts. Electrical equipment is either bolted with expansion anchor bolts, or welded to an embedded plate. Mechanical equipment and large tanks are typically anchored with cast in place bolts. The vast majority of the anchorage is covered by the criteria in GIP-2. The licensee evaluated exceptions from the GIP-2 criteria for their anchorage adequacy by case specific assessments. The SRT performed bolt tightness checks on all accessible expansion anchor bolts encountered during the walkdown. The licensee identified and evaluated twenty-two anchorage related concerns to ensure their adequacy and integrity. The means for resolving these 22 concerns included: supplementary engineering analysis for verification of anchor capacity, addition of missing anchor bolts, replacement of loose anchor bolts, tightening of loose nuts, and addition of a unistrut and associated bolts. The staff reviewed the above described methodology, walkdown procedures, and remedial measures adopted by the licensee in ensuring the adequacy and functionality of the ANO-1&2 anchorage, and finds them adequate and acceptable for the resolution of USI A-46 at ANO-1&2 because they meet the GIP-2 provisions.

2.4.4 Seismic Spatial Interaction Evaluation

The licensee addressed potential spatial interaction effects as a part of the screening provision for verifying the seismic adequacy of an item of mechanical or electrical

equipment, for the equipment in Sections 5.3.4 and 5.4.4 of the seismic evaluation report (Reference 12). This serves to ensure that there is no adverse seismic spatial interaction between the equipment under consideration and nearby equipment, systems, and structures which could cause the equipment to fail to perform its intended safe shutdown function. The interactions of concern are: (1) proximity effects, (2) structural failure and falling, and (3) flexibility of attached lines and cables. Appendix D of GIP-2 contains the guidelines for judging potential interaction effects, when verifying the seismic adequacy of equipment.

The licensee evaluated approximately 742 ANO-1 components and 633 ANO-2 components during the USI A-46 plant-specific walkdown. Among the key issues evaluated during the walkdowns were seismic capacity versus demand, conformance to caveats, anchorage adequacy, and seismic interaction effects. The licensee tabulated results of the walkdowns in the screening verification data sheet (SVDS). The licensee identified 26 ANO-1 components and five ANO-2 components to have adverse seismic interaction concerns. The licensee's disposition of these concerns and the method used in assessing whether equipment is free of seismic interaction effects, or the interaction effects are acceptable and do not compromise the safe shutdown function of the equipment were evaluated by the staff and were judged as adequate for resolving the seismic spatial interaction concerns. The licensee resolved the outliers by appropriate means including provision of positive connections for light fixtures, provision of additional bolts between adjacent control panels, and installation of additional restraints. The staff finds the measures taken by the licensee adequate and acceptable for the resolution of the USI A-46 program at ANO-1&2 because they meet the intent of GIP-2.

2.5 Tanks and Heat Exchanger

The response of a fluid-filled vertical tank to a seismic event is the combined motions of sloshing fluid and the impulsive mode from fluid-structure interaction. The sloshing of the fluid at the top surface contributes to the overturning moment of the tank. The impulsive mode includes the tank shell responding to seismic events at frequencies associated with the shell modes of vibration. In computing tank responses, the licensee neglected the effects of the attached piping. However, flexibility of attached piping was checked during the walkdown to judge whether it could accommodate slight movement of the tank base. The licensee determined that three ANO-1 vertical tanks (borated water storage tank (T-3), non-safety-related condensate storage tank (T-41), and Q-condensate storage tank (T-41B)), and three ANO-2 vertical tanks (one borated water tank (2T-3) and two condensate storage tanks (2T-41A and 2T-41B)), to be outliers per the GIP-2 provisions for a variety of reasons including insufficient seismic capacity, shear and buckling failure of bolt chair stiffeners, unacceptable tank wall thickness-to-radius ratio and existence of ring foundation.

The licensee used tank configuration specific analyses for these tanks to determine their "high confidence low probability of failure (HCLPF)" seismic capacities as a basis for concluding that there is reasonable assurance that these tanks will maintain their intended safety functions when subject to the design basis earthquake motion. The HCLPF capacities computed by the licensee are 0.56g, 0.33g, and 0.59g for the above listed ANO-1 tanks, respectively. The HCLPF capacities for the three ANO-2 vertical tanks listed above are 0.75g, 0.36g, and 0.36g, respectively. The licensee stated that

since GIP-2 does not provide specific requirements for the methods in which tank outliers can or should be resolved, analytical determination of sufficiently high HCLPF tank capacities would provide a reasonable way to resolve these tank outliers. The results of the licensee's effort were that, for the worst case tank (T-41), the HCLPF capacity is almost 1-½ times the design-basis earthquake at ANO-1&2 (0.33g HCLPF for T-41). The licensee further stated that a HCLPF capacity at such a high magnitude provides an adequate basis for resolving these tank outliers in a manner that establishes a high level of safety margin and, therefore, should be acceptable to the staff. The staff finds that the above reasoning presented by the licensee to be reasonable and acceptable for the resolution of the USI A-46 program at ANO-1&2.

The licensee evaluated two horizontal tanks and four heat exchangers for ANO-1, and four horizontal tanks and two heat exchangers for ANO-2, with respect to GIP-2 acceptance criteria, and concluded that they all met GIP-2 allowable stress criteria except that the bolts of ANO-2 emergency diesel fuel tanks (2T-57 A&B) were over-stressed and were designated as outliers. In its response to a staff RAI pertaining to the issue dated March 30, 1999 (Reference 14), the licensee committed to resolve these bolt outliers via implementation of additional engineering analysis and will report the disposition of the tank outliers in its completion letter to NRC for ANO-2. Several ANO-1&2 items belonging to the "other Class 21 tank and heat exchanger" category were evaluated by the licensee with respect to the GIP-2 criteria and were all found to meet the criteria. The staff finds that the licensee's evaluation of horizontal tanks and heat exchangers, and disposition of the outliers reasonable and acceptable for the resolution of the USI A-46 program at ANO-1&2.

In Reference 14, the licensee stated that outlier tanks 2T-57 A and B are undergoing further analysis to resolve their outlier status. The analyses are not yet complete, but it is expected that the tank outliers will be resolved in this manner without modifications. The disposition of these tank outliers will be included with the completion letter for ANO-1&2.

2.6 Cable and Conduit Raceways

The licensee indicated that essentially all of the raceway systems in the ANO-1&2 safety-related buildings were included in the walkdown. The licensee stated that its SRT checked for possible anomalies in design and construction of the cable tray and conduit raceways and confirmed that all inspected cable tray and conduit raceways met the requirements of Section 8.2.2 of GIP-2 including cable tray and conduit spans, cantilever bracket support integrity, appropriate channel nut configuration, and non use of friction based beam clamps. In addition, to the above-noted inclusion rules, the SRT inspected the raceways for the caveats known as "other seismic performance concerns" and "seismic interaction review."

The licensee performed the limited analytical review (LAR) in accordance with the guidance provided in GIP-2. The licensee evaluated the structural integrity of cable tray and conduit supports which have been chosen as representative, worst case examples of different types of raceway support configurations within the ANO-1&2 plants. The SRT determined that fourteen and ten supports chosen for ANO-1&2, respectively,

should adequately represent and envelop the existing support configurations of the plants.

The licensee used calculations employing the methodology outlined in Section 8 of GIP-2 to evaluate the selected supports. For certain supports with statically indeterminate members, the licensee used the computer program ANSYS-PC/LINEAR in obtaining forces, moments, and reaction loads.

During the cable tray and conduit raceway walkdown of ANO-1, the licensee identified five potential seismic resistance-related concerns. These concerns include an improperly-supported bracket hanger, a missing rod in a trapeze rod hanger, lack of an engineered flexibility at the reactor building/reactor auxiliary building interface, improper anchoring of bracket supports, and lack of slackness in cable bundles coming out of conduits. The licensee implemented appropriate repairs or performed case-specific engineering evaluations that led to adequate resolution of these concerns. As a result of the cable tray and conduit raceway walkdowns, the licensee did not identify any potential seismic issues except for a few instances where support was provided from both sides of adjacent structures and there was limited flexibility provided for the conduit raceways or cable trays. However, the licensee resolved these few instances of concern by assessment of the maximum differential displacement expected at the locations of these interface crossings of cable or conduit raceways.

As a result of the ANO-1 LAR, the licensee identified three outliers. LAR No.13 outlier involved a missing support rod and the licensee committed to perform further analysis and, as needed, a strut will be added to resolve the outlier. The outliers related to LAR No. 14 and LAR No. 10 pertain to a need to perform further engineering analyses to determine if additional support members will be needed to ensure their structural integrity. The licensee committed to add additional support members if called for by the analysis results. The 10 LARs performed for ANO-2 showed that all were found to meet the screening guidelines provided in the GIP-2. The staff finds that the scope, methodology, and approach used by the licensee in outlier resolution for ANO-1&2 cable tray and conduit raceway acceptable for the resolution of the USI A-46 program at ANO-1&2 since they meet the provisions of GIP-2.

2.7 Essential Relays

The licensee stated in the summary report (Reference 12) that the relay evaluation process consists of first developing an associated relay list (ARL) that is associated with the SSEL equipment. The essential relay list (ERL) is then developed by eliminating devices on the ARL that have no functional bearing on the SSEL equipment, or are inherently rugged (i.e., handswitches). The final step is evaluating the relays on the ERL for seismic adequacy. Basic technical guidance for this report was obtained from GIP-2, and Electric Power Research Institute reports, NP-7148-SL (Reference 16), NP-7147 (Reference 17), and NP-5223 (Reference 18).

In ANO-1, the licensee identified a total of 2314 relays or relay-type devices as associated with SSEL equipment. Of the 2314 relays, they identified 2002 as “non-essential” as a result of the functional analysis. In addition, the relays screened on the basis of assumed operator actions are also marked as “CA” (chatter acceptable)

since they are considered non-essential. Of the 2314 relays or relay-type devices, the licensee determined that 89 relays/items are either not vulnerable or not required for further evaluation. Finally, they considered 223 relays to be essential to the operation of SSEL equipment, and should be seismically adequate for the particular housing cabinet on the particular elevation in the plant. The licensee performed a relay capacity screening analysis to screen relays that have sufficient capacity to survive the expected demands during the seismic event. The results obtained indicated that 83 devices passed seismic capacity screening (SCS), 48 devices did not pass SCS, and 92 devices have unknown capacities. The relays/devices that did not pass SCS or have unknown capacities are the subject of further investigation and resolution, and are to be completed by the end of refueling outage 1R15 (Reference 20).

Similarly, in ANO-2, the licensee identified a total of 2956 relays or relay type-devices as associated with SSEL equipment. Of the 2956 relays, they identified 2255 relays as "non-essential," as a result of the functional analysis. In addition, the relays screened on the basis of assumed operator actions are also marked as "CA" (chatter acceptable) since they are considered non-essential. Of the 2956 relays or relay types-devices, they determined that 428 relay/items are not vulnerable or not required for further evaluation. Finally, the licensee considers 273 relays to be essential to the operation of SSEL equipment, and should be seismically adequate for the particular housing cabinet on the particular elevation in the plant. The licensee performed a relay capacity screening analysis to screen relays that have sufficient capacity to survive the expected demands during the seismic event. The results obtained indicated that 65 devices passed SCS, and 198 devices have unknown capacities. The relays/devices that did not pass SCS or have unknown capacities are the subject of further investigation and resolution, and are to be completed by 1R15 (instead of 1R13) (Reference 20).

The staff finds EOI's approach in verifying seismic capacity of essential relays at ANO-1&2 reasonable and is, therefore, acceptable for the resolution of the USI A-46 program at ANO-1&2.

2.8 Human Factors Aspect

As part of the resolution of USI A-46, SQUG developed GIP-2 for use in part by licensees to identify and verify a SSEL and ensure that adequate procedures and training were in place for plant operators to mitigate the consequences of an SSE.

GIP-2 described the use of operator action as a means of accomplishing those activities required to achieve safe shutdown. Section 3.2.7, "Operator Action Permitted," states, in part, that timely operator action is permitted as a means of achieving and maintaining a safe shutdown condition provided procedures are available and the operators are trained in their use. Additionally, Section 3.2.6, "Single Equipment Failure," states that manual operator action of equipment which is normally power operated is permitted as a backup operation provided that sufficient manpower, time, and procedures are available. Section 3.2.8, "Procedures," states, in part, that procedures should be in place for operating the selected equipment for safe shutdown and operators should be trained in their use. It is not necessary to develop new procedures specifically for compliance with the USI A-46 program.

In Section 3.7 “Operations Department Review of SSEL,” of GIP-2, SQUG also described three methods for accomplishing the operations department review of the SSEL against the plant operating procedures. Licensees were to decide which of the following methods, or combination thereof, were to be used for their plant-specific reviews. These methods included:

1. a "desk-top" review of applicable normal and emergency operating procedures (EOPs),
2. use of a simulator to model the expected transient, and/or
3. performing a limited control room and local in-plant walk-down of actions required by plant procedures.

The staff’s evaluation of the SQUG approach for the identification and evaluation of the SSEL, including the use of operator actions, was provided in Section II.3 of the staff’s SSER on GIP-2. The evaluation concluded that the SQUG approach was acceptable.

The staff's review focused on verifying that the licensee had used one or more of the GIP-2 methods for conducting the operations department review of the SSEL, and had considered aspects of human performance in determining what operator actions could be used to achieve and maintain safe shutdown (e.g., resetting relays, manual operation of plant equipment).

The licensee determined that the systems and equipment selected for seismic review in the USI A-46 program are those for which normal, abnormal, and EOPs are available to bring the plant from a normal operating mode to a safe shutdown condition. The shutdown paths selected were reviewed by the ANO operations staff and they determined that the procedures would provide adequate guidance to the operators in response to a seismic event. The licensee provided assurance that ample time existed for operators to take the required actions to safely shut down the plant.

The staff verified that the licensee had considered its operator training programs and verified that its training was sufficient to ensure that those actions specified in the procedures could be accomplished by the operations crew. The Operations Department verified that all actions necessary to safely shutdown the plant were included in existing normal, abnormal, and EOPs. The licensee verified that no additional operator actions, beyond those associated with the safe shutdown paths, must be performed to bring the plant from a normal operating mode to a safe shutdown condition. However, as part of the USI A-46 review, the licensee identified two additional actions required to reset two relays associated with the local start of the emergency diesel generators (EDGs). Specifically, the operators are required to check the status of the EDGs at a local annunciator panel. For each EDG that is required at that time, the operators will be required to reset the flag associated with the EDG lockout relay, reset the EDG lockout relay, and reset the EDG exciter. The licensee described these actions as being within the general skill-of-the-craft, verified that they were covered by procedures, and would not affect the operators ability to place the plant in a safe shutdown condition.

In addition, the staff requested verification that the licensee had adequately evaluated potential challenges to operators, such as lost or diminished lighting, harsh environmental conditions, potential for damaged equipment interfering with the

operators tasks, and the potential for placing an operator in unfamiliar or inhospitable surroundings. The licensee provided information to substantiate that potential challenges to the operator were explicitly reviewed during validation of the pertinent plant operating procedures related to the licensee's desktop and walkdown evaluations and as part of the USI A-46 reviews and previous evaluations related to the licensee's individual plant evaluation regarding external events. The review determined that no local operator actions were required for the safe shutdown of the plant. In addition, the licensee explicitly evaluated the potential for local failure of architectural features and the potential for adverse spacial interactions in the vicinity of safe shutdown equipment, where local operator action may be required, as part of the GIP-2 process.

As a result of the review, a potential control room interaction source was identified to be associated with non restrained equipment (e.g., an unsecured oxygen bottle rack, file cabinets, and two loose ladders) and with the control room light diffuser panels. The licensee stated that these issues have been evaluated and corrected by relocating or removing the hazard. With respect to the light diffuser panels, the licensee's SRT determined that the diffusers would not pose a safety hazard and were retained. The licensee performed seismic interaction reviews which eliminated any concerns with the plant components and structures located in the immediate vicinity of the components which had to be manipulated. Therefore, the potential for physical barriers resulting from equipment or structural earthquake damage which could inhibit operator ability to access plant equipment was considered and eliminated as a potential barrier to successful operator performance.

The licensee has provided the staff with sufficient information to demonstrate conformance with the NRC-approved review methodology outlined in GIP-2 and is, therefore, acceptable for the resolution of the USI A-46 program at ANO-1&2.

2.9 Outlier Identification and Resolution

An outlier is defined as an item of equipment which does not comply with the GIP-2 screening guidelines.

In Section 5.4 of the ANO-1&2 USI A-46 summary report (Reference 12), the licensee discusses resolution of the identified seismic concerns and outliers. There were several equipment outliers identified due to the fact that some reference (capacity) spectra did not envelope the IRS at about 12 Hz frequency and above. The licensee provided three technical justifications as the generic bases for resolving the outliers. The staff reviewed the licensee's justifications, the licensee's responses to the staff RAIs, and key comparisons of seismic demand-to-capacity spectra at elevations approximately 40 feet above the plant's average grade for frequencies ranging from 8 to 15 Hz. Based on these reviews, the staff concludes that the licensee's use of the generic resolution for the seismic capacity-related outliers is adequate and acceptable.

Outliers related to equipment anchorage, seismic spatial interaction evaluation, essential relays, tanks and heat exchangers, and cable tray and conduit raceway supports, as well as their disposition, are discussed in Sections 5.4, 9.0, and 11 of the summary report (Reference 12) and in previous sections of this SER.

In Reference 14, the licensee stated that the ANO-1 SSEL contains 17 equipment items and the ANO-2 SSEL contains 29 equipment items (identified as outliers pending completion of the USI A-46 walkdown) in their respective summary reports. They were identified equipment items discovered after the scheduled walkdowns for each ANO unit (September 1993, and February 1994, for ANO-1 and March and May 1994, for ANO-2), but prior to submittal of the summary reports.

Since the submittal of the ANO-1&2 summary reports, these equipment items have been walked down. The SRTs performing the walkdowns have reported that no new outlier issues were identified during the seismic screening and verification walkdowns. Screening evaluation worksheets are being prepared and finalized as part of the documentation for these equipment items. No further action needs to be taken at this time relative to these equipment items.

In accordance with GIP-2 relative to the USI A-46 closure process, each licensee is to provide a "completion letter" advising the NRC that any corrective actions identified in the summary report, or agreed to with the staff as a result of other related correspondence, have been completed. A summary of the results of the resolution of equipment item outliers for each ANO unit will be included in the completion letter to the NRC. EOI plans to submit this completion letter subsequent to the 1R15 refueling outage, which was completed in the fall of 1999 (Reference 20).

The staff's review of the licensee's actions regarding outliers indicates that most identified outliers have been satisfactorily resolved and some are in the process of being resolved by analysis or corrective actions. Upon completion of remaining outlier resolutions, the staff considers the licensee's actions reasonable for resolution of USI A-46 at ANO-1&2.

3.0 SUMMARY OF MAJOR STAFF FINDINGS

Based on the information provided by the licensee, the staff found that the licensee's USI A-46 program has, in general, followed GIP-2 guidelines, and that no programmatic or significant deviations from the guidelines were made during the USI A-46 resolution process at ANO-1&2. As stated in Section 2.9, the licensee had committed to provide a summary report of resolution of equipment item outliers for each ANO unit to be included in the completion letter to the NRC subsequent to the 1R15 refueling outage, which was completed in the fall of 1999 (Reference 20). On November 18, 1999 (Reference 22), the licensee provided its GL 87-02 completion letter. The completion letter indicates that all of the equipment outliers and corrective actions identified in the ANO summary reports have been completed. The staff finds that the completion letter is acceptable.

4.0 CONCLUSIONS

EOI's USI A-46 program at ANO-1&2 was established in response to Supplement 1 to GL 87-02 through a 10 CFR 50.54(f) letter. In general, the licensee conducted the USI A-46 implementation in accordance with GIP-2. The licensee's USI A-46 implementation program did not identify any instance where the operability of a particular system or component was called into question. The staff's review of the licensee's implementation program did not reveal any significant findings that would

suggest inadequacy of the licensee's A-46 program in light of the GIP-2 guidelines. The staff concludes that the licensee's USI A-46 implementation program has, in general, met the purpose and intent of the criteria in GIP-2 and the staff's SSER No. 2 for the resolution of USI A-46. The staff has determined that the licensee's already completed actions will result in safety enhancements which, in certain aspects, are beyond the original licensing basis. As a result, the licensee's actions provide sufficient basis to close the USI A-46 review at the facility. The staff also concludes that the licensee's implementation program to resolve USI A-46 at the facility has adequately addressed the purpose of the 10 CFR 50.54(f) request. Licensee activities related to the USI A-46 implementation may be subject to NRC inspection.

Regarding future use of GIP-2 in licensing activities, the licensee may revise its licensing basis in accordance with the guidance in Section I.2.3 of the staff's SSER No. 2 on SQUG/GIP-2, and the staff's letter to SQUG's Chairman, Neil Smith, on June 19, 1998 (Reference 21). It should be noted that the primary consideration in the staff's determination to permit the licensee to incorporate GIP-2 in the licensing basis, is the licensee's completion of all the identified outliers, in accordance with the GIP-2 requirements. Where plants have specific commitments in the licensing basis with respect to seismic qualification, these commitments should be carefully considered. The overall cumulative effect of the incorporation of the GIP-2 methodology, considered as a whole, should be assessed in making a determination under 10 CFR 50.59. An overall conclusion that no unresolved safety question (USQ) is involved is acceptable so long as any changes in specific commitments in the licensing basis have been thoroughly evaluated in reaching the overall conclusion. If the overall cumulative assessment leads a licensee to conclude a USQ is involved, incorporation of the GIP-2 methodology into the licensing basis would require the licensee to seek an amendment pursuant to 10 CFR 50.90.

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6. NRC “Supplement No. 1 to Generic Letter 87-02 that tranmits Supplemental Safety Evaluation Report No. 2 on Seismic Qualification Utility Group’s Generic Implementation Procedure, Revision 2, as corrected on February 14, 1992,” dated May 22, 1992

7. Letter, J. J. Fisicaro, EOI to NRC, “Arkansas Nuclear One, Units 1 & 2 Response to Generic Letter 87-02, Supplement 1 - SSER 2,” dated September 18, 1992

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12. Letter, Dwight C. Mims, EOI, to NRC, “Individual Plant Examination of External Events (IPEEE) and Unresolved Safety Issue (USI) A-46 Summary Reports,” dated May 31,1996

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15. Memorandum, B. W. Sheron, to A. C. Thadani, “Task Action Plan for Performing Plant-Specific Review of the Implementation of the Resolution for Unresolved Safety Issue (USI) A-46,” dated July 26, 1994

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19. SAIC Relay Analysis Package (SRAP) Users Manual and Documentation, Version 1.0, Science Applications International Corporation, 1993

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