August 26, 2003

MEMORANDUM TO: Robert A. Gramm, Section Chief
Project Directorate IV-1
Project Directorate IV
Division of Licensing Project Management

FROM: Mark P. Rubin, Section Chief /***RA/***
Safety Program Section
Probabilistic Safety Assessment Branch
Division of Systems Safety and Analysis

SUBJECT: PROBABILISTIC SAFETY ASSESSMENT BRANCH INPUT TO SAFETY EVALUATION REGARDING LICENSE AMENDMENT REQUEST FOR ARKANSAS NUCLEAR ONE, UNIT 2, TO EXTEND THE ALLOWED OUTAGE TIME FOR A SINGLE INOPERABLE LOW PRESSURE SAFETY INJECTION (LPSI) TRAIN FROM 72 HOURS TO 7 DAYS

The Probabilistic Safety Assessment Branch (SPSB) has reviewed the proposed TS change requested by Entergy Operations, Inc. The proposed change will revise TS 3.5.2, Low Pressure Safety Injection Train Allowed Outage Time (AOT) from 72 hours to 7 days when one LPSI train is inoperable in MODES 1, 2, and 3. The licensee performed an integrated review and assessment of plant operations, taking into account deterministic/design basis factors, and impact on plant risk. The results of this study demonstrate that the proposed AOT extension provides plant operational flexibility while simultaneously resulting in minimal plant risk perturbations. The licensee's risk evaluation shows that the risk impact of extending the AOT for an inoperable LPSI train from 72 hours to 7 days was small and within the guideline values of Regulatory Guides 1.177 and 1.174. In addition, the licensee made a regulatory commitment to implement four compensatory measures as discussed in the staff safety evaluation report. These measures will be put in place prior to implementing this revision to TS 3.5.2, ACTION a. This proposal should enhance overall plant safety by avoiding potential unscheduled shutdowns and providing for increased flexibility in scheduling and performing maintenance and surveillance activities. The staff finds this proposal acceptable. Our risk-informed evaluation is attached. This completes our effort on TAC No. MB6362.

Attachment:
As stated

CONTACT: Millard Wohl, SPSB/DSSA/NRR
301-415-1181

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Attachment: As stated

Distribution: SPSB: r/f

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G:\wohl\ANO-2 LPSI AOT.wpd NRR-096
*See prior concurrence

OFFICE	SPSB	SPSB:SC
NAME	MWohl:nxh2*	MRubin
DATE	08/23/03	08/26/03

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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION
RELATING TO LPSI TECHNICAL SPECIFICATION CHANGE
FOR ENTERGY OPERATIONS, INC.
ARKANSAS NUCLEAR ONE, UNIT 2,
DOCKET NO.MB6362

1.0 INTRODUCTION

In letters dated September 19, 2002, and July 18, 2003, Entergy Operations, Inc. (the licensee) requested a license amendment to revise Arkansas Nuclear One, Unit 2, TS 3.5.2, Low Pressure Safety Injection (LPSI) Allowed Outage Time (AOT) in their technical specifications (TS). The proposed change would revise current TS 3.5.2, LPSI train Allowed Outage Time, from 72 hours to 7 days when one LPSI train is inoperable in MODES 1,2,or 3. The licensee performed an integrated review and assessment of plant operations, deterministic/design basis factors and plant risk. The results of the study demonstrated that the proposed AOT extension would provide plant operational flexibility while simultaneously perturbing plant risk very minimally. Additionally, the licensee made a regulatory commitment to implement four compensatory measures to be put in place prior to implementing this revision to TS 3.5.2, ACTION a. This proposal will enhance overall plant safety by avoiding potential unscheduled shutdowns, providing for increased flexibility in scheduling, and better optimizing the performance of maintenance and surveillance activities.

2.0 BACKGROUND

The Commission's regulatory requirements related to the contents of TS are set forth in 10 CFR 50.36, which ensures that the TS-specified limiting conditions for operation are consistent with the assumed values of the initial conditions in the licensee's safety analysis. In accordance with 10 CFR 50.36, the staff and the NSSS Owners' Groups developed improved improved standard technical specifications (ISTS), which meet 10 CFR 50.36 (c)(2) ii and 10 CFR 50.36 (c)(3) requirements. The licensee is using the guidance from the staff-approved NUREG-1432, Revision 2, and the guidance from NUREG-800, Standard Review Plan, as appropriate for their plant. The licensee performed a detailed risk evaluation using Regulatory Guides 1.177 and 1.174. The results of the risk evaluation show that the risk significance of extending the proposed AOT for an inoperable LPSI train from 72 hours to 7 days was small and within the acceptance guidelines of RGs 1.177 and 1.174. Operation of the LPSI system with the proposed AOT is in compliance with General Design Criteria 34, 35, and 37, which require residual heat removal function, ECCS function, and ECCS testing requirements, respectively.

3.0 REGULATORY EVALUATION

3.1 Regulatory Requirements and Guidelines

As stated above operation of the LPSI systems with the proposed AOT is in compliance with General Design Criteria 34, 35, and 37, which require residual heat removal function, ECCS function, and ECCS testing requirements, respectively.

The following Regulatory Guides (RGs) provide a basis for the licensee's submittal and the staff's evaluation thereof:

RG 1.177, “An Approach for Plant-Specific Risk-Informed Decisionmaking: Technical Specifications.”

RG 1.174, “An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decisions on Plant-Specific Changes to the Licensing Basis”.

In addition, guidance for pre-maintenance safety assessments are provided by the maintenance rule.

4.0 TECHNICAL EVALUATION

Consideration of the risk factors impacted by the extension in AOT from 72 hours to 7 days demonstrate that essentially very little increase in average “at power” core damage frequency (CDF) for ANO-2 exists. An analysis was performed of the impact of the proposed LPSI AOT extension on large early release scenarios. The licensee assessments of the three classes of events (containment bypass, severe accidents accompanied by loss of containment isolation, and containment failure associated with energetic events in containment) were considered by the licensee for these scenarios. It concluded that the increased unavailability of one LPSI train would result in a very small impact on the large early release probability for ANO-2. The staff agrees based on the ANO-2 risk evaluation with respect to the acceptance guidelines of RGs 1.174 and 1.177.

Safety Assessment for Extension of LPSI AOT to 7 Days

The licensee performed an assessment of the change in the ANO-2 core damage frequency (CDF) for allowing ANO-2 to continue at power operation with a LPSI train out of service for 7 days. Using the ANO-2 Internal Events Level-1 PSA model, the CDF associated with at-power plant conditions was assessed. The summary of the risk analysis provides a best estimate evaluation using current modeling techniques including a relative change in CDF values.

The current ANO-2 PSA model (revision 3p1) was used for the present licensee analysis. The PSA model provides only internal events at-power risk estimates. Anticipated Transients Without Scram (ATWS), Interfacing System LOCAs (ISLOCAs), and external initiators, such as seismic events, internal or external floods, high winds, and tornadoes are not considered in the licensee’s analysis since these were not available in the above model. The licensee performed a supplemental assessment considering these issues, which is discussed later in this SE.

Although mode transition and shutdown risks were not explicitly considered by the licensee, the licensee expects insignificant impacts in these modes. Since LPSI is chiefly a shutdown system, allowing extended maintenance outages during power operations may increase its availability during shutdown operations and will avoid unnecessary plant shutdowns due to an inoperable LPSI train, in which LPSI operation is necessary.

The impact of the proposed AOT extension on Large Early Release Frequency (LERF) is not explicitly considered by the licensee, but is expected by the staff to be less than ten percent of similar impacts on Core Damage Frequency (CDF) based on the staff’s understanding of large dry high-pressure containment conditional failure probability. In previous license applications, the licensee has estimated a base LERF value that is less than three percent of the base CDF.

For the preventive maintenance cases, no other safety-related components or systems were considered out-of service (OOS) by the licensee. However, test and maintenance event frequencies were left at nominal values for conservatism. When one train is OOS for preventive maintenance (PM), the licensee does not allow the other train to be in a test or maintenance condition. It is assumed that PM is planned such that plant risk is minimized consistent with the requirements of 10 CFR 50.65 (a)(4). Corrective maintenance is defined as an emergent maintenance evolution due to equipment failure. Since CM is not planned, plant risk may be elevated due to other equipment failures, common-cause failure being a prominent example.

The results of the ANO-2 LPSI proposed 7-day risk analyses due to internal event contributors calculated by the licensee show that the ICCDP value is well below the RG 1.177 guideline. Further, the delta CDF value is below the RG 1.174 value.

Tier 1–PRA Capability and Insights

The Tier 1 considerations constitute an evaluation of the impact on plant risk of the proposed 7-day LPSI AOT as expressed by the change in core damage frequency (delta CDF), the incremental conditional core damage probability (ICCDP), and, when necessary, the changes in large early release frequency (delta LERF), and the incremental conditional large early release probability (ICLERP). For the proposed 7-day LPSI AOT (preventive maintenance (PM)), the licensee's calculated delta CDF is 1.08E-07/yr, which is within the RG 1.174 acceptance guideline of 1.0E-05/yr. The ICCDP is 3.61E-08, which is within the 5E-07 acceptance guideline value of RG 1.177. The licensee's corresponding results for corrective maintenance (CM) are 1.85E-07/yr (delta CDF) and 2.81E-07 (ICCDP), both of which are within the acceptance guidelines. Adoption of the proposed AOT extension would also probably reduce the risk contribution of shutdowns, though this risk reduction is not quantified. The LERF impacts (i.e., delta LERF and ICLERP) are estimated by the staff to be proportionally smaller (by more than a factor of ten) to the CDF impacts, and therefore, are also within the RG 1.174 and 1.177 acceptance guidelines.

Tier 2–Avoidance of Plant Risk

The avoidance of risk-significant plant configurations leads to the identification of potentially high risk configurations that could exist if equipment in addition to that associated with the TS AOT change is concurrently taken out of service, or other risk-significant operational factors such as concurrent system or equipment testing are involved. This ensures that appropriate restrictions are placed on dominant risk-significant configurations that could be relevant to the proposed TS AOT change. The licensee stated that they have not identified any additional constraints or compensatory actions that should be included with the proposed LPSI 7-day AOT in order to avoid planned high-risk configurations. Assessments performed in accordance with provisions of the licensee's Equipment-out-of-Service (EOOS) Model should give reasonable assurance that the risk significances of unexpected configurations resulting from unplanned maintenance or unexpected conditions while in the risk-informed AOT are properly evaluated.

Tier 3–ANO-2 Risk Management Program

The EOOS model provides the configuration risk management tool at ANO-2 for compliance with 10 CFR 50.65(a)(4). The program provides assurance to the licensee that risk-significant

plant equipment configurations are minimized when plant equipment is removed from service. This program is a proceduralized, risk-informed assessment process to manage the risk associated with planned and unplanned plant maintenance activities. The licensee states that the program ensures that the risk impact of out-of-service equipment is appropriately evaluated prior to performing a planned maintenance activity and soon after entering an emergent maintenance condition. Procedures and guidelines have been developed that govern this process. These documents require an integrated review (both quantitative and qualitative) of maintenance activities to identify risk-significant plant equipment outage configurations. The licensee requires this review both during the work management process and for emergent conditions during normal plant operation. Appropriate consideration is given to equipment unavailability, operational activities such as testing or load dispatching, and weather conditions. This program includes provisions for performing a configuration-dependent assessment of the overall impact on risk of proposed licensee plant configurations prior to, and during, the performance of maintenance activities that result in the removal of equipment from service. The licensee reassesses risk if an equipment failure/malfunction or emergent condition produces a plant configuration risk that has not been previously assessed. This provides an acceptable process for assessing the risk impact of planned maintenance activities during the proposed LPSI extended AOT.

PSA Model Quality

The ANO-2 Individual Plant Examination (IPE) model was developed by ANO-2 Safety Analysis Design Engineering personnel with support from SAIC (now DS&S), other Design Engineering groups, and Operations. As part of the IPE development process, an expert panel review was performed on the results. This panel was composed of experienced personnel from these groups. In addition, ERIN Engineering performed an external review of the IPE model and results. The ANO-2 Probabilistic (Safety) Analysis (PSA) model has been updated several times since completion of the IPE to maintain it consistent with the as-built/as-operated plant, to incorporate improved thermal hydraulic results, and to incorporate PSA methodology improvements. The updates have involved a cooperative effort including both licensee personnel and PSA consultant support. In each of the updates, an independent review of the revisions to the PSA model is performed. The PSA model and results have been maintained as plant calculations or engineering reports. As part of each major update, in order to ensure adequacy of the updated model, an internal review of PSA model results is performed by utilizing an expert panel. The panel is typically composed of experienced personnel from various plant organizations, including Operations, System Engineering, Design Engineering, Safety Analysis, and PSA. In addition the CE Owners Group conducted a peer review of the ANO-2 model in February of 2002. The results of this review, however, have not been issued to date. The staff has, however, reviewed the results of the current ANO-2 PSA model as part of the benchmarking of the ANO-2 Significance Determination Program Notebook. This review was conducted by the staff and its contractors at the ANO-2 site during the week of November 26, 2001. Also, the staff performed a review of the risk assessment, primarily the human reliability analysis and fire risk analysis methods that were considered as part of its review of the risk impact of the ANO-2 extended power uprate. This review included a site visit on December 18 and 19, 2001. These staff reviews did not identify any issues that would directly impact this license amendment application.

External Events

The licensee's PSA model does not address the risk associated with external events, including seismic events, internal fires, and other external events (i.e., high winds, external flooding, and accident involving nearby industries, transportation and military facilities). Nor does the model address the risk associated with several other risk contributors, namely Anticipated Transients Without Scram (ATWS) scenarios, Interfacing System Loss of Coolant Accidents (ISLOCAs), and High and Medium Energy Line Breaks (HELBs and MELBs). The licensee performed qualitative analyses to assess the risk impacts of these non-modeled events for extending the current LPSI AOT. The licensee considers these analyses to be qualitative, since they are relatively simplistic and not based on comprehensive and detailed fault tree/event tree models. The licensee's intent of these methods and results was to provide an order-of- magnitude assessment of the risk associated with these risk contributors.

The licensee's methodology is essentially the same as that used for the ANO-2 Emergency Diesel Generator (EDG) AOT extension reported to the staff by letter dated May 22, 2003. Differences in the methodology are due to differences in the risk issues associated with extending the EDG vs. LPSI AOTs. The methodology was previously described in the licensee's May 22, 2003 letter; thus, the discussion below focuses on the licensee-perceived differences in the use of this methodology for the present LPSI AOT relaxation submittal.

Removing a LPSI train from service does not affect the risk associated with any of the external events listed above, according to the licensee. This conclusion is based on the following observations:

The LPSI system has two safety functions:

(1) The LPSI emergency core cooling mode provides reactor coolant system (RCS) makeup during the injection phase of a large break LOCA (LBLOCA) and

(2) The LPSI shutdown cooling mode provides a means of cooling the RCS during shutdown conditions.

None of the non-modeled events (including external events) causes or involves a LBLOCA. Thus, degradation of the LPSI emergency core cooling function due to the removal of a LPSI train from service does not affect the risk associated with any of the non-modeled risk contributors.

The safe end state for most of the non-modeled events is the Hot Standby (HSB) condition. Thus, degradation of the LPSI emergency core cooling function due to the removal of a LPSI train from service affects only those non-modeled events which require entry into the SDC mode as a safe end state.

The licensee considers the HSB condition to be the safe end state for all but a few accident scenarios. The staff agrees; this position is consistent with the NUREG-0933 item A-31 statement that the "safe shutdown for a nuclear power plant following an accident not related to a LOCA has been typically interpreted as achieving a "hot-standby" condition (i.e., the reactor is shut down, but system temperature and pressure are still at or near normal operating values)." The ANO-2 PSA model is consistent with this position. This position also applies to accidents not included in the ANO-2 PSA model. Thus, entry into the SDC mode is not generally required for successful mitigation of any of the non-modeled events, including external events. A

licensee review of each of the non-modeled risk contributors was performed using insights from the ANO-2 IPEEE results, where available, in order to assure that this general rule applies to each of the non-modeled risk contributors. The effect of each non-modeled event in causing either a LBLOCA or a Steam Generator Tube Rupture (SGTR) event, both of which require the use of LPSI, was considered.

A licensee review of the external events indicates that none inherently requires entry into the SDC mode for successful mitigation. All can be modeled as a special transient event that is already included in the ANO-2 PSA model. Specific licensee observations for each of the non-modeled risk contributors follow:

1) A fire event is assumed to cause a transient that involves the failure of a specific set of components. None of these failures directly causes a LBLOCA or a SGTR. The ANO-2 IPEEE fire risk analysis assumed that the HSB condition was a safe end state; thus, LPSI failures do not appear in any of the fire risk analysis cutset results for any fire initiator. Hence, the effect of removing a LPSI train from service has essentially no impact on the assessed fire risk. Due to this, the licensee did not make a detailed fire risk assessment.

2) A seismic event is also categorized by the licensee as a special transient event. No seismic event smaller than the 0.3g Review Level Earthquake (RLE) was identified to result in a LBLOCA or SGTR. Thus, no seismic event within the scope of the ANO-2 IPEEE study is expected to require entry into the SDC mode. The licensee has concluded that, given a seismic event large enough to result in a LBLOCA or SGTR would probably also disable the LPSI system or systems that support it, the effect of removing a LPSI train from service has essentially no impact on the seismic risk. The staff agrees that this impact would be extremely small.

3) Similar arguments can be justified for internal floods and other external events (i.e., high winds, external flooding, and accidents involving nearby industries, transportation, and military facilities). None result in a LBLOCA or SGTR event and all could be modeled as special transient events. Thus, the staff judges that the effect of removing a LPSI train from service would have extremely small impact on the risk of other external events.

4) Similar arguments can be made for the risk impacts of HELB and MELB, with similar arguments regarding the very low impact on LPSI unavailability.

5) The remaining risk contributors not included in the licensee's PSA/PRA model, namely the ATWS and ISLOCA events, require additional consideration:

ISLOCA

The licensee's IPE identified three ISLOCA scenarios:

(1) LPSI system injection line failures,
(2) SDC suction line failures, and
(3) Reactor Coolant Pump (RCP) seal cooler failures.

The first two situations contribute to core damage significantly, according to the licensee, only if either involves the loss of reactor coolant system (RCS) inventory outside of the containment

building. Without mitigation, if RCS inventory is lost outside of containment, core damage will occur regardless of LPSI availability. For these events, if the break is isolated, the RCS will repressurize and a LPSI train is not required to mitigate either of the events. The last scenario does not result in a LBLOCA and, as such, does not require the LPSI ECC mode. Since the HSB condition is a safe end state, the LPSI SDC mode is not required for this event. Thus, the licensee concludes that removing a LPSI train from service at power does not significantly increase the risk associated with an ISLOCA, because the LPSI train is not needed to mitigate any of these ISLOCA events. The staff agrees with this conclusion based on the results of the licensee's qualitative evaluation.

ATWS

The licensee performed a scoping level analysis of the ANO-2 ATWS event as part of the ANO-2 IPE reported to the staff by letter dated August 28, 1992. This analysis assumed that successful termination of the ATWS event required entry into the SDC mode. An insight from this analysis is that the proposed extension of the LPSI AOT will impact the plant risk due to an ATWS.

The licensee's nominal ATWS CDF is estimated to be 1.59E-06/r-yr, which was reported to the staff by letter dated May 22, 2003.

The effect of removing a LPSI train from service on the ATWS contribution to CDF was assessed by adjusting the Long Term Cooling event probabilities in the ATWS event tree logic. The LTC event accounts for the failure of the shutdown cooling function following an ATWS event.

The licensee-estimated instantaneous CDF (r/yr) for ATWS for PM was 1.84E-06, while that for CM was 1.88E-06. The licensee's ICCDP estimates were 4.7E-09 (PM) and 5.5E-09 (CM), which are well-within the RG 1.177 guideline. The licensee's ICCDP estimates also meet the RG 1.177 acceptance guideline for ICLERP. The licensee's annual average delta CDF estimates were 1.4E-08/r-yr (PM) and 3.7E-09/r-yr (CM), which are well-within the RG 1.174 guideline. The licensee's annual average delta CDF estimates also meet the RG 1.174 acceptance guideline for delta LERF.

Licensee Satisfaction of at-Power Compensatory Measures

The Equipment Out of Service (EOOS) model provides the licensee's configuration risk management program (CRMP) program tool for compliance with 10 CFR 50.65, particularly with respect to paragraph (a)(4). The program provides assurance that risk-significant plant equipment configurations are precluded or minimized when plant equipment is removed from service. A detailed description of the CRMP was provided to the staff by letter dated Sept. 19, 2002, "License Amendment Request to Extend Allowed Outage Time for Low Pressure Safety Injection System. The licensee has not identified any high-risk configurations associated with the proposed AOT extension. However, when at power, the licensee states that the following actions will be taken prior to taking a LPSI train out of service for maintenance purposes. These actions will not be taken unless entry into the AOT is expected to extend beyond the current 72 hour AOT.

1. All safety injection tanks will be verified operable.

2. All emergency feedwater (EFW) sources will be verified operable.

3. Operations will perform a briefing with the appropriate maintenance personnel in attendance to discuss the impact associated with unavailable components and flow paths. The brief will also include consideration of the actions that would need to be taken to return the affected LPSI train to functional use should the need arise.

4. Parts and tools will be pre-staged when appropriate to minimize outage time Generally, the LPSI AOT will not be entered unless these actions are satisfied. However, it should be recognized that unforeseen circumstances may arise that prohibit complying with these actions.

It is standard operational licensee practice to verify redundant train operability along with the required support systems prior to removing any TS components regardless of the length of time a TS component is removed from service. If the redundant LPSI train is not operable, the maintenance activity will not be performed.

In all cases, maintenance activities are managed and assessed as required by the licensee's risk management program and 10 CFR 50.65(a)(4). When practical, valves are placed in their optimum position and maintenance activities are efficiently scheduled.

5.0 EMERGENCY/EXIGENT PROVISIONS

The proposed license amendment was not processed using the emergency or exigent provisions of 10 CFR 50.91. Therefore, this section is not pertinent to the NRC's findings and conclusions regarding the proposed license amendment.

6.0 FINAL NO SIGNIFICANT HAZARDS CONSIDERATION DETERMINATION

The proposed license amendment was not processed using the emergency or exigent provisions of 10 CFR 50.91 and a hearing has not been requested for this amendment. Therefore, this section is not pertinent to thee NRC's findings and conclusions regarding the proposed license amendment.

7.0 STATE CONSULTATION

The technical staff have no input to this section of the safety evaluation.

8.0 ENVIRONMENTAL CONSIDERATION

The technical staff have no input to this section of the safety evaluation.

9.0 CONCLUSION

Based on the evaluations discussed in the safety evaluation, the staff finds that the proposed extension of the LPSI AOT at ANO-2 is acceptable based upon the licensee's risk-informed assessment. This assessment concludes that the increase in plant risk is small and consistent with the acceptance guidelines of RG 1.177 and RG 1.174.

Principal contributor: Millard Wohl