ACRSR-1984

March 14, 2002

The Honorable Richard A. Meserve
Chairman
U. S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Dear Chairman Meserve:

SUBJECT: CORE POWER UPRATE FOR ARKANSAS NUCLEAR ONE, UNIT 2

During the 490th meeting of the Advisory Committee on Reactor Safeguards, March 7-9, 2002, we completed our review of the Entergy Operations, Inc. (Entergy) application for a power uprate of 7.5 percent for Arkansas Nuclear One – Unit 2 (ANO-2), and the related NRC staff's Safety Evaluation Report (SER). Our Subcommittee on Thermal-Hydraulic Phenomena also reviewed this matter on February 13, 2002. During our review, we had discussions with representatives of the Applicant and the NRC staff, and we also had the benefit of the documents referenced.

Conclusions and Recommendations

1. The Entergy application for a power level increase from 2815 MWt to 3026 MWt for ANO-2 should be approved.

2. The process used by the staff and the Applicant was comprehensive enough to identify the important issues associated with pressurized water reactor (PWR) power uprates. The process would be greatly improved by the availability of a standard review plan to guide both staff and the Applicant.

3. The process used by the Applicant to perform the Reload Safety Analysis appears to be appropriate. Because this is the first large power uprate for a PWR, the staff should review the Reload Safety Analysis for the transitional core reloads to ensure that the plant will operate in compliance with the regulations.

Discussion

In 1997, the staff performed a comprehensive review of an application for a PWR power uprate involving the Joseph M. Farley nuclear power plant. The Farley plant Licensee used the guidance in WCAP-10263, "A Review Plan for Uprating the Licensed Power of a PWR Power Plant," to prepare its application. This guidance has not been formally reviewed and approved. ANO-2 is a Combustion Engineering reactor, not a Westinghouse reactor like Farley. We believe, however, that there is enough similarity

between the ANO-2 plant and the Westinghouse plants to justify the use of WCAP-10263 and the Farley plant SER as templates and guidelines. The Applicant also used General Electric Topical Report NEDC-31897P-A, "Generic Guidelines for BWR Extended Power Uprates," and SECY 97-042, Section 3, "Power Uprate Review Process," to support and substantiate its analyses.

Although we believe that the approach used by Entergy and the staff is sufficiently comprehensive to identify the important PWR power uprate issues, the process would be greatly improved by the availability of a better template such as a standard review plan.

It is difficult to perform a major power uprate in a PWR unless significant modifications are made to the plant. In a PWR, the power is limited by the amount of heat exchange surface. ANO-2 installed larger replacement steam generators that can accommodate the higher thermal power, but, these larger steam generators impose greater accident loads on the containment. The increased energy release during a potential steamline break accident required an increase in the containment building design pressure rating from 54 psig to 59 psig. Instead of modifying the containment building, the Applicant reanalyzed the strength of the containment S considering additional tendons that had not been credited in the original analysis. The containment pressure capability was demonstrated by conducting a pressure test at 68 psig. We conclude that the Applicant's analyses of containment loads and demonstration of the design capability of the containment structure are adequate.

Entergy does not propose to alter the basic thermal-hydraulic design of the reactor core, but will change the neutronic design to provide more core power flattening.

For the uprated power plant, the licensee will use a different code for the analysis of the large-break LOCA. This code has previously been reviewed by the staff. It includes a revised reflood heat transfer coefficient correlation, derived from the FLECHT data, and other code improvements to the Appendix K ECCS evaluation model. The model predicts a peak cladding temperature approximately 150°F less than the previous evaluation model.

Because of the significant changes to the physical plant and to the analytical models used to analyze the plant under accident conditions, the staff should review the transition reload safety analyses for this plant to ensure that the Applicant properly incorporated plant design changes and parameters that describe the characteristics of the transition reload.

The Applicant has scheduled many modifications to the balance of plant to accommodate the increased power output and the additional component duty that will result from an increase in rated power. These involve changes to the Main Unit Turbine/Generator, the Main Unit Condenser, and accessories and associated supporting systems. We did not find significant safety issues associated with the planned modifications.

The uprated power level leads to an increase of reactor head temperature and thereby will increase the susceptibility of the Control Rod Drive Mechanism (CRDM) nozzles to cracking. ANO-2 is a "cold head" plant. There is some bypass flow directed to the reactor head region which lowers the reactor head temperature and reduces susceptibility to cracking of CRDM nozzles. This plant was ranked as an "intermediate plant" using Electric Power Research Institute Materials Reliability Program Reports 44 and 48 and will remain an "intermediate plant." Appropriate management of the issues involved in reactor vessel CRDM weld and nozzle cracking is under active consideration by the staff and the nuclear industry. The resolution of this problem will not be affected by the power uprate.

The ANO-2 reactor vessel has a very large margin to the pressurized thermal shock and upper-shelf energy limits and, thus, the neutron fluence and thermal conditions for the upgraded power level will have little effect.

The ANO-2 application for power uprate was not submitted as a "risk informed" application. However, the Applicant did supply risk information, which the staff examined. The Applicant's evaluation of the increase in Core Damage Frequency (CDF) and Large Early Release Frequency (LERF) indicates that these changes can be classified under the guidelines of Regulatory Guide 1.174 as a "small change" for CDF and as a "very small change" for LERF.

Based on our review of the ANO-2 power uprate application and the associated NRC staff's SER, we believe that the requested power level increase for ANO-2 should be approved.

Additional comments by ACRS Member George E. Apostolakis are provided below.

Sincerely,

/RA/

George E. Apostolakis
Chairman

Additional Comments by ACRS Member George E. Apostolakis

I appreciate the fact that the power uprate requests are not risk informed. Even though estimates of ΔCDF and ΔLERF are provided, the decision of whether to approve the requested uprate is based primarily on conservative "deterministic" calculations.

An important input to the estimation of ΔCDF and ΔLERF is the change in human error probabilities (HEPs). This change is due to shorter available times for operator action that the power uprate generates.

The licensee and the staff did a commendable job in identifying operator actions that could be affected by the power uprate.

I do object, however, to the HEP quantitative estimates that are provided. I do not believe that there are any credible HEP models that are sufficiently sensitive to the calculated reductions in available time to be able to yield believable HEP estimates. For example, Table 8.1 of the SER lists the following human failure event: "Failure to re-energize 2A1/2A2 from ST2 (SBLOCA or SGTR)." The pre-uprate available time was 42 minutes and the estimated HEP was 0.19. The post-uprate available time was estimated to be 39 minutes and the new HEP was 0.29.

I do not believe these results. I do not think that the model that will discriminate between 42 and 39 minutes has been developed yet. The licensee states that these estimates are produced using several EPRI reports. These reports have not been approved by the NRC and are not widely accepted by the technical community. The staff is careful to state (Section 8.1.4) that "... the licensee's human reliability analysis application is consistent with the identified methodologies...." While this may be a true statement, it really does not say anything about the methodologies themselves.

I do not know whether the staff's conclusion that the HEP values reasonably reflect the reductions in times available for operator action is true. I suspect it is, but I do not have a credible model that will convince me that it is true.

I do not think that the staff should accept results that are produced from methodologies that are neither approved by the NRC, nor widely accepted.

References:

1. Memorandum dated December 19, 2000, from Entergy Operations, Inc., to U.S. NRC, Subject: Arkansas Nuclear One-Unit 2 Application for License Amendment to Increase Authorized Power Level.
2. Memorandum dated January 22, 2002, from Amarjit Singh, ACRS, to ACRS Members, transmitting memorandum dated January 18, 2002, from J. A. Zwolinski, Office of Nuclear Reactor Regulation, NRC, to John T. Larkins, ACRS, transmitting Arkansas Nuclear One, Unit No. 2 - Draft Safety Evaluation for Extended Power Uprate (Predecisional).
3. Letter dated March 1, 2002, from Sherri R. Cotton, Entergy Operations, Inc., to Nuclear Regulatory Commission, Subject: ANO Unit 2, Follow-up Questions Resulting from the ACRS Subcommittee's Review of ANO-2's Proposed Power Uprate, dated March 1, 2002.
4. Memorandum dated February 7, 2002, from Paul Boehnert, ACRS, to ACRS Members, Subject: ACRS Review of ANO Unit 2 Core Power Uprate Request - Additional Background Material.

5. Letter dated February 7, 2002, from Glenn R. Ashley, Entergy Operations, Inc., to USNRC, Subject: ANO Unit 2, Response to Request for Additional Information on Vessel Head Penetration Nozzles Regarding the ANO-2 Power Uprate License Application.
6. Letter dated February 7, 2002, from Glenn R. Ashley, Entergy Operations, Inc., to USNRC, Subject: ANO Unit 2, Comments Regarding the Draft NRC Safety Evaluation for the Proposed ANO-2 Power Uprate.
7. Memorandums from Entergy Operations, Inc., Response to Requests for Additional Information Regarding the ANO-2 Power Uprate License Application, dated December 20 (contains proprietary material), November 16 (contains proprietary material), November 16, November 9, October 31(contains proprietary material), October 30, October 17, October 1, and September 14, 2001.
8. Memorandum dated January 31, 2002, from Entergy Operations, Inc., to Nuclear Regulatory Commission, Subject: Arkansas Nuclear One Unit 2 Response to Follow-up Request for Additional Information Concerning SGTR and MHA Dose Assessment Calculations Supporting ANO-2 Power Uprate.
9. Entergy Operations, Inc., Memorandums, Response to Requests for Additional Information Regarding the ANO-2 Power Uprate License Application, dated May 30, June 20, June 26, June 26, June 28, July 3 (contains proprietary material), July 24, July 24, August 7, August 13, August 21, August 23 (contains proprietary material), August 30, 2001.
10. Letter dated September 29, 2000, from Thomas W. Alexion, Office of Nuclear Reactor Regulation, NRC, to Craig G. Anderson, Entergy Operations, Inc., Subject: ANO Unit 2, Issuance of Amendment Re: Technical Specification Changes and Unreviewed Safety Question Resolution Related to Applicable Limits and Setpoints for Steam Generator Replacement.
11. Letter dated November 13, 2000, from T. Alexion, Office of Nuclear Reactor Regulation, NRC, to Craig G. Anderson, Entergy Operations, Inc., Subject: ANO Unit 2 Issuance of Amendment Re: Technical Specification Changes and Unreviewed Safety Question Resolution Related to Containment Building Design Pressure Increase to 59 PSIG.
12. GE Nuclear Energy Licensing Topical Report, “Generic Guidelines for General Electric Boiling Water Reactor Power Uprate,” NEDC-31897P-A, dated May 1992.
13. U. S. Nuclear Regulatory Commission, Regulatory Guide 1.174, “An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decisions on Plant-Specific Changes to the Licensing Basis,” July 1998.