UNITED STATES
NUCLEAR REGULATORY COMMISSION
ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
WASHINGTON, DC 20555 - 0001

November 10, 2008

MEMORANDUM TO: Joseph G. Giitter, Director
Division of Operating Reactor Licensing
Nuclear Reactor Regulation

FROM: Edwin M. Hackett, Executive Director **/RA/**
Advisory Committee on Reactor Safeguards

SUBJECT: TRANSMITTAL OF ACRS MEMBERS' CONCERNS REGARDING CONTAINMENT OVERPRESSURE (COP) CREDIT FOR THE BROWNS FERRY EXTENDED POWER UPRATE

On February 16, 2007, the ACRS (the Committee) issued a letter report on the Browns Ferry Unit 1 (BFN-1) 5-percent power uprate application. The application included containment analyses performed at the bounding conditions of 20 percent above the original licensed thermal power (OLTP). In its letter report, the Committee concluded that "Granting of COP credit during long-term loss-of-coolant accident and 10 CFR Part 50 Appendix R fire scenarios at 120-percent of the OLTP will require support by more complete evaluations."

On July 10, 2008, Tennessee Valley Authority (TVA) representatives briefed the Committee on technical issues associated with COP credit for the extended power uprates (EPUs) of Browns Ferry Units 1, 2, and 3. The presentation described the fire hazard screening criteria and the corresponding containment overpressure calculations that supplement the Appendix R licensing analyses. TVA representatives also discussed the basis for the decision to rely on COP credit, instead of implementing plant modifications, to ensure that the pumps can perform their safety function during an Appendix R fire scenario.

During the July 10, 2008, briefing the Members raised several concerns that were not adequately addressed in the presentation materials or in the discussions. The enclosed document describes these concerns. It is important to note that additional issues requiring further clarification may arise during the formal ACRS review of the Browns Ferry EPU application in March 2009. Since the Committee has not yet reviewed the staff's COP White Paper, the enclosed document does not include questions on the staff's COP credit position.

Enclosure:
COP Credit Committee Briefing Browns Ferry Units 1, 2, and 3, July 10, 2008

cc w/enclosure: ACRS Members

cc w/o enclosure: ACRS Consultants
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301-415-8716

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Containment Overpressure Credit Committee Briefing
Browns Ferry Units 1, 2, and 3
July 10, 2008

In preliminary discussions of the Browns Ferry EPU, ACRS members expressed concerns over: (1) the crediting of high containment backpressure for long durations; (2) the need for operator actions that turn off automatic system responses; and (3) the low or no margins to pump cavitation even with the COP credit. The BFN Appendix R NPSH calculations result in low margins despite high COP credit (e.g., 1.6 psi minimum margin) and the COP credit is needed for at least 69 hours. In addition, the calculation assumes that the drywell coolers would be turned off no longer than two hours after the start of the fire in order to maximize the available containment pressure. The ACRS members suggested that TVA perform a fire risk analysis to demonstrate that the risk associated with the COP credit is low. In lieu of the fire risk analysis, TVA elected to perform an alternative fire analysis to show that a less prescriptive, but still conservative, fire hazard deterministic analysis that accounts for damage in identified fire areas would yield lower COP credit and duration.

On July 10, 2008, TVA briefed the ACRS on its COP alternative analyses. The briefing was supported by a June 12, 2008, submittal. During the briefing, the members raised several questions. In addition, in their review of the documents supporting the briefing, the members identified a need for additional information in order to be able to assess the adequacy of the alternative analysis. The following section describes the needed information.

Note that this document may not necessarily address all issues that may arise during the formal review of the Browns Ferry EPU application.

1) Staff Review of the Alternative Fire Hazard Analysis NPSH Calculation

The July 9, 2008, draft COP SER submittal to the ACRS stated that, *"The NRR staff briefly examined the information TVA provided; however, the information provided did not result in a revision to the previous staff's basis regarding credit for containment overpressure."* The following questions address the staff's review of the TVA fire hazard analyses.

a) The November 2007 Round 13 RAI response presents the fire hazard analysis screening criteria. Did the staff review the fire hazard screening criteria and find the criteria reasonable? Will the alternative fire analysis and the associated COP analysis presented to the Committee be reviewed, approved and incorporated into the safety evaluation report?

b) Has the staff reviewed the alternative sensitivity analyses supporting the LOCA, SBO and ATWS COP to determine if the key assumptions, input parameters and equipment performance used in the deterministic analyses are reasonable?

2) Clarification of the Alternate Analysis July 10, 2008, Presentation

(RAI APLA-35/37 of the November 15, 2007, RAI responses - Round 6)

a) Specify the balance of plant equipment assumed to be available during the scenario. Are there any limitations to the equipment availability for the duration of the event that would affect the mitigating systems?

b) Describe how the systems and equipment (RHR & BOP) will be aligned to support the core and suppression pool cooling. Are these alignments included in the plant procedures for this event? What ensures that the appropriate personnel remain trained and qualified for this mode of operation?

c) For the alternate fire analysis presented to the ACRS, was a reactor core cooling analysis performed or were the reactor core conditions evaluated without reanalysis?

d) For the fire hazard analyses, would any fire requiring COP result in a LOOP? Since BOP systems depend on off site power, could a fire in areas 04 and/or 09 cause LOOP?

e) Identify any key parameters, inputs, and assumptions in the analysis that differ from the licensing calculations. Compare the values and assumptions used and justify the differences.

f) On Page E-4, TVA states that they have identified minor changes to procedures that will be made in order to improve the response to the fire event. What are these minor procedural changes? Would these procedural changes affect the Appendix R safe-shutdown instruction (SSI) or the Units' EOPs?

g) The following questions relate to the Appendix R analyses:

   i) Is LOOP assumed for this event? If so, are the drywell coolers available for the first two hours of the event as assumed in the Appendix R analysis?

   ii) Provide discussions on how the staff confirms that the operator actions specified in the procedures and the operator trainings are consistent with the mitigation actions assumed in the analyses. For example, explain how the drywell coolers (within 2 hours of the start of the event) would be implemented in the SSI, EOP or other procedures.

   iii) For the different fire scenarios, are there any conditions that could result in the drywell coolers not being turned off or being restarted after being initially turned off? If this is feasible, explain the specifics (e.g., operator actions) of each fire scenario that would be implemented in procedures.

3) Pump Performance Data

In determining the required NPSH for given flow conditions, the pump vendor establishes required minimum NPSH values that correspond to operation at some degree of cavitation corresponding to 1% or 3% head loss.

a) For Browns Ferry RHR and CS pumps, explain if the 3% head loss was always used in determining the required NPSH or was the 1% criteria initially used for the Browns Ferry pump performance evaluation.

b) The SULZER report states that the original test records were lost or misplaced. During the briefing, it was stated that the raw data for the required NPSH are available. These statements appear to be conflicting. Please, clarify.

c) For the ST-LOCA, the vendor states that the scenario falls outside the established operating recommendations for the RHR pumps. However, based on some test data, the vendor concludes that although vibrations and noise may occur due to surges and cavitation, the pumps should be able to continue to function. In these tests, the suction pressures were varied so that the pumps would cavitate. At what temperature were these tests conducted? Would the test results be different if the suction temperature of the flow is also increased in order to make the test more prototypic?

d) For the Appendix R scenarios, the vendor states that: "The minimum required NPSH value that will allow the subject pumps to successfully operate at 9000 gpm for 70 hours is 17 feet. At this NPSHa, level there is little to no theoretical NPSH margin remaining. The RHR pump, subject to these conditions will likely exhibit signs of cavitation; however it will continue to function throughout the event." Similar to the assessment for the ST-LOCA, were the tests conducted at prototypic temperatures?

e) In the SULZER report, the vendor combines empirical data and calculations to develop the NPSHr curves for different pumps and flow rate. In essence, the operability of the pumps and the flow rates for both Appendix R and the ST-LOCA rely on the accuracy of the SULZER tests. In addition, the generated NPSHr do not include or quantify uncertainties, which may affect the calculated margins in all events. Have these uncertainties been quantified? What are the uncertainties in the NPSHr values at different flow rates?

f) Data from all the pumps manufactured by the vendor that are similar to the RHR and core spray pumps used in Browns Ferry have been averaged to develop average characteristic curves for the pumps. In both the Appendix R and the more realistic fire scenario only one RHR pump will be in service. The characteristic curve of this pump could be different from the average behavior of all pumps. Considering the 1.6 psi margin for Appendix R calculations, the accuracy of the characteristic curves becomes important. Are the uncertainties in the characteristic curves small enough to assure that there actually is margin for the Appendix R scenario?

g) The cavitation free required NPSH is 75.3 ft for flow of 12,000 gpm. The SULZER recommended required NPSH for 12,000 GPM, for 40,000 hours is 99.8 ft. Explain the discrepancies between the lower cavitation free NPSH and the recommended NPSH, which does not preclude cavitation. There is a similar discrepancy for the core spray pumps at 4500 gpm.

h) The draft staff SER justifies the operation of the RHR pumps for a short-duration under degraded conditions, in part, based on sensitivity analyses that showed with lower LPCI flows (11,000 gpm) and drywell humidity (50%), the margin increases. Explain the reasons for the difference between the maximum LPCI flow used in the NPSH calculations (11,000 gpm) for the ST-LOCA and the manufacturers design runout flow 11,500 gpm)

4) Inhibiting Automatic Actuation of Containment Coolers

For Browns Ferry Appendix R, the drywell coolers are assumed to be turned off after 2 hours into the event in order to maximize the containment pressure. Without turning off the drywell coolers, the required NPSH for the sole RHR pump would exceed the available NPSH for a significant amount of time. The drywell coolers are considered non-safety systems but are relied upon in meeting the TS containment pressure and temperature. These TS containment P/T values are assumed as initial conditions in the containment analyses. The following questions relate to the turning automatic systems off.

a) Operator actions requiring turning off automatic systems under high temperature and pressure containment environment are counter-intuitive in terms of containment integrity. Justify why counter-intuitive operator actions under a high PT conditions are acceptable, in the context of industry lessons- learned experience. In addition, provide evaluation of the NRC lessons-learned assessment and actions in reference to inhibiting automatic although non-safety containment pressure reduction features that would then result in an increase in containment pressure. The issue is not whether the specific Appendix R scenario would threaten containment integrity but rather implementing operator actions that would counter the overall containment integrity objective of reducing the pressure.

5) Impact of High Temperature Environment on Pumps and Penetration Seals

a) For Appendix R, demonstrate that the high P/T environment would not adversely affect the systems and components required to mitigate the event, such as SRV tailpipes and neutron monitoring systems.

b) Evaluate the impact of prolonged exposure to high pressure/temperatures and radiation field on the seals and penetrations. For any adverse impact, evaluate how it affects the availability of containment overpressure and the operability of the equipment relied upon to mitigate the event such as pumps.