

May 4, 2011

MEMORANDUM TO: Brian W. Sheron, Director
Office of Nuclear Regulatory Research

FROM: Eric J. Leeds, Director */RA/*
Office of Nuclear Reactor Regulation

SUBJECT: USER NEED REQUEST: OFFICE OF NUCLEAR REGULATORY
RESEARCH TECHNICAL SUPPORT FOR NUCLEAR REACTOR
REGULATION RISK ASSESSMENT OF LICENSEES' USE OF
CONTAINMENT ACCIDENT PRESSURE TO PROVIDE ADEQUATE
NET POSITIVE SUCTION HEAD FOR EMERGENCY CORE
COOLING SYSTEM AND CONTAINMENT HEAT REMOVAL
SYSTEM PUMPS

The purpose of the memorandum is to request the assistance of the Office of Nuclear Regulatory Research (RES) in evaluating the risk associated with licensees' use of containment accident pressure (CAP) to provide adequate net positive suction head (NPSH) for emergency core cooling system (ECCS) and containment heat removal system pumps. The Office of Nuclear Reactor Regulation (NRR) needs generic estimates of the risk of CAP credit for pressurized water reactors (PWRs) and for boiling water reactors (BWRs), taking into account any differences in containment performance that might be important to the risk results. The specific areas where NRR is requesting RES assistance are detailed under "Areas of Needed Assistance," below. This user need request has been discussed with members of your staff.

Background

The accident analyses for many operating reactors rely on pressure higher than that present before the postulated accident to provide NPSH margin for the pumps in the ECCS and the containment heat removal system. NPSH margin is a measure of the pump's ability to avoid excessive cavitation so that it can perform its safety function. In calculating NPSH margin, the inclusion of some or all of the pressure developed in the containment during an accident is referred to as CAP credit.

For PWRs, the vapor pressure during a loss-of-coolant accident (LOCA) (determined by the sump water temperature) is predicted to be greater than the total containment pressure before the postulated accident. This vapor pressure is credited to demonstrate adequate NPSH margin. Some PWRs also credit a portion of the air partial pressure to ensure adequate NPSH margin. For BWRs, both the partial pressure of the vapor in the containment atmosphere and the air partial pressure are used to demonstrate adequate NPSH margin for LOCA analyses and in the analyses of certain other events; e.g., station blackout, anticipated transients without scram, and safe shutdown following fires.

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(301) 415-2889

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(301) 415-2865

The amount of CAP credited and its duration depend on pump and system characteristics, which vary from plant to plant.

The Advisory Committee on Reactor Safeguards (ACRS) recommended in the early 1970's that the practice of crediting CAP should be discontinued for new designs. The Nuclear Regulatory Commission (NRC) staff did not backfit this position on plants that were already licensed with credit for CAP, and has allowed credit for CAP throughout the years because of various operating reactor conditions and in response to specific technical issues. The ACRS objection to CAP credit was again raised when, as the result of power uprates, some BWRs required increased CAP credit as a result of the higher decay heat levels following a reactor trip.

The staff has discussed the use of CAP with ACRS on many occasions, both generically and as it applies to specific operating reactors. The staff understands the ACRS position on risk to be that the defense-in-depth margins that are involved in allowing CAP credit should be relaxed only if the associated increase in risk is small (transcript of NRC Commission meeting with the ACRS, June 9, 2010 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML101660107), pp. 32, 34).

To support ongoing staff dialogue with the ACRS regarding CAP, RES performed a generic risk assessment of CAP credit for a BWR. This analysis showed that the risk from allowing CAP credit for a BWR/3 with a Mark I containment with a leak detection interval of once per month is very small (i.e., CDF < 1×10^{-6} per year), based on a generic risk assessment. This risk assessment was presented to the ACRS on May 6, 2010 (transcript of Advisory Committee on Reactor Safeguards 572nd Meeting (ADAMS Accession No. ML101370608), pp. 96+). However, RES staff has not formally documented this generic BWR risk assessment beyond the presentation and slides included in the ACRS meeting transcript. In addition, the staff has not assessed the potential risk of CAP credit for other reactor or containment types.

Areas of Needed Assistance

NRR is requesting that RES perform generic assessments of the risk of CAP credit for PWRs and for BWRs, taking into account any differences in containment performance that might be important to the risk results. NRR needs RES support as outlined in the following task descriptions. The points of contact for all four tasks are:

NRR – Steven A. Laur, (301) 415-2889

RES – Anders Gilbertson, (301) 251-7592

Task 1: Identify Additional Reactor Plants for Analysis

This task is to identify reactor plants to be included in this study. RES has already performed risk assessments of CAP credit for the Browns Ferry and Monticello nuclear plants. Both of these plants have Mark I containments. NRR is requesting that RES assess the risk of CAP credit for other BWR containment types and for various PWR containment designs. The goal is to select plants with containment designs that could result in different risk insights regarding CAP credit. For example, BWR non-inerted containments should be included, since the results of the already completed generic assessment showed a high degree of dependence upon leak detection interval. A PWR with a large, dry containment should be included in the analysis. PWRs with ice-condenser containments do not use CAP credit, so they are not in scope for this request. Task 1 is to identify the set of reactors to be analyzed such that the containment types

of interest will be covered in the results. It is anticipated that four to eight plants (in addition to Browns Ferry and Monticello) will be included in the scope.

Task 2: Perform Generic Risk Assessment of CAP Credit for One Additional Reactor Plant and Provide Preliminary Report of all Analyses to Date

In this task, RES would develop a draft report that fully documents the risk analyses already performed for Browns Ferry and Monticello. One additional plant from those identified in Task 1 would be selected for analysis. The risk of CAP credit for this additional plant would be estimated in a similar manner to the other two and fully documented in the draft report. The report would describe the analysis including methods, assumptions, inputs, computer codes used, models, and results. The draft report should be prepared for NRR review and comment.

The following guidance should help RES in structuring its risk assessment:

- NRR is seeking these risk analyses to confirm the assumption that the risk of crediting CAP is not a significant contributor to the risk profile of any plant. The risk assessment should be considered a “scoping analysis” rather than a detailed, realistic estimate of CAP credit risk.
- RES analysts should make simplifying assumptions regarding success criteria as appropriate. If bounding assumptions provide results that confirm that CAP credit is not a risk outlier, then such assumptions may be employed. If the need for detailed thermal-hydraulic analyses arises, NRR will consider whether to perform such analyses or to request RES assistance via a revised user need request.
- The level of detail of the models should be similar to what was done for Browns Ferry and Monticello; i.e., a scoping study level of detail should be appropriate.
- For this study, only the internal events risk should be considered. Core damage frequency and large early release frequency should be considered.
- Operator actions to recover from a loss of ECCS NPSH should not be considered. Operator actions that could adversely impact CAP availability should be considered qualitatively if identified.
- Because these are scoping analyses, uncertainty analyses will not be required.

Task 3: Perform Generic CAP Risk Assessments on Remaining Plants from Task 1 and Provide Final Report

Once NRR comments have been received on the draft report, including any that may affect how the remaining analyses should be performed, RES should do the risk assessments for the remaining plants chosen in Task 1. The report should be finalized by incorporating all comments and all results. The final report, following concurrence by NRR, should be entered into ADAMS.

Task 4: Support Presentations of Results to Stakeholders (e.g., NRR Management; ACRS; Licensees; General Public)

The NRR staff anticipates that it may require RES support when presenting the results of this effort to various stakeholders. For example, ACRS may be very interested in hearing the results of this study. Public meetings may be held to present the results to interested members of the

public and licensees. NRR does not anticipate that RES support for Task 4 would require a large level of resources. It is expected that this Task could be handled as “level of effort.”

Proposed Project Milestones		
Task	Description	Completion (months after project start)
1	Identify additional reactor and containment types for analysis	1
2	Provide a draft report that: <ul style="list-style-type: none"> • Describes the identification of plants selected for subsequent analysis; • Describes the analysis including methods, assumptions, computer codes used, models; and, • Provides preliminary results for Browns Ferry, Monticello, and one additional plant (the first two having already been completed by RES as part of the extended power uprate applications for those plants) 	5
3	Provide a final report that: <ul style="list-style-type: none"> • Incorporates NRR’s comments on the draft report provided under Task 2; • Includes results for all remaining plants identified in Task 1; and, • Is entered into ADAMS upon NRR concurrence. 	7
4	Support presentations to stakeholders, including NRR management, the ACRS, licensees, and the general public	As needed

Priority

NRR considers this user need request to be “high” priority. The priority of this user need request was determined using guidance provided in Office Instruction BUD-101, “NRR Internal Planning, Budgeting, and Performance Management (PBPM) Process,” which identified the 5 major NRC strategic goals as: Safety, Security, Efficiency/Effectiveness, Management Excellence, and Openness. This user need request is ranked “High Priority” in both of its primary and secondary goals, Safety and Efficiency/Effectiveness, respectively, because it directly supports reactor licensing actions. This ranking results in a combined score of 4 for the requested risk assessments.

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