February 9, 2005

MEMORANDUM TO: John T. Larkins, Executive Director
Advisory Committee on Reactor Safeguards

FROM: Farouk Eltawila, Director ***/RA/***
Division of Systems Analysis and Regulatory Effectiveness
Office of Nuclear Regulatory Research

SUBJECT: TRANSMITTAL OF REPORT ENTITLED "THERMAL HYDRAULIC EVALUATION OF PRESSURIZED THERMAL SHOCK," NUREG-1809

The subject report is now available for Advisory Committee on Reactor Safeguards (ACRS) review. The purpose of the report is to address the main thermal hydraulic issues that arose during the reevaluation of pressurized thermal shock (PTS). The focus of the report is to document responses to thermal hydraulic questions raised by the ACRS and the PTS peer review group, related to determining the applicability and uncertainty of RELAP5 for PTS analyses. The report describes the applicability of RELAP5 for performing PTS analyses. In particular, it demonstrates that RELAP5 can adequately predict the thermal hydraulic boundary conditions required by the fracture mechanics. The report can be accessed through ADAMS Accession Number ML050390012.

The thermal hydraulic models used in RELAP5, which provide the inputs for evaluating the probability of a vessel rupture caused by PTS, are found to be adequate. The ability of RELAP5 and the correlations used in the constitutive relations to calculate the temperature and pressure histories for the various scenarios of interest is compared to a variety of experiments, and found to be satisfactory. The correlation between the calculated and predicted results is better than past safety studies might suggest, because the transients of interest largely occur when the system is filled with single-phase sub-cooled liquid. The complications and uncertainties inherent in a two-phase flow are not generally present. The challenge in this problem was not in modeling the system, but rather in selecting the transients and boundary conditions that cover all the possibilities that can lead to failure of the vessel.

One specific concern raised by the ACRS was whether the heat transfer coefficients selected for evaluating the downcomer heat transfer were inadequate. This does not appear to be the case. A sensitivity study cited in this report shows that the downcomer heat transfer coefficient is not a very important parameter. Conduction in the metal dominates the overall heat transfer. The method employed by RELAP5, using either the forced convection or natural convection heat transfer coefficient, whichever is larger, is generally recommended for mixed convection problems. The fact that the code is able to predict the metal temperatures well into the transient is an indication that there is no serious deficiency in that model.

CONTACT: David E. Bessette, RES
(301) 415-6763

The report is part of a much larger, integrated evaluation of PTS, and is one of six thermal hydraulic reports prepared on the subject. In addition to the thermal hydraulic reports, a number of other reports document work done on probabilistic risk assessment (PRA) and fracture mechanics. The overall project results of the PTS reevaluation are found in “Technical Basis for Revision of the Pressurized Thermal Shock (PTS) Screening Limit in the PTS Rule (10 CFR 50.61) Summary Report,” NUREG-1806. That report summarizes the overall results, including thermal hydraulics, fracture mechanics, and PRA.

There were three parts to the thermal hydraulics work.

(1) Under contract to the Nuclear Regulatory Commission (NRC), ISL, Inc. generated thermal hydraulic boundary conditions using RELAP5, and transmitted them to Oak Ridge National Laboratory (ORNL) for input to the FAVOR code. PTS-specific assessment of RELAP5 was performed. This work is documented in two reports:

   (a) Arcieri, W.C., Beaton, R.M.S., Fletcher, C.D., Bessette, D.E., "RELAP5 Thermal Hydraulic Analysis to Support PTS Evaluations for the Oconee-1, Beaver Valley-1, and Palisades Nuclear Power Plants," NUREG/CR-6858, October 2003. This report describes the RELAP5 calculations of PTS scenarios defined by PRA and by the uncertainty evaluation.

   (b) Fletcher, C.D., Prelewicz, D.A., Arcieri, W.C., “RELAP5/MOD3.2.2γ Assessment for Pressurized Thermal Shock Applications,” NUREG/CR-6857, October 2004. This report describes the specific assessment of RELAP5 to demonstrate its applicability and uncertainty to the analysis of PTS.

(2) Estimates of the uncertainties were required for the calculated parameters of temperature, pressure, and heat transfer. The uncertainty evaluation of the thermal hydraulic calculations was done by the University of Maryland, and is documented in:

   (a) Chang, Y.H., Almenas, K., Mosleh, A., Pour-Gol, M., “Thermal Hydraulic Uncertainty Analysis in Pressurized Thermal Shock Risk Assessment,” CRR-0401, University of Maryland, October 2004. This report describes the thermal hydraulic uncertainty methodology used in the PTS reevaluation.

(3) The Oregon State University APEX facility was used to generate PTS-specific experimental data. The APEX program is documented in:

   (a) Reyes, J.N., “Scaling Analysis for the OSU APEX-CE Integral Test Facility,” NUREG/CR-6731, 2003. This report describes the scaling basis for the PTS experiments performed in support of the current program, in the APEX-CE test facility at Oregon State University.

   (b) Reyes, J.N., et. al., “Final Report for the OSU APEX-CE Integral Test Facility,” NUREG/CR-6856, October 2004. This report describes the results of the PTS experiments performed in support of the current program, in the APEX-CE test facility at Oregon State University.

One must consider the Technical Basis report, the above five thermal hydraulic reports, and the current thermal hydraulic evaluation report, to get a complete picture of the thermal hydraulic work that was performed.

We will look forward to meeting with the Committee on this subject in the near future. Please contact me or David Bessette, if you have any questions.

One must consider the Technical Basis report, the above five thermal hydraulic reports, and the current thermal hydraulic evaluation report, to get a complete picture of the thermal hydraulic work that was performed.

We will look forward to meeting with the Committee on this subject in the near future. Please contact me or David Bessette, if you have any questions.

Distribution:
ARREB R/F
DSARE R/F
AHiser
SBahadur
MMayfield
MKirk
ALevin

E:\Filenet\ML050400608.wpd
*See Previous Concurrence
OAR in ADAMS? (Y or N) Y ADAMS ACCESSION NO.: ML050400608 TEMPLATE NO. RES-006
Publicly Available? (Y or N) Y DATE OF RELEASE TO PUBLIC 10 daysSENSITIVE? N
To receive a copy of this document, indicate in the box: "C" = Copy without enclosures **"E"** = Copy with enclosures **"N"** = No copy

OFFICE	ARREB*		ARREB*		C:ARREB*		D:DSARE*	
NAME	DBessette:dfw		JDanna		JRosenthal		FEltawila	
DATE	02/09/05		02/09/05		02/09/05		02/09/05	

OFFICE	SISP Review*		SISP Review*	
NAME	DBessette		JRosenthal	

DATE	02/09/05	02/09/05