REQUEST FOR ADDITIONAL INFORMATION

PRESSURIZED WATER REACTOR OWNERS GROUP

REPORT NO. FAI/11-0497,

"PWROG MODEL FOR THE TWO-DIMENSIONAL FREE EXPANSION OF A FLASHING, TWO-PHASE, CRITICAL FLOW JET"

RAI-JM-1

Note that the intent of this activity is to develop a jet model for a flashing critical flow jet. A jet composed of single-phase vapor was not addressed. Is the new jet model applicable to single phase jets? Is the model "best estimate" or do the assumptions in the model result in potential conservatism or non-conservatism? Please identify how assumptions used in the model derivation affect the conservatism of the developed jet model.

RAI-JM-2

What is the expected range of applicability for the new jet model? That is, over what range of mass flow rates, liquid subcooling, initial pressures, etc. is the model expected to be validated?

RAI-JM-3

A recent review of the American National Standards Institute (ANSI) jet model by Wallis and Ransom found the ANSI model to be potentially non-conservative. (Initial calculations performed by the U.S. Nuclear Regulatory Commission Office of Nuclear Regulatory Research have found, however, that the ANSI model overpredicts pressures recorded in the subcooled Marviken tests.) Please provide a comparison between predictions based on the new model to those from the ANSI model and appropriate experimental data (Marviken, Westinghouse Canada, or Wyle) to validate the new model and extent of any conservatisms for zone of influence (ZOI).

RAI-JM-4

One of the major assumptions is that Gaussian profiles describe the off-centerline jet properties. The radial gradients are based on work by H. Seifert, et al. It would be helpful if Fauske and Associates, LLC (FAI) could provide a copy of this paper. Of concern, is the scalability of this assumption? Assuming that the data on which the Seifert paper is based is from relatively small diameter pipes, please provide justification that the Gaussian profile is sufficiently accurate for large diameter pipes for which the new jet model is considered applicable.

RAI-JM-5

Please provide a basis and/or reference for Equation (3-4). This appears to be an expression for mass conservation, where the density is constant.

ENCLOSURE

RAI-JM-6

The derivation to obtain Equations (3-8), (3-9), and (3-10) is described fairly well. However, the report omits several steps and it is difficult to independently obtain the same expressions. For example, it is not immediately clear where the erf() comes from. In the first two expressions, it appears as if terms were substituted into the left hand side (LHS), and integrated. Is the right hand side (RHS) used? For Equation 3-10, however, the LHS appears to come from the RHS of Equation 3-7. Is there an "r" missing in the LHS for 3-10? Please provide a step-by-step derivation of Equations (3-8) to (3-10).

RAI-JM-7

Please provide a basis for Equations (3-12) and (3-13).

RAI-JM-8

Please provide a step-by-step derivation of Equation (3-15).

RAI-JM-9

Please provide a basis for Equation (3-22), and indicate how the baseline slip ratio (k_0) is to be determined.

RAI-JM-10

In Equation (3-23), please indicate how the liquid core (L_c) is calculated.

RAI-JM-11

Equation (3-25) comes from one of the Seifert expressions. Please show the step-by-step derivation to obtain Equation (3-26) from this. This appears to be related to Equations (3-8), (3-9), or (3-10) but the relationship is not discussed. Please explain.

RAI-JM-12

What is the basis for assuming "9" in Equation (3-27)?

RAI-JM-13

Please provide a basis and/or reference for Equations (3-29) and (3-30).

RAI-JM-14

On Page 42, the jet outer boundary is assumed to grow at an angle of 10 degrees. Why? Or, why is this appropriate for ZOI calculations?

RAI-JM-15

Section 4.0 describes, and Table 4-1 lists, the values of several parameters used in comparison of the new jet model to Marviken and Westinghouse Canada test data. While

spreading coefficients σ_w, δ, and k_0 are constant, σ is varied from test to test. How will the value of σ be determined for general calculations for a plant?

RAI-JM-16

How does the model calculate temperature effects from the jet?

RAI-JM-17

The ANSI/American Nuclear Society (ANS) 58.2-1988 standard uses the thrust coefficient (C_T) to relate a steady state jet impingement force to an equivalent static impingement force which can be redefined as an impingement pressure by dividing by area. The jet calculation method provided by the Pressurized Water Reactor Owners Group (PWROG) only describes a method to calculate the static or stagnation pressures. While the use of a stagnation pressure may be appropriate to calculate force on a small target after considering drag effects, how does the PWOG propose to calculate the impingement pressure or force on a large target? This question is directed toward the calculation methodologies used in the two models, not the way that destruction pressures will be used to determine ZOIs.

RAI-JM-18

Please define the downstream distance from the break or nozzle for which the new jet model will be validated. For many potential materials of interest the destruction pressures are low and are beyond the range where the jet has been fully depressurized. Are the dynamic pressures in the far field predicted accurately and has this been validated? Please describe how the new proposed model calculates the impingement pressure on a large object in the far field. In addition, please provide details on any tests that provide this validation for these calculations.