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SUMMARY OF CORE DAMAGE FREQUENCY FROM INTERNAL INITIATORS: PEACH BOTTOM*

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INTRODUCTION

Probabilistic risk assessments (PRA) based on internal initiators are being conducted on a number of reference plants in order to provide the Nuclear Regulatory Commission (NRC) with updated information about light water reactor risk. The results of these analyses will be used by the NRC to prepare NUREG-1150 which will examine the NRC's current perception of risk. Peach Bottom has been chosen as one of the reference plants.

PEACH BOTTOM CHARACTERISTICS

The Peach Bottom Atomic Power Station has two boiling water reactor (BWR) units, each with a capacity of 1150 megawatts electrical. The reactors are each housed in a Mark I containment. Peach Bottom Unit 2 analyzed here, was studied before as part of WASH-1400 [1].

* This work is supported by the United States Nuclear Regulatory Commission and performed at Sandia National Laboratories which is operated for the US Department of Energy under contract Number DE-AC04-76DP00789.

DISCLAIMER

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A number of plant features tend to be important in determining the nature and frequency of the core melt scenarios for Peach Bottom. These features include the recent above average diesel generator performance history, the single Emergency Service Water System for both units, the numerous emergency core cooling systems, recent procedure modifications, and the low volume containment.

RESULTS

A mean core melt frequency of about 8E-6/year was calculated in the updated analysis of Peach Bottom Unit 2 [2]. Two general kinds of accidents dominate the results. Loss of all AC power accidents comprise approximately 85% of the core melt frequency, while anticipated transients without scram (ATWS) scenarios make up almost 15%.

Table 1 provides a list of those features most important to (1) reducing the core melt frequency and (2) maintaining the core melt frequency at its current value (i.e., the reliability or availability should not be allowed to degrade significantly). Note that diesel generator hardware failures and operator failure to recover power tend to be among the dominant contributors to core melt.

A Latin Hypercube sampling program was used to generate statistical samples of parameter values [3]. A top event quantification code (TEMAC) was used to incorporate the statistical uncertainties of parameter values into the sequence models [4]. Modeling uncertainties were assessed by recalculating of the base case with a different set of modeling assumptions and considerations. The modeling uncertainty calculations considered common mode failure effects, key plant specific modeling uncertainties (e.g., uncertainties associated with the failure modes of the Emergency Service Water System), and ATWS-related uncertainties (e.g., operator initiation of the Standby Liquid Control system). Figure 1 shows the results of all of these analyses on the core melt frequency estimate. The figure demonstrates a considerable uncertainty in the "true" core melt frequency with the "best estimate" mean value falling in the range of approximately 3E-6 to 1E-5.

A comparison of the WASH-1400 results with the NUREG-1150 analysis shows a considerable difference in both the core melt frequency and the dominant types of sequences. Table 2 summarizes these differences. Reasons for the differences include plant design and operational changes (e.g., changes to the Automatic Depressurization System, new procedures such as containment venting, ATWS, ...) as well as improvements in PRA methodology.

One particularly important insight from this study as well as the other reference plant studies is that loss of all AC power accidents are the dominant core melt sequences for BWRs.

REFERENCE

[1] United States Nuclear Regulatory Commission (NRC), "Reactor Safety Study," NRC Report, WASH-1400, October 1975.

[2] A. M. Kolaczkowski, et al., "Reference Plant Accident Sequence Likelihood Characterization: Peach Bottom, Unit 2," NUREG/CR-4550, Volume 3, September 1986.

[3] R.L. Iman, M.J. Shortencarier, "A FORTRAN 77 Program and User's Guide for the Generation of Latin Hypercube and Random Samples for Use with Computer Models," NUREG/CR-3624, SAND83-2365, Sandia National Laboratories, March 1984.

[4] R. J. Iman, M. J. Shortencarier, "Top Event Matrix Analysis Code," Draft, Sandia National Laboratories, June 1986.

Table 1. Dominant Contributors to Core Melt

FEATURES MOST IMPORTANT IN REDUCING THE CORE MELT FREQUENCY

- DC battery common mode failure
- Failure to recover AC power
- Diesel generator hardware failure
- Mechanical failure of the control rods
- Failure to start the standby liquid control system

FEATURES MOST IMPORTANT IN MAINTAINING THE CORE MELT FREQUENCY AT CURRENT VALUE

- Mechanical failure of the control rods
- Maintenance outage associated with the emergency service water
- DC battery common mode failure
- Miscalibration of low reactor pressure sensors
- Diesel generator and emergency service water failure

Table 2. Comparison of WASH-1400 and Updated Results

ITEM	WASH-1400	UPDATED NUREG-1150
Core Melt Frequency	2.5E-5 (sum of medians)	8.2E-6 (mean of a calculated distribution)
Dominant Sequence Types and Percent Contribution to Core Melt	- Loss of all AC (<1%) - ATWS (~40%) - Loss of long term heat removal (~55%)	- Loss of all AC (~85%) - ATWS (~12%) - Loss of long term heat removal (<1%)

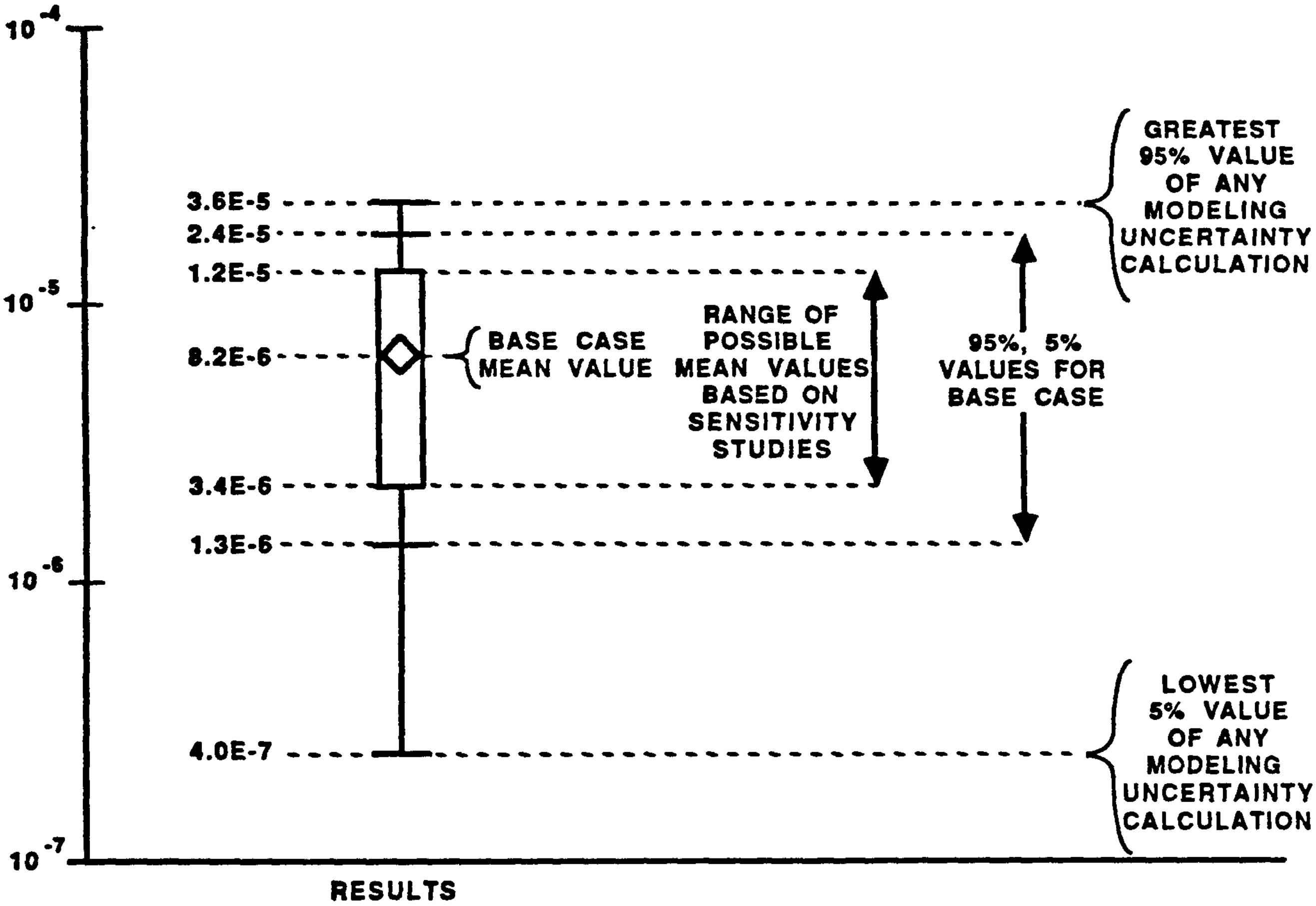

Figure 1. Summary Of Core Melt Frequency Estimates For Peach Bottom