GSI-191

Thermal Hydraulic Analysis Plan

NRC Meeting, November 29, 2012

AGENDA

- Introduction
- Background
- Review of High Level Thermal Hydraulic Analysis Plan
  - Success Criteria
  - Analysis Objectives
  - Plant Categories
  - Suggested Analyses
  - Critical Inputs & Major Assumptions
- Questions/Open Discussion

INTRODUCTION

- As part of PA-SEE-1090, "Comprehensive Analysis and Test Program for GSI-191 Closure" a thermal hydraulic analysis is being planned to evaluate the effects of core inlet blockage on long-term core cooling (LTCC).

  Current Analysis Considerations
  - Large Hot Leg Break Scenarios
  - All ECCS through Cold Leg Injection
  - Complete Core Inlet Blockage
  - Bypass Flow through In-Vessel Alternate Flow Paths
  - Steam Generator Filling and Spillover

- The analysis results will be used to develop suitable acceptance criteria for future GSI-191 in-vessel testing.
- The details of the analysis plan are preliminary and subject to change as work progresses.

BACKGROUND
Previous Analysis

- WCAP-16793 Rev. 2 documents the previous analytical work performed for core inlet blockage.
  - The simulations were designed to bound the entire U.S. PWR fleet with one model.
    - Limiting Break Type and Vessel Design
    - Highest Core Power Density
    - Non-physical Time to Reach Complete Core Inlet Blockage
    - Alternate Flow Paths not Considered
  - Results indicate that adequate removal of decay heat occurs with up to 99.4% of the core inlet blocked

SUCCESS CRITERIA

- Meeting the analysis success criteria is demonstrated by the ability to adequately maintain LTCC after the LOCA event. There are two aspects to LTCC that are considered:

    1. Decay heat removal – requires that sufficient coolant reaches the core such that temperatures are maintained at acceptably low levels
    2. Boric acid precipitation control – requires that boron concentrations in the vessel remain below the solubility limit

ANALYSIS OBJECTIVES
Overall Goal

- The overall goals of this analysis are:
  - Evaluate the adequacy of alternate flow paths and/or steam generator spillover to maintain LTCC following switchover to cold leg recirculation.
  - Include the postulated formation of a highly resistive debris bed at the core inlet for a large hot leg break LOCA scenario.

- To achieve this goal, several objectives have been developed.

ANALYSIS OBJECTIVES
Plant Models

1. Determine an appropriate and manageable number of plant models that will be used for the analysis.
   - Due to schedule and resource constraints, every plant in the PWR fleet cannot be modeled.
   - Plants will be divided into categories with similar vessel and steam generator features.

ANALYSIS OBJECTIVES
Critical Inputs and Assumptions

2. Identify critical model inputs and major assumptions.
   - Determine values for those critical inputs that bound the specific category of plant under consideration.
   - Westinghouse and AREVA shall compare critical inputs and major assumptions to ensure consistency.

ANALYSIS OBJECTIVES
Analysis Results

3. Identify analysis results that will be used to evaluate the effect of alternate flow paths and/or steam generator spillover.
   – Westinghouse and AREVA should be consistent in choosing the analysis results presented such that direct comparison can be easily made.

ANALYSIS OBJECTIVES
Comparison of Results

4. Compare Westinghouse, AREVA, and STPNOC results and look for consistency.
   - Identify any differences in model results and understand any differences that may exist.
   - The STPNOC results will be used to compare the response to steam generator spillover.

ANALYSIS OBJECTIVES
Documentation and Recommendations

5. Document analysis results and provide recommendations for acceptance criteria that can be used for future GSI-191 testing.
   – It is expected that the acceptance criteria will be different for each category of plants being analyzed.

PLANT CATEGORIES

- The PWR fleet can be broken into several categories based on vessel design.

Summary of PWR Fleet Alternate Flow Paths						
NSSS Design	# of Units	Baffle Design			Upper Head Spray Nozzle Design	
		Upflow	Converted Upflow	Downflow	T-Cold	T-Hot
W- 4LP	29	16	4	9	22	7
W- 3LP	13	2	5	6	2	11
W- 2LP	6	-	2	4	-	6
CE	14	14	-	-	-	-
B&W	7	7	-	-	-	-
Total	69	39	11	19	24	24

SUGGESTED ANALYSES

- A minimum of 3 sets of analyses are needed:
  1. B&W plant design
  2. W/CE upflow baffle designs
  3. W downflow baffle designs
- Available plant models will be used as a starting point
  - Comparisons need to be made between Westinghouse and AREVA analyses
    - Comparison with results from a test facility
    - Comparison of results of items 2 or 3
    - 4th analysis using a common plant

CRITICAL INPUTS & MAJOR ASSUMPTIONS

- The critical inputs and major assumptions discussed to date are as follows:
  - Baffle and Upper Head Spray Nozzle Flow Resistance – maximum resistance
  - Decay Heat – Appendix K w/ top skewed axial power shape
  - Switchover to Recirculation Time – minimum time
  - Break Flow – Pressure Boundary set to justifiable low value
  - Cold Leg SI Flow – minimum flow rate and maximum temperature
  - Core Blockage – All channels blocked beginning at sump recirculation
  - Guide Tube Bypass – Not credited (blocked)
- This list may increase as work continues.

QUESTIONS & OPEN DISCUSSION

NRC FORM 8C
(7-94)
NRCMD 3.57

COVER SHEET FOR CORRESPONDENCE

USE THIS COVER SHEET TO PROTECT ORIGINALS OF MULTI-PAGE CORRESPONDENCE