PWROG

PWR Owners Group

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GSI-191 Comprehensive Analysis and Test Program Update: Introduction and Overview

NRC Public Meeting

April 16, 2014

PRESSURIZED WATER REACTOR OWNERS GROUP

Meeting Agenda

Time	Subject	Presenter(s)
8:30 – 8:40 AM	Welcome, Introductions	J Rowley (NRC)
8:40 – 8:50 AM	Opening Remarks	PWROG, NRC
8:50 – 9:15 AM	PWROG Program - Introduction • High-Level Overview (Process Diagram and WCAP volumes / timeframes) • Plant status • Overall path to fuel limits and closure	Brown/Croyle
9:15 – 10:00 AM	T/H Analyses and Alternate Flow Path Evaluation • Recap of April 1 meeting content and takeaways • Review scope of near-term NRC feedback to support program decisions for testing and future T/H analyses • Review testing for alternate flow path validation	Spring (Westinghouse) Wissinger (AREVA)
10:00 – 10:15 AM	Break	
10:15 – 11:15 AM	Chemical Effects • Review results (in detail) • In-bag/out-of-bag and chemical effects testing • How it will be used (in conjunction with T/H analyses and future tests)	Andreychek (Westinghouse)
11:15 AM– 12:00 PM	Subscale and Fuel Testing • Review of subscale test loop, conditions, test series, results, conclusions	Andreychek (Westinghouse) Spring (Westinghouse) Wissinger (AREVA)
12:00 – 12:45 PM	Lunch	

Meeting Agenda (cont.)

Time	Subject	Presenter(s)
12:45 – 2:00 PM	Subscale and Fuel Testing (cont.) • Discussions on fiber and particulate type and size, p:f ratio, temperature • Scaling and use of subscale tests to develop dP vs. fiber relationships • Upcoming chemical corrosion tests and possibility of fuel assembly tests	Andreychek (Westinghouse) Spring (Westinghouse) Wissinger (AREVA)
2:00 – 2:30 PM	Cold Leg Break Methodology • Methods, strategy (plant-specific calcs using methods from a WCAP), sample, summary of results (# of plants in each category of fiber limits)	Croyle (Westinghouse) Andreychek (Westinghouse)
2:30 – 2:45 PM	Break	
2:45 – 3:25 PM	UPI Plant Evaluations • Chemical Effects Work Applicability • UPI HLBs and the CLB methodology • UPI CLBs and the T/H calcs and fuel testing	Andreychek (Westinghouse) Spring (Westinghouse)
3:25 – 3:50 PM	Staff Breakout	NRC
3:50 – 4:15 PM	Staff Feedback	NRC
4:15 – 4:20 PM	Opportunity for Public Comment	NRC
4:20 – 4:30 PM	Closing Remarks	NRC/PWROG
4:30 PM	Adjourn	

PWROG Program – Introduction

Agenda

- High Level Overview
- Preliminary Status of US PWR Plants
- Overall Path to Fuel Limits and Closure

High Level Overview

- Program Purpose

  PWROG PA-SEE-1090 has been funded to support testing and analyses in an effort to improve upon the bounding in-vessel fiber results documented and approved under WCAP 16793-NP-Rev. 2

  Higher fiber limits obtained by this revised program will minimize or reduce final impacts on medium to high fiber plants

  These results will also provide margin for low to medium fiber plants for possible assessments of OPERABILITY

  Plant benefits will vary with design and operation

High Level Overview

- Program Approach

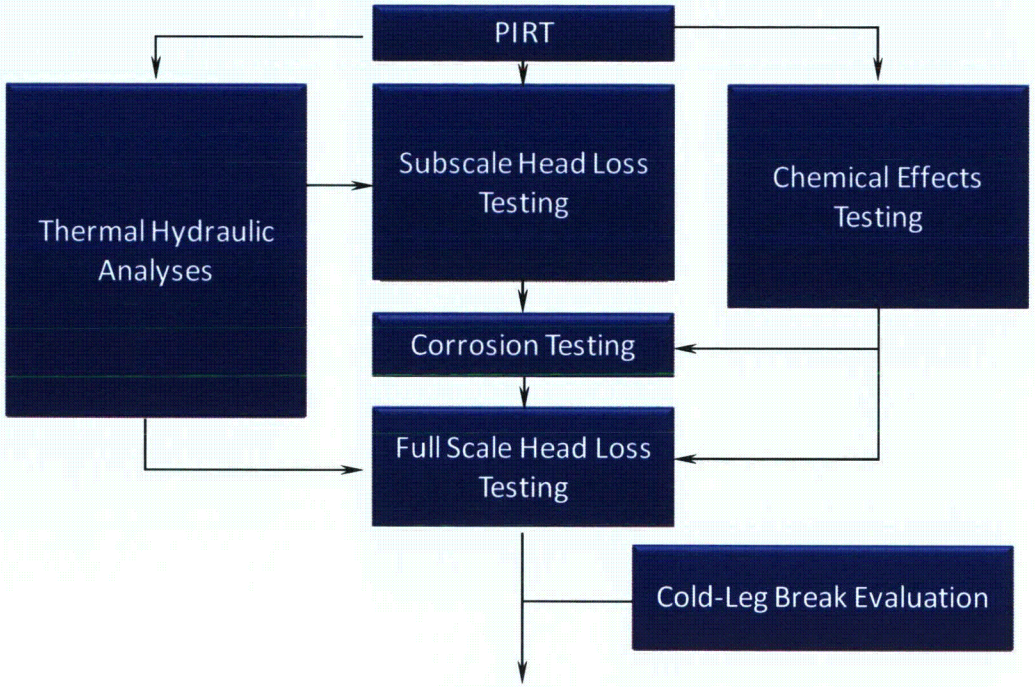
  The PWROG program takes advantage of margins not previously considered in the WCAP-16793 program

  - Prototypical chemical effects and timing
  - Alternate cooling flow paths that are available in the event of core blockage
  - Additional head loss testing

  Integration of the associated analyses and testing over the time period of interest will ultimately yield allowable debris limits which will ensure long term core cooling

High Level Overview

PA-SEE-1090 Program Elements



WCAP 17788 (Volumes 1-8)

High Level Overview

- WCAP 17788-NP Submittal Schedule

Volume	Topic	Estimated Submittal Date
1	Overall Summary; pulls together full methodology into a final summary of limits and applicability	11/30/2014
2	Phenomena Identification and Ranking Table (PIRT)	4/18/2014*
3	Cold Leg Break Methodology	5/15/2014
4	Thermal/Hydraulic Analyses (Alternate Flow Paths)	8/31/2014
5	Chemical Effects (Autoclave) Testing	7/31/2014
6	Subscale Testing	7/31/2014
7	Chemical/Corrosion Testing	9/30/2014
8	Fuel Assembly Testing	11/30/2014

Preliminary Status of US PWR Plants

- 4 Units (~One Unit is Option 2A) ~15-35 g/FA
  - Early chemical effects (all 4)
    - If chemical corrosion testing dP is low enough in first 4-6 hours, this issue may be eliminated
  - Limiting cold-leg break results (2 of 4)
    - Based on 7.5 g/FA; higher at-fuel limit would raise these values.
- 8 Units (~3 Units are Option 2A) ~25-50 g/FA
  - No chemical effects in first 24 hours
  - Limiting cold-leg break results
    - Based on 7.5 g/FA; higher at-fuel limit would raise these values.
- 53 Units (~25 Units are Option 2A) ~50-75+ g/FA
  - No chemical effects in first 24 hours, or late (8-24 hours) chemical effects
  - Vast majority of plants/units with significant margin gained
- Ranges / numbers of plants subject to change (testing, CLB calcs)

Overall Path to Fuel Limits & Closure

Introduction

- As part of PA-SEE-1090, "Comprehensive Analysis and Test Program for GSI-191 Closure", additional analysis and testing is being completed to evaluate the effects of core inlet blockage on long-term core cooling (LTCC).
- Under certain conditions following a LOCA with cold side injection, testing has shown that fiber/particulate can accumulate around the lower end grid and form a debris bed.
- When chemical precipitates were introduced to the bed, flow through the test assembly stopped.
- This result implies that flow to the core through the normal flow path may be impeded in a post-LOCA scenario.

Introduction

- Consequently, additional analysis and testing is being completed to investigate:
  - timing of chemical precipitate formation for various sump chemistries
  - effectiveness of alternate flow paths for maintaining LTCC
  - fiber and particulate limits without chemical precipitates for various conditions based on FA testing
- Once this work is done, the plants will have a comprehensive method for setting a debris limit based on plant conditions for resolving GSI-191
- This presentation lays out the current thinking on what the final results will look like (i.e. what will be documented in the final WCAP)

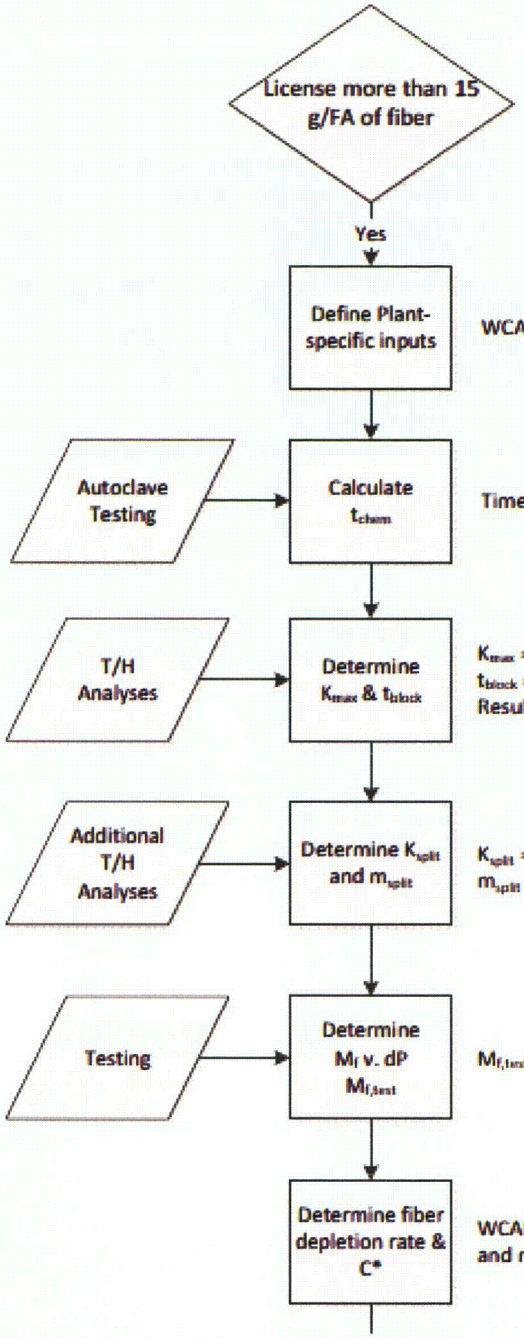
Target Debris Limit

- Particulate Limit
  - Mass of particulate defined by testing
- Fiber Limit
  - Mass of fiber allowed past the sump screen is the minimum of that calculated for a cold leg break and for a hot leg break

$$M_f = \min (M_{f,HLB}, M_{f,CLB})$$

- How are $M_{f,HLB}$ and $M_{f,CLB}$ determined?

Overall Solution Flow Chart, Rev 4 (simpler)
4/16/2014, DRAFT



WCAP-17788, Vol. 1, Table 9-1

Time of chemical precipitate formation

K_{max} = max resistance from fiber+particulates
t_{block} = earliest time that complete core blockage can be tolerated
Results from WCAP-17788, Vol. 1, Table 6-1 based on plant design

K_{split} = resistance at which flow diverts to AFP, from WCAP-17788 Figure 6-1
m_{split} = flow split between core inlet and AFP after K_{split}, from WCAP-17788, Vol. 1, Figure 6-2

$M_{f,test}$ determined using K_{max} in WCAP-17788, Vol. 1, Figure 7-1

WCAP-16406P method at both max and min ECCS flow rates

Overall Solution Flow Chart, Rev 4 (simpler)
4/16/2014, DRAFT

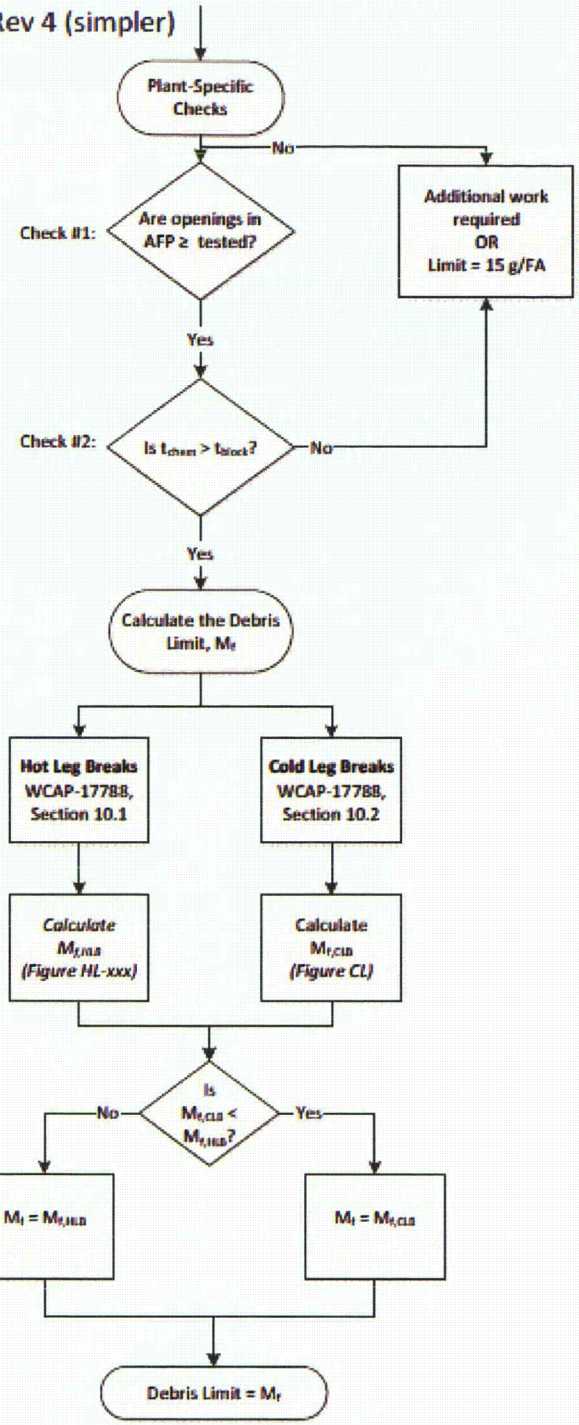


Figure HL-B&W – for B&W plant designs
Figure HL-Alt – for W/CE plants that alternate hot and cold side injection after HLSO
Figure HL-Sim – for W/CE plants that have simulataneous hot and cold leg injection after HLSO
Figure HL-UPI – for W plants with UPI

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