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FULL SPECTRUM LOCA STATUS UPDATE
Considered Statistical Approach for Treatment of Uncertainties in FSLOCA Methodology

December 3, 2007

Rev. 0

Westinghouse Electric Company LLC
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Meeting Objectives

- Update NRC Staff on Full Spectrum LOCA Development Status
- Focus on Uncertainty Methodology →
  - Statistical Treatment of Uncertainties
- Obtain NRC Staff Feedback

Meeting Agenda – 12/03/2007

1:00 – 1:30

- Introductions (W and NRC)
- Recap from prior meetings and status (Nissley)

1:30 – 3:30

Overview of Considered Statistical Approach (Frepoli)

- Review of ASTRUM approach and FSLOCA considerations
- Objectives/Functional Requirements for FSLOCA
- Overview of the new methodology
- Preliminary testing of the method

3:30 – 4:00 Discussion (All)

Update NRC Staff on Full Spectrum LOCA Development Status

Mitch Nissley

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FSLOCA – Scenario Description

FSLOCA Scenario

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Focus of Prior Meetings

- December 13, 2005
  - Drivers
  - Integrated PIRT approach
  - Code selection
  - Assessment matrix

Focus of Prior Meetings

- October 18, 2006
  - Code development update
  - Assessment matrix update
    - Mapping of tests to PIRT
    - Intent to focus on ROSA for integral effects
  - Outline of submittal

Focus of Prior Meetings

- June 11-12, 2007
  - PIRT review of selected highly ranked phenomena
  - Code development update
  - Code assessment status

Focus of This Meeting

- Statistical Methods for Estimating Figures of Merit at 95/95
  - Dramatic improvement over order statistics
  - New to US reactor licensing

Status of Overall Program

- Code Development
  - Near completion
    - Current version features
  - Expect one more frozen version prior to submittal (Jan-Feb 2008)
    - Additional features

Status of Overall Program

- Code Assessment
  - Formal Engineering Reviews to be completed in December 2007
    - Review teams of 10-12 peers
  - Final assessments will be performed with final frozen code version

Status of Overall Program

- Uncertainty Methodology
  - Physical model ranging based on PIRT, code assessment results
  - Plant operating conditions based on parameters known to influence LOCA results (ICs, BCs)

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  - Approach & theory follow

Projected Submittal Schedule

- Volumes 1 & 2 – April 2008
  - Models and correlations
  - Code assessment results
- Volumes 3 & 4 – July 2008
  - Uncertainty methodology
  - Demonstration plant analyses
- Schedule to be finalized at the pre-submittal meeting

Overview of Considered Statistical Approach

Cesare Frepoli

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Outline

- Review the lessons learned from licensing and use of the ASTRUM methodology
- Review of Regulatory Guides
- FSLOCA Uncertainty Method Functional Requirements
- Description of the method:
  - Generation of the Full Spectrum LOCA sample
  - Statistical method for the analysis
  - Compliance with 10 CFR 50.46 criteria
- Testing of the approach and discussion of results
- Conclusions

Lesson Learned from ASTRUM Implementation

- Use of direct Monte Carlo methods for the treatment of uncertainties has proven several advantages when compared to response surface methods:
- ASTRUM approach addressed disadvantages of responses surface methods identified in Appendix A of RG 1.203:
  - "*dependency of the number of computer simulations on the number of phenomena or processes determined in the PIRT that may be needed to estimate the total uncertainty*"
  - "*cross-product runs must be made when several of the phenomena or processes have significant covariance*"

Lesson Learned From ASTRUM Implementation (cont'd)

- ASTRUM is considered a rather conservative approach in addressing compliance with the three 10 CFR 50.46 criteria:
  - A singular uncertainty statement was required to address three independent variables: PCT, MLO, and CWO
  - The maximum value of PCT, MLO, and CWO within a sample of 124 runs have been selected as bounding "estimators" of the 95th percentile for each of the variables with 95% probability.
  - According to Guba-Makai (2003), the sample size requires up to 124 runs in the sample.
  - No statements with regard to the correlation between the MLO/CWO and PCT are required/needed.

Lesson Learned From ASTRUM Implementation (cont'd)

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Lesson Learned From ASTRUM and ASTRUM-FS Objective

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FSLOCA Statistical Treatment of Uncertainty Method - Objectives/Functional Requirements

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Statistical Treatment of Uncertainty Method in Full Spectrum LOCA (ASTRUM-FS)

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Overview of FSLOCA Statistical Treatment of Uncertainty Method (ASTRUM-FS)

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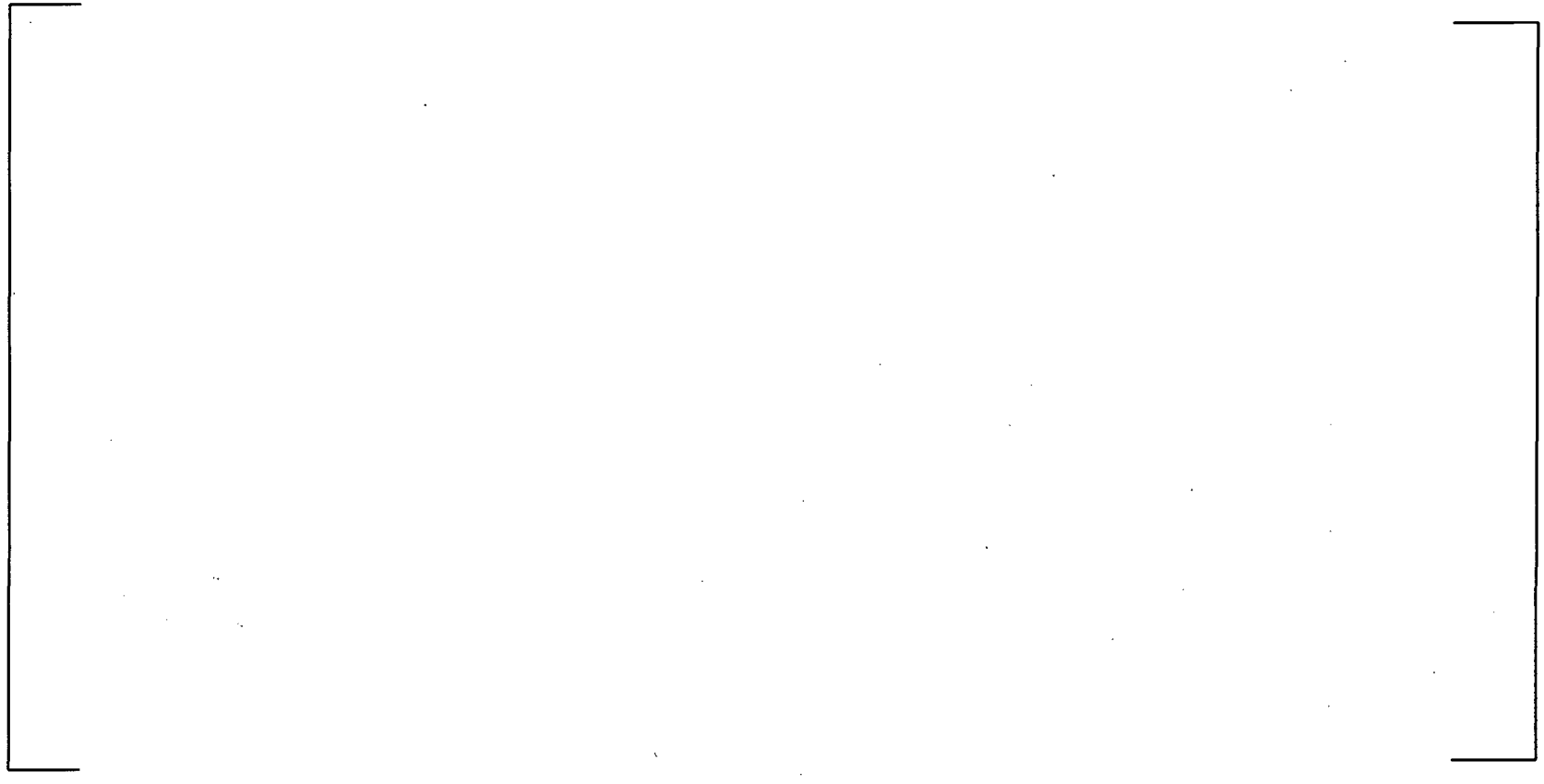

Overview of FSLOCA Statistical Treatment of Uncertainty Method (ASTRUM-FS) – cont'd

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PART I – Sample Generation Overview

- Sample Generation
  - Main Objective: Generate a sufficient sample to allow a stable and robust estimate of the 95/95 PCT and MLO
- Fundamental Considerations
  - Treatment of Break Size
  - Treatment of LOOP/NO-LOOP

Treatment of Break Size General Considerations

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Treatment of Break Size General Considerations (cont'd)

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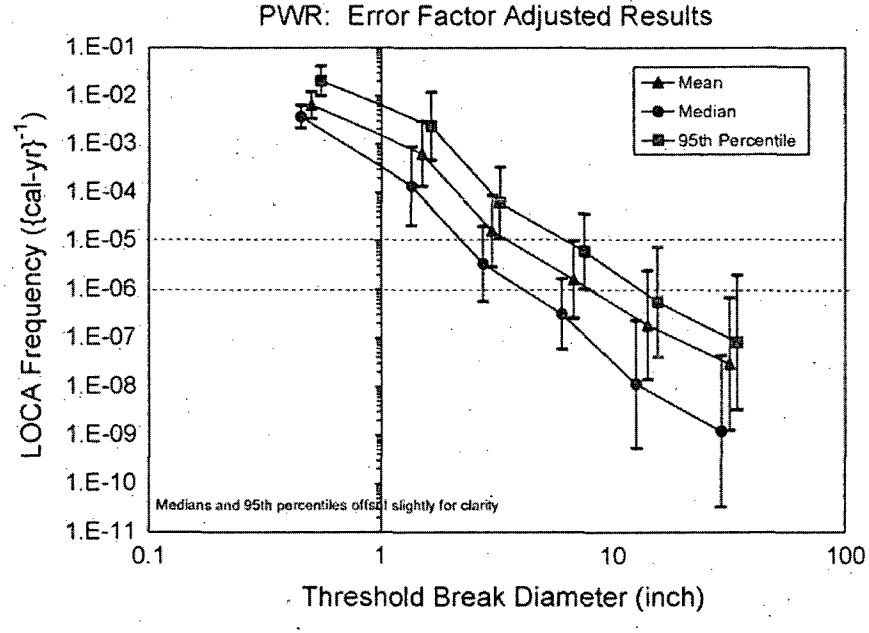

See 2006 NED "LOCA frequency evaluation using expert elicitation" by R.L. Tregoning, et. al

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Treatment of Break Size FSLOCA Approach

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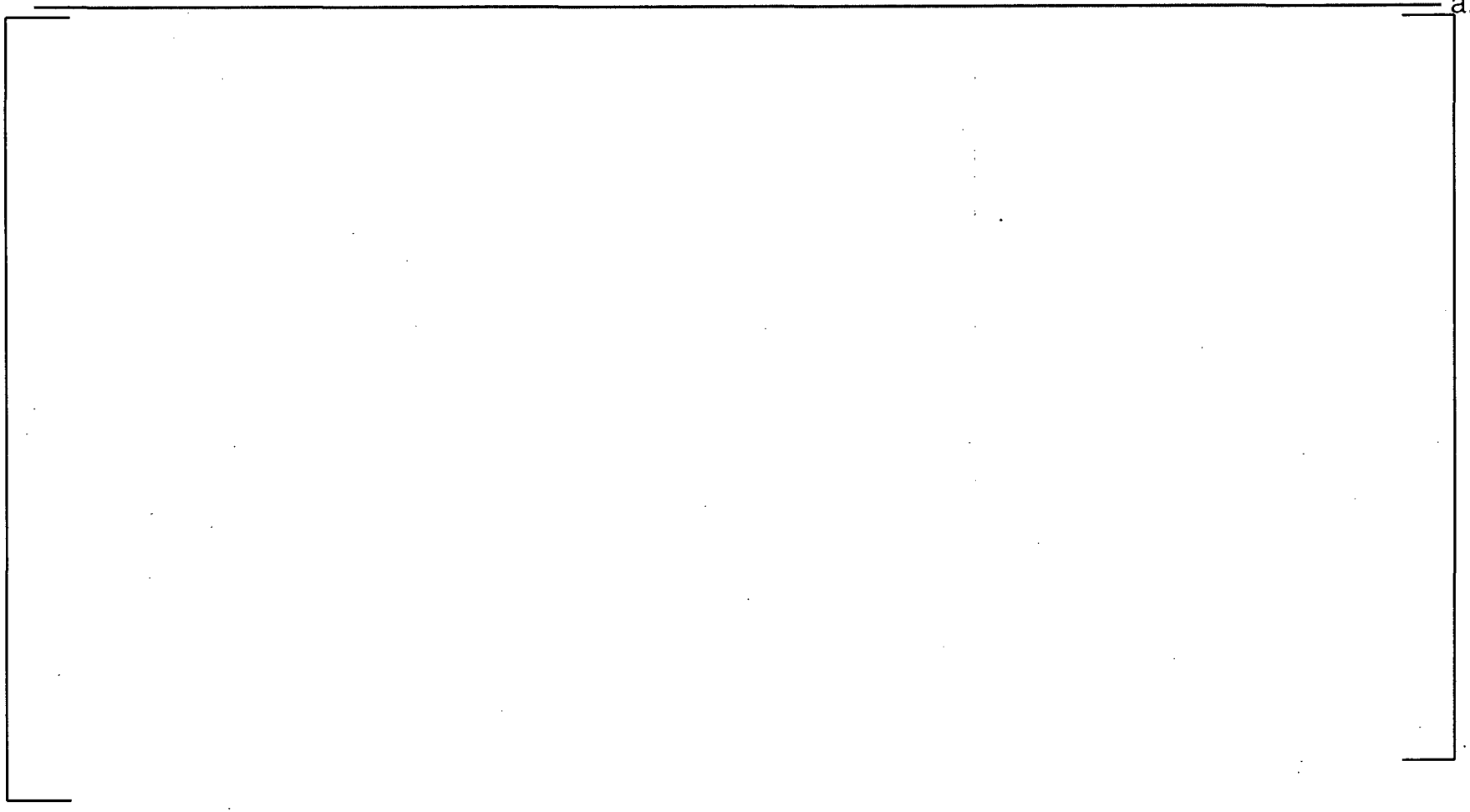

Treatment of Break Size FSLOCA Approach - Benefits

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Treatment of Break Size FSLOCA Practical Implementation

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Treatment of Break Size FSLOCA Practical Implementation

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Treatment of Offsite Power Availability General Considerations

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Treatment of Offsite Power Availability Treatment for LB region

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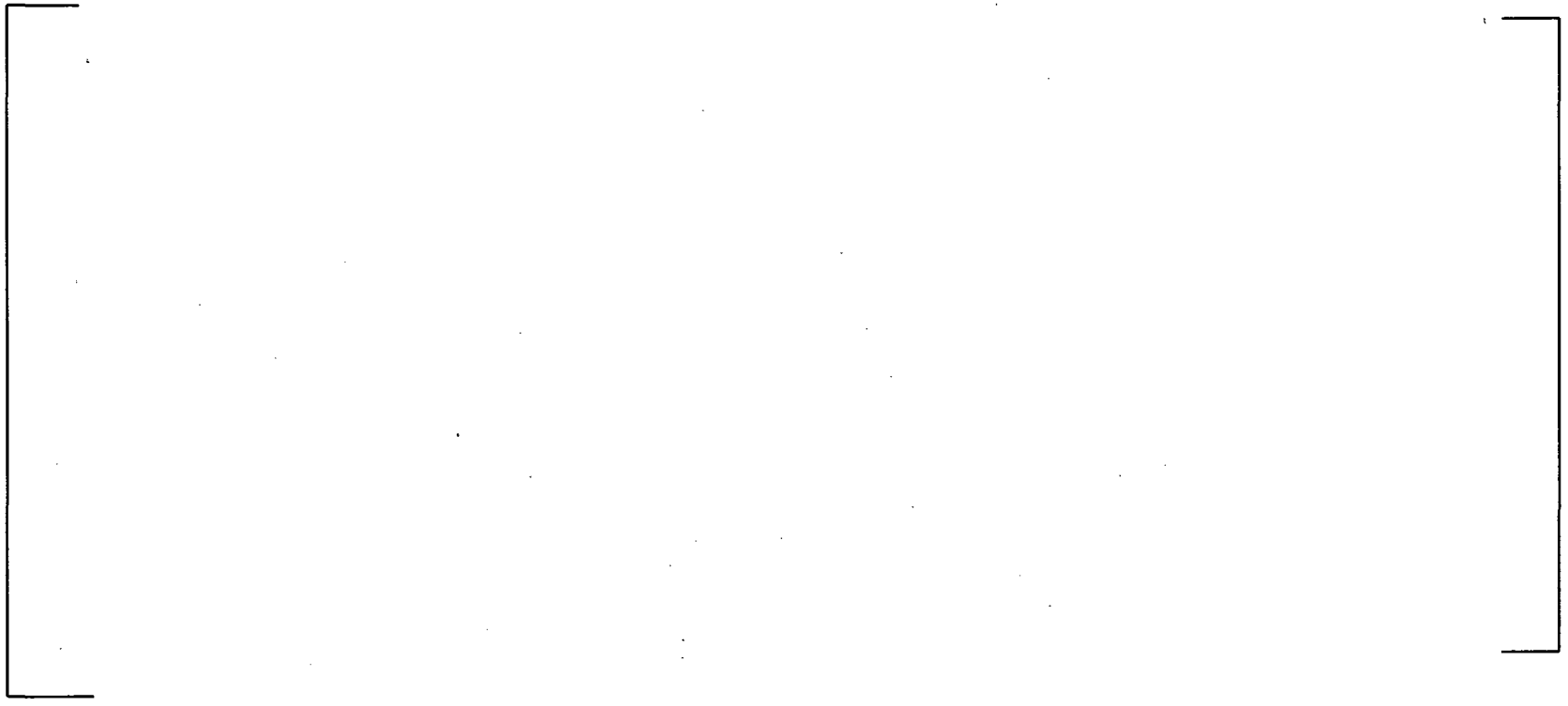

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Treatment of Offsite Power Availability Treatment for LB region (cont'd)

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Part I - Sample Generation Conclusions

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Part II - Statistical Analysis and 95/95 Statements

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Part II - Statistical Analysis and 95/95 Statements (cont'd)

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Part II - Statistical Analysis

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Part II - Statistical Analysis

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Part II - Statistical Analysis

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Part II - Statistical Analysis

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Part II - Statistical Analysis

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Part II - Statistical Analysis

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Part II - Statistical Analysis and 95/95 Statements

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Part II - Statistical Analysis 95/95 Statements

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Part II - Statistical Analysis
Q95 of the original sample

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Part II - Statistical Analysis Confidence Level

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Part II - Statistical Analysis 95/95 Statements

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Part II - Statistical Analysis and 95/95 Statements - Conclusions

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PART III – Feasibility Studies and Preliminary Demonstration

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Test Model Definition
Surrogate PCT Generator Model

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Nominal PCT model

Test Model Definition
Nominal PCT Model + Noise

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Test Model Definition
Surrogate PCT Models

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Simulation Analysis on Test Model General Considerations

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Simulation Analysis on Test Model Main Results – TM#1

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Simulation Analysis on TM#1

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Simulation Analysis on TM#1

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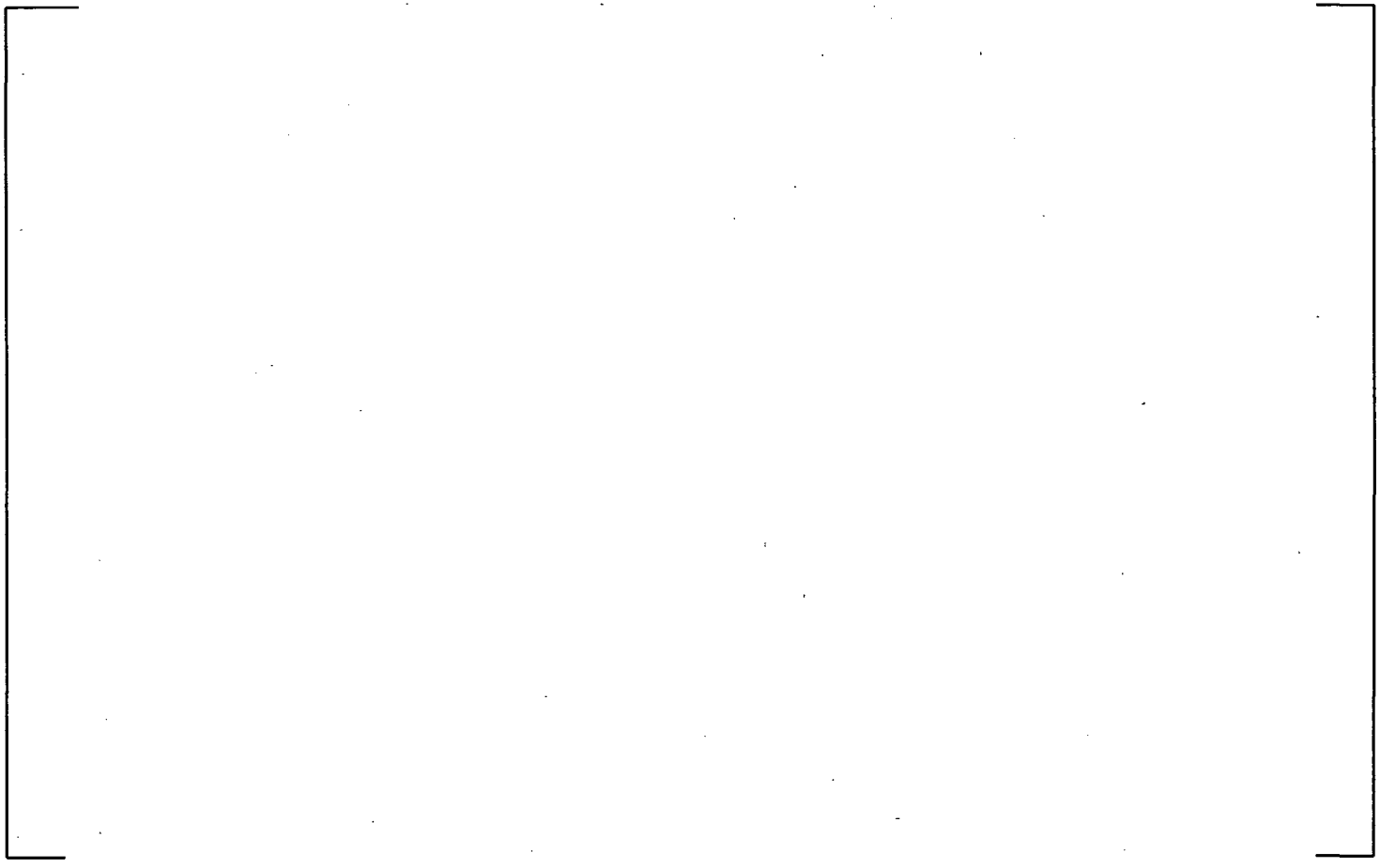

Simulation Analysis on TM#1

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Simulation Analysis on TM#1

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Simulation Analysis on TM#1

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Results From Test Model #1.1

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Simulation Analysis on Test Model Main Results – TM#1.1

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Simulation Analysis on TM#1.1 a,c

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Simulation Analysis on TM#1.1

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Simulation Analysis on TM#1.1

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Simulation Analysis on TM#1.1

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PART III – Feasibility Study on TM#1 & #1.1 Conclusions

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PART III – Feasibility Study on TM#1 & #1.1 Conclusions

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PART IV – Planned Studies and Models

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Other Planned Test Models Objectives

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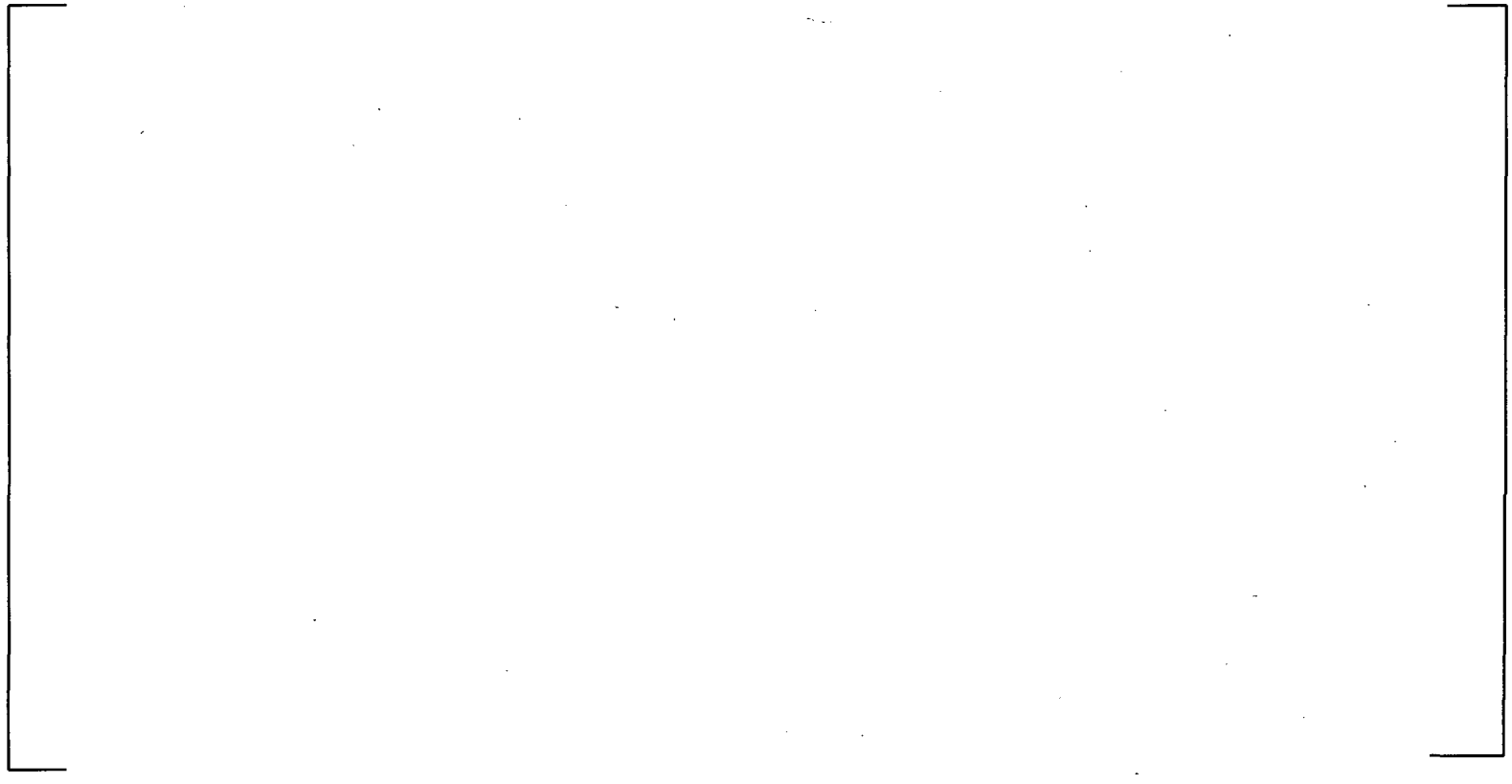

PART V - Other Considerations/Positions

Break Type Position

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PART V - Other Considerations/Positions

Core Wide Oxidation Position

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Conclusions

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