

# Westinghouse Containment Analysis Methodology

James H. Scobel

Containment and Radiological Analysis

412 374 5030 - [scobeljh@westinghouse.com](mailto:scobeljh@westinghouse.com)

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# Purpose

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- To present content and schedule for the Westinghouse containment analysis methodology topical report submittal
- Objectives of the Meeting
  - Inform NRC of Westinghouse's plan to submit a topical report for updated LOCA mass and energy release and containment analysis methods for PWRs and BWRs
  - Get NRC feedback on methodology and schedule

# Current Westinghouse M&E Methodology

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- Loss of Coolant Accidents
  - SATAN/REFLOOD/FROTH/EPITOME (WCAP-10325)
    - Bias initial conditions to maximize initial stored mass and energy
    - Conservative assumptions to maximize releases for maximum containment pressure
    - Non-mechanistic SG depressurization over 1 hour
  - CEFLASH-4A/FLOOD-3/CONTRANS (CE Plants)

# Current Westinghouse M&E Methodology

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- Main Steam Line Break
  - LOFTRAN or RETRAN
    - Bias initial conditions to maximize steam generator inventory and energy
  - SGN-III (CE Plants)
- Pressurized Water Reactors Only
  - No approved methodology for Boiling Water Reactors

# Current Westinghouse Containment Analysis Methodology

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- **Various applications with specific biases**
  - Peak Pressure and Temperature Calculations
  - Long Term Pressure and Temperature for Equipment Qualification
  - Minimum Containment Backpressure for LOCA PCT
- **Separate containment code with analyses performed iteratively with M&E code**
  - COCO for Dry/Sub-Atmospheric containments
  - LOTIC for Ice Condenser Containments
  - CONTRANS for CE Containment Designs
  - WGOTHIC for Passive Plant
  - Recent analyses with GOTHIC for Dry Containments
- **Generally plant specific analyses submitted individually**

# Need for Change

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- Code Convergence (Westinghouse, CE and Passive Plant)
- Improved technology
  - Increased computational capabilities
  - State-of-the-art codes and models are available
  - Capability to couple M&E and Containment Analysis
- Improved operational flexibility for customers
  - Power Uprate and Replacement SG Programs
- Westinghouse is selling BWR fuel
  - Customers need engineering services from fuel supplier
- Generic approval of containment analysis methodology

# Updated Methodology

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- Seeking generic approval
- Containment Analysis
  - Currently approved containment analysis code
  - GOTHIC
- GOTHIC Models for BWR and PWR Containments
  - Mark I, II and III
  - Large-Dry, Sub-Atmospheric
  - Ice Condenser
  - Passive Containment

# Updated Methodology

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- LOCA Mass and Energy
  - Currently approved LOCA M&E Model or
  - Approved ECCS model biased to maximize M&E release
    - WCOBRA/TRAC for PWR (Westinghouse and CE)
    - GOBLIN for BWR
- MSLB Mass and Energy
  - Essentially unchanged from currently approved methods
  - RETRAN
  - LOFTRAN
  - SGN-III for CE Plants



# BWR Mass & Energy Releases

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- Peak Pressure Analyses
  - Start with base approved GOBLIN ECCS Model
  - Bias input conditions to maximize M&E releases
  - Add uncertainties to volumes, initial pressures and temperatures, core stored energy, etc.
- Minimum ECCS Backpressure Analyses
  - Use GOBLIN ECCS model for M&E releases
- BISON for ATWS Events
- GOTHIC for SBA, IBA and SSLB

# BWR ECCS Minimum Backpressure Calculation

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- Current methodology is to use atmospheric pressure
- Proposed methodology is to use GOTHIC to calculate minimum backpressure for ECCS Analyses
  - Containment model biased to calculate minimum pressure
- Separate presentation to follow...

# PWR Mass & Energy Releases

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- **Start with base approved WC/T ECCS model**
- **Bias Conditions to maximize M&E releases**
  - Add uncertainties to volumes, initial pressures and temperatures, core stored energy
  - Alter input to model steam generator energy
- **Updated WC/T ECCS Model**
  - Improved WC/T modeling for SG tube quench specifically for M&E
  - Validated against FLECHT-SEASET Test
  - Considered to be ECCS model biased for M&E
- **Updated WC/T can be coupled with GOTHIC**
  - RWST mass, RHR and spray temperature for containment analysis
- **GOTHIC for long term (post-reflood) mass and energy releases**

# Contents of Base Topical Report

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- **GOTHIC Code description**
- **References to applicable regulations, guidance and SRPs**
- **Applications and Biases**
  - Peak Pressure and Temperature
  - Long Term Pressure and Temperature for Equipment Qualification
  - Peak Suppression Pool Temperature
  - Minimum Net Positive Suction Head Calculations
  - ECCS Minimum Containment Backpressure Calculations
- **Mass and Energy Release**
  - Any approved ECCS code through post reflood
  - GOTHIC for long term M&Es

# Contents of Topical Report Appendices

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- Specific plant models submitted as separate appendices to the base topical report
- Scope of Appendices
  - Model Descriptions
  - Benchmarking for Containment Analyses
  - Sample Transients
    - Representative set of cases to demonstrate capability

# Contents of Topical Report Appendices

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- BWR Mass and Energy Releases
  - GOBLIN for LOCA and MSLB M&Es
    - Discuss input biases for specific applications
    - Transition to GOTHIC long term M&E release
  - BISON for ATWS
  - GOTHIC for small breaks
- Boiling Water Reactor GOTHIC Containment Models
  - Mark I
  - Mark II
  - Mark III

# Contents of Topical Report Appendices

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- PWR Mass and Energy Releases
  - WCOBRA/TRAC for LOCA Mass and Energy Releases
  - Input biases for specific applications
  - Steam generator model for LOCA M&E
  - Transition to GOTHIC for long term M&E release
  - LOFTRAN and RETRAN for MSLB M&Es
- Pressurized Water Reactor GOTHIC Models
  - Large-Dry and Sub-Atmospheric
  - Ice Condenser
  - Passive Containment

# Topical Report – Potential Addendum

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- Full Spectrum WCOBRA/TRAC coupled with GOTHIC Containment Model
- Schedule to be determined



# Schedule for Topical Report Submittal

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- Phased Submittal of Appendices
- July 2006
  - Base Topical Report
  - BWR Mass and Energy Releases
  - BWR Mark 1 Containment Analysis
- September/October 2006
  - RAIs on Base Report and Mark 1

# Schedule for Topical Report

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- December 2006
  - PWR Mass and Energy Releases
  - PWR Large Dry, Sub-Atmospheric Containment Analysis
  - BWR Mark II Containment Analysis
  - Response to RAIs on Base Report and Mark I
- March 2007
  - RAIs on December Submittal

# Schedule for Topical Report Submittal

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- May 2007
  - BWR Mark 1 SER in May 2007 to meet utility needs
  - Response to RAIs on December Submittal
- To Be Determined
  - BWR Mark III Containment Analysis
  - Ice Condenser
  - Passive Containment
  - Full Spectrum WCOBRA/TRAC
- Other SER dates determined at submittal

# What Westinghouse is looking for from NRC

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- Feedback on the use of WCOBRA/TRAC for M&Es
  - Standard ECCS WCOBRA/TRAC model biased for M&E
  - Updated code
    - SG Metal with tube quench modeling
    - GOTHIC Coupling
- Feedback on Submittal Approach
- 1 year turnaround on SER for BWR Mark 1 method
- Feedback on approach for calculating BWR minimum backpressure