
AREVA

RLBLOCA Rev. 0 Transition Review
RLBLOCA Rev. 2 Program Discussion

Transition Program - Bert Dunn
RLBLOCA Revision 2 Discussion - Ken Carlson

Others Attending
Bob Baxter
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Scott Franz
Ronnie Gardner

May 7, 2008
Rockville, Maryland

Meeting Outline

- RLBLOCA Revision 0 Issue Resolution
  - Introduction
  - Brief Review of Transition Approach
    - Fuel Rod Quench
    - Forslund/Rohsenow
    - Break Size
    - Containment Pressure
    - Rod-to-Rod Radiation
    - Downcomer/Boiling
    - Core Power
    - GDC-35
    - Power Uprate
- Status Report on Revision 2
  - Dispersed Flow Film Boiling
  - Rod to Rod Radiation
  - Modeling Improvements
- Meeting Conclusions

Introduction - Goals for Today

- **The Most Important Outcome of this Process Is the Stability of the Resultant Conclusions**
- **Stability Does Not Mean "Deep Freeze"**
  - **New phenomena or effects must be addressed**
  - **If demonstrably important the industry needs to do this quickly**
  - **If corrections but non-significant, we should do so generically with balance across the analytical organizations**

Introduction - The Statistical Approach

- **Non-Parametric Statistical LOCA**
  - **Based on the CSAU Approach comprises the repeated combination of as many variable parameters as practical using both conservative and non-conservative values in individual combinations (cases) to achieve a true representation of the probability distribution of LOCA results**
  - **The LOCA probability distribution is then used to determine if there is a HIGH LEVEL of CONFIDENCE that the criteria of 10CFR50.46 are met**

Introduction – Sequoyah 1 Submittal

- The NRC Reviewed and Approved ANP-2655, Sequoyah 2 RLBLOCA, on April 4, 2008
- Sequoyah 1 Submitted ANP-2695, Sequoyah 1 RLBOCA, on April 14, 2008
- Both use the Transition Package as Described in our December 12, 2007 Meeting with the NRC

Specific Issue – Fuel Rod Quench

- **The Issue**
  - **The clad surface temperature must be less than Tmin and the void fraction less than 0.95 in S-RELAP5 before quench is allowed**
- **The Resolution**
  - **Coding has been changed to require that the local void fraction be less than 0.95**

Specific Issue – Forslund/Rohsenow

- **Issue**
  - **The NRC considers the Forslund-Rohsenow heat transfer correlation to have been applied outside of its range of application**
- **Resolution**
  - **Coding has been changed to limit the contribution of Forslund-Rohsenow to no more than 15 percent of the total heat transfer coefficient at anytime that the void fraction is at or above 0.9. To assure smooth transition in the interpolation region, the limit is applied above a void fraction of 0.7 whenever the Forslund-Rohsenow contribution exceeds 15% of the total heat transfer**

Specific Issue – Break Spectrum

- Issue
  - The use of probability sampling theory to satisfy the acceptance criteria for peak cladding temperature, maximum local oxidation, and core wide oxidation should be limited to breaks falling within the appropriate phenomenologically-driven region
- Resolution
  - The RLBLOCA methodology has been modified as follows:
  - Consistent with Regulatory Guide 1.157, the split and guillotine type breaks both span the complete break size range up to the largest possible break
  - Lower end of break spectrum adjusted to approach .2 to .3 times the double ended Break Area

Specific Issue – Break Spectrum, Disposition of Breaks between SBLOCA and RLBLOCA

> Minimum PCT Difference – Large to Intermediate Break

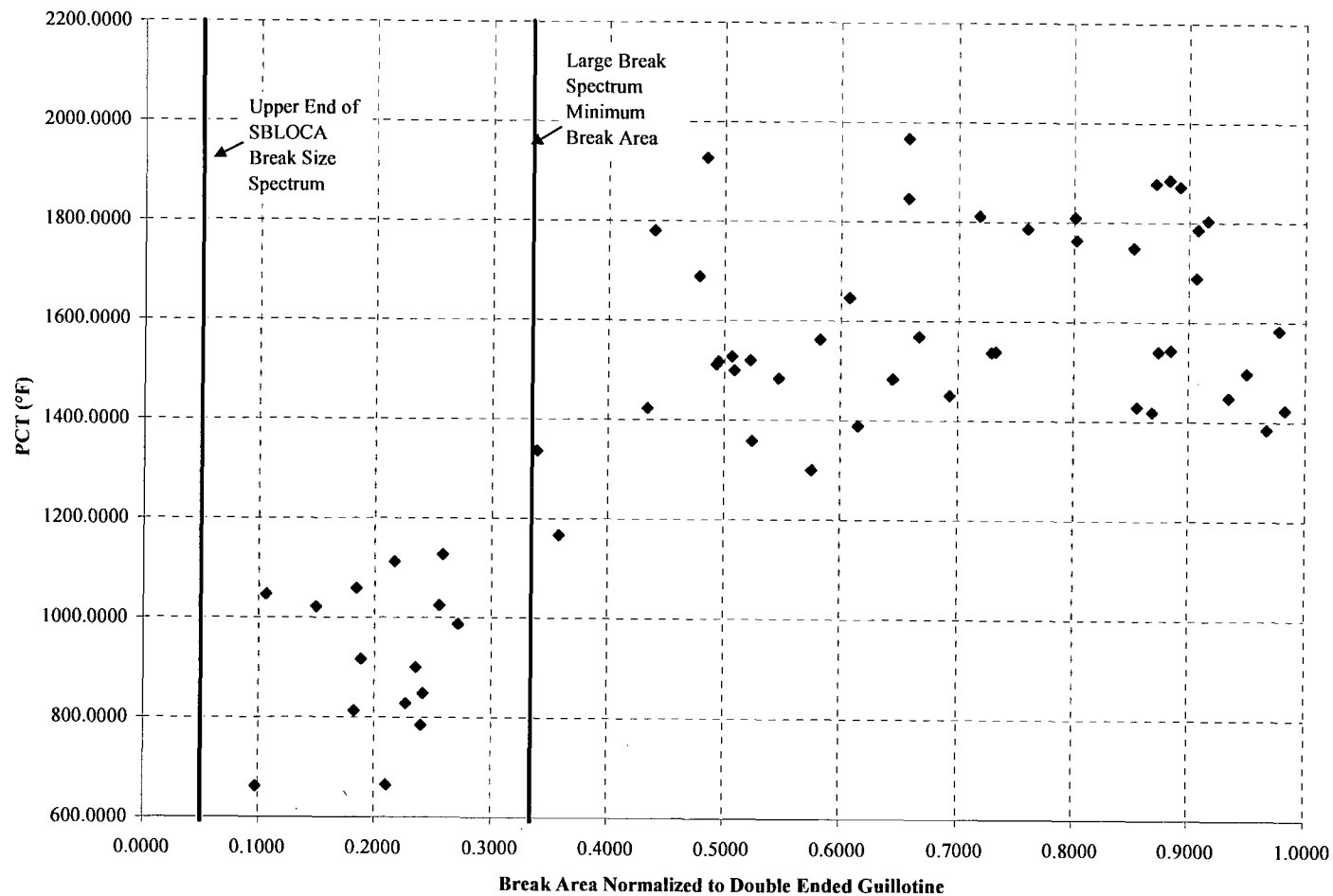
- ◇ **73 cases examined none are limiting and only one within 450 F**

Plant Description	Generic Plant Label	Maximum PCT (°F) Intermediate Size Break	Maximum PCT (°F) Large Size Break	Delta PCT (°F)	Average Delta PCT (°F)
3-Loop W Design	A	1746[1]	1887	141[1]	427[1]
	B	1273	1951	678	
	C	1326	1789	463	
2x4 CE Design	D	984	1751	767	767
	E	869	1636	767	
4-Loop W Design	F	1127	1967	840	840

»***Note: The second highest PCT was 1183 F or a – 704 F differential***

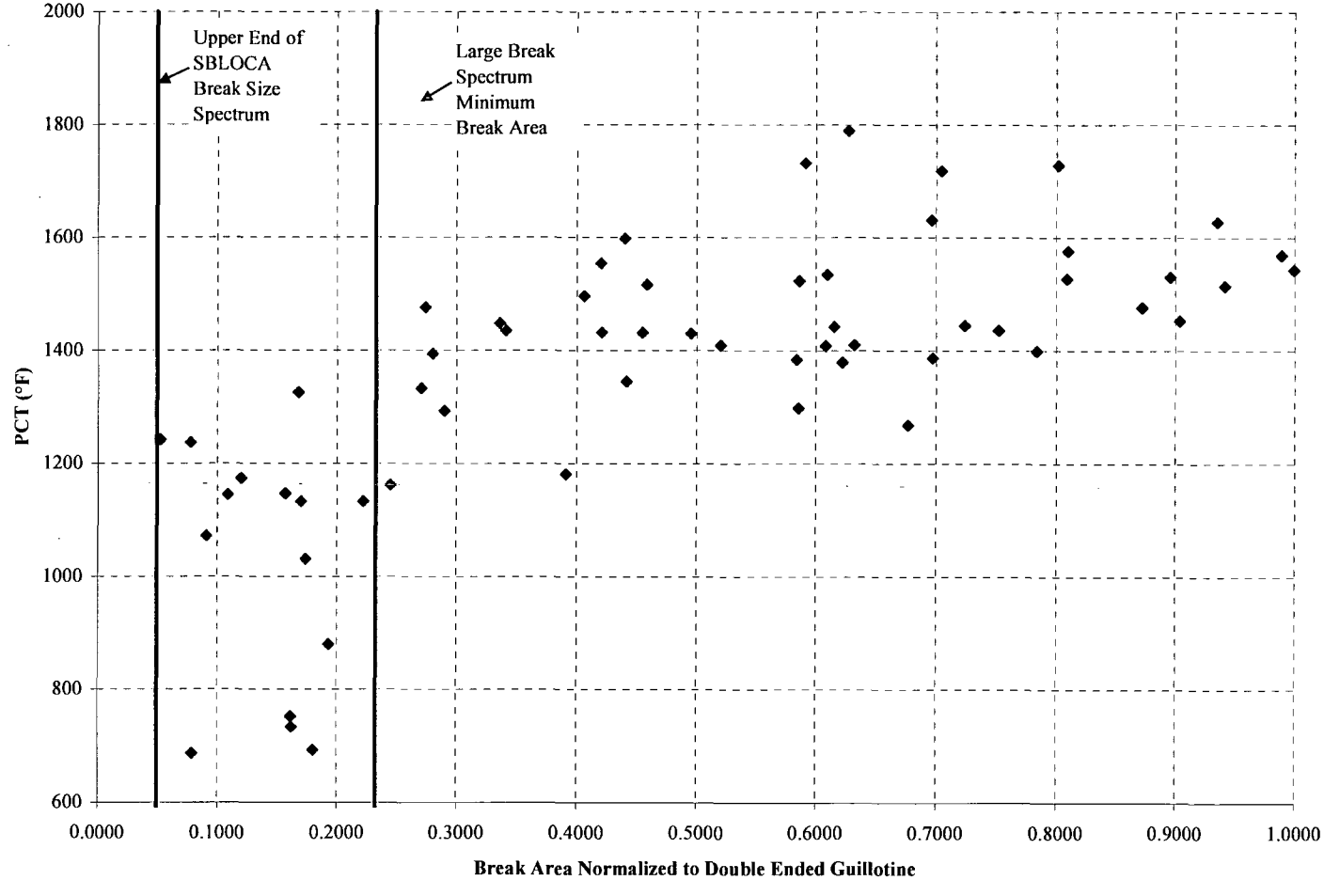
Specific Issue – Break Spectrum, Disposition of Breaks between SBLOCA and RLBLOCA

> Westinghouse 4-Loop Design – Plant F



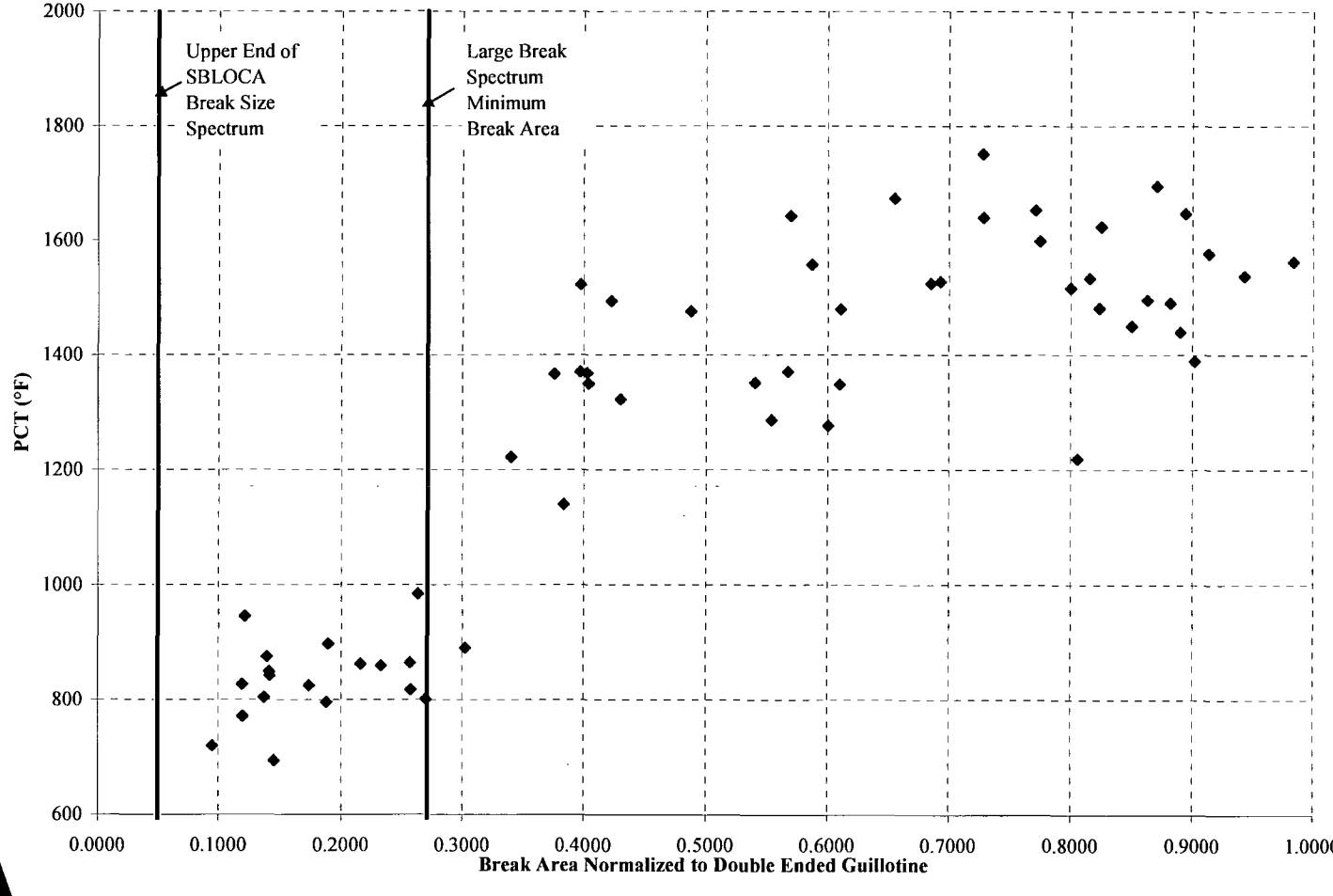
Specific Issue – Break Spectrum, Disposition of Breaks between SBLOCA and RLBLOCA

> Westinghouse 3-Loop Design – Plant C



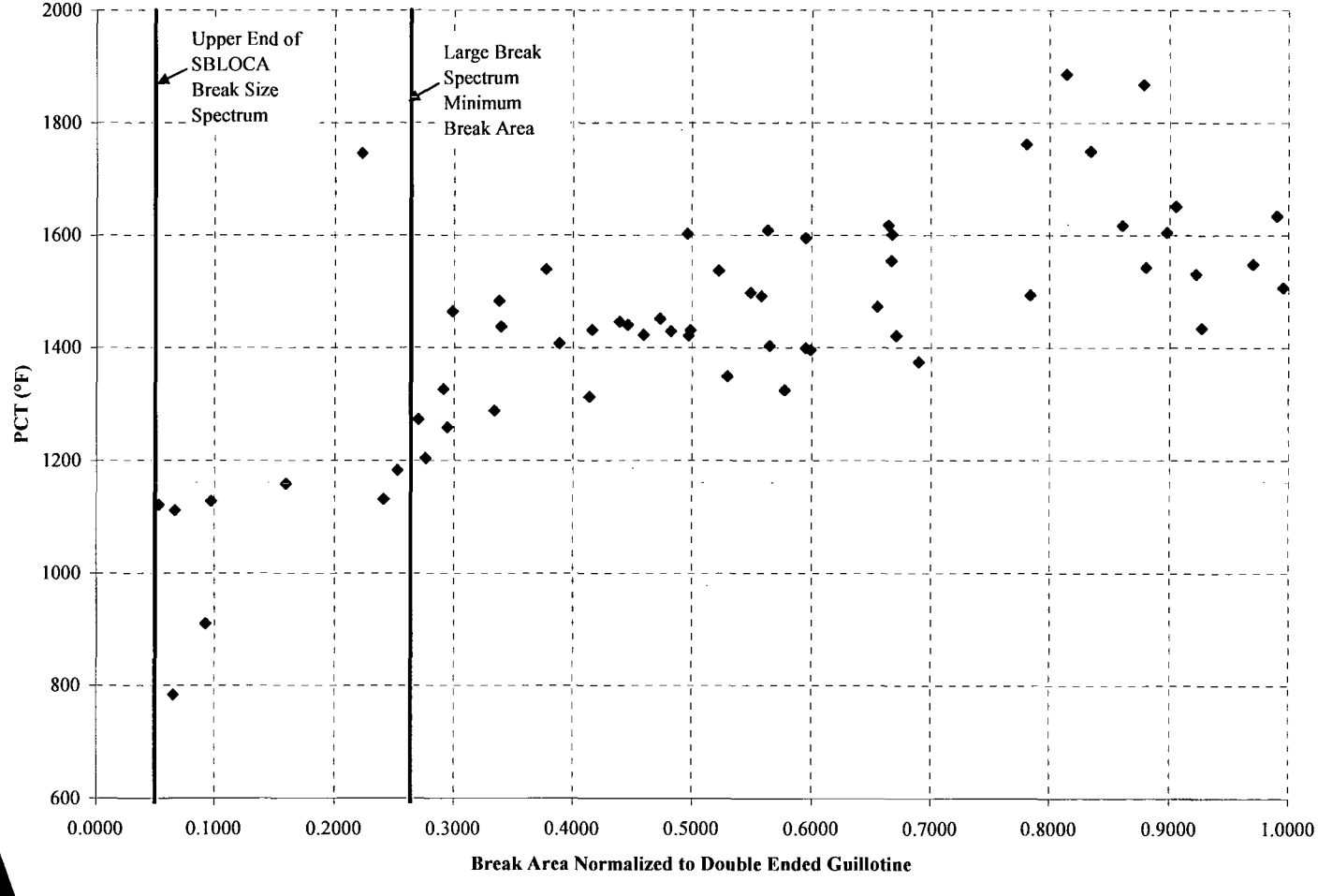
Specific Issue – Break Spectrum, Disposition of Breaks between SBLOCA and RLBLOCA

> Combustion Engineering 2 x 4 Design – Plant E



Specific Issue – Break Spectrum, Disposition of Breaks between SBLOCA and RLBLOCA

> Westinghouse 3-Loop Design – Plant A



Specific Issue – Containment Evaluation

- Issue
  - NRC requests demonstration of applicability of lead plant containment approach or plant-specific demonstration similar to that of the lead plant.
- Resolution
  - AREVA has prepared an inclusive technical description of how the containment pressure model input was determined for each plant submittal and why slightly lower pressures than true best estimate are predicted.

Specific Issue – Rod-to-Rod Radiation

- Issue
  - A lack of a rod-to-rod radiation model in S-RELAP presents the potential that the uncertainty evaluation of the remaining heat transfer processes may over estimate the associated heat transfer. Thus, for conditions that do not involve significant rod-to rod radiation, the S-RELAP evaluation may over estimate the net rod heat transfer
- Resolution
  - For a PWR evaluation, a radial local peaking is present
    - Local power differences enhanced temperature differences
    - Increasing net radiation heat transfer from the hotter rods
  - Plant rod-to-rod radiation exceeds the experiments
  - Therefore, implicit inclusion of rod-to-rod radiation in the EMF-2103AP RLBLOCA methodology is conservative
  - Presented at December 12, 2007 meeting and documented in transition program submittals

Specific Issue – Downcomer Boiling

- **Issue**
  - **The NRC is not satisfied with AREVA's treatment and response to the downcomer boiling issue. Additional justification for the applicability of the methodology must be supplied if a plant has a calculated PCT above 1800F or a containment pressure less than 30 psia**
- **Resolution**
  - **Sensitivity studies on the size and number of axial control volumes have been conducted**
  - **Results when combined with existing studies on azimuthal noding assure that the Revision 0 downcomer model can conservatively resolve downcomer boiling phenomena**

Specific Issue – Core Power

- **Issue**
  - **The plant licensing basis LOCA analysis must not be performed at less than the full licensed power level.**
- **Resolution**
  - **The methodology has been changed to eliminate the sampling of core power**
  - **Core power is held constant throughout the case set at a value equal to the plant rated power plus the established measurement uncertainty**
  - **For plants that have not incorporated measurement uncertainty recapture (MUR), the applied uncertainty will be 2 percent**

Specific Issue – Emergency Power Redundancy

- Issue
  - The NRC has stated that the approved RLBLOCA approach of sampling offsite power with a 50/50 probability is not in compliance with GDC-35 and that a full case set must be provided with the worst offsite power configuration.
- Resolution
  - AREVA has changed methodology for transition to conduct 2 full case sets with identical seeds
    - One set assumes no off-site power is available
    - One set assumes off-site power is available
  - Both sets are reported in the Summary Report
  - The case set with the highest PCT becomes the Analysis of Record

New Submittals

- Summary Report (Submittal to NRC)
  - Chapter 1 – Introduction and Deviations from Revision 0 Methodology
  - Chapter 2 – Summary of Results
  - Chapter 3 – Analysis and Model Descriptions
    - Description of Models
    - Details on Containment modeling
    - Analytical Results Presentation
  - Chapter4 – Generic Supports for Transition Package
    - Reactor Power
    - Rod Quench Conditions
    - Rod-to-Rod Radiation
    - Film Boiling Heat Transfer Limit
    - Downcomer Heat Transfer and Fluid Volume Modeling
    - Break Size Determination and Disposition of Intermediate Breaks
    - Containment Modeling
    - Determination of Off-Site Power Availability
    - Maintenance of Analysis Applicability to Plant
  - Chapter 5 - Conclusions

Conclusion

- **Conclusions**
  - **AREVA has Implemented December 12 Commitments**

RLBLOCA Revision 2 Discussion

- > Revision Goals
- > Revision 2 Plan
- > Status
- > Meeting Conclusions

Revision 2 Goals

- > Replace Forslund-Rohsenow in DFFB
- > Apply Rod to Rod Radiation
- > Address All Revision 1 SER Issues (Rev 0 Transition PROGRAM)
- > Downcomer Issue Resolution
- > Revise LOCA Model Nodalization
- > Revise Uncertainty Analysis

Revision 2 Schedule

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Revision 2 Schedule

Revision 2 Schedule

Dispersed Flow Film Boiling (DFFB)

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Thermal Radiation

Thermal Radiation

Model Nodalization

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Topical Report

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Conclusions

- Conclusions
- Documentation
- Next Meeting