PRELIMINARY – ANALYSES STILL IN-PROGRESS

## Cladding Rupture Study

- Using analysis inputs skewed to maximize the PCT, determine if cladding rupture is postulated during the hot leg LOCA transient during the BWST injection phase.
- Perform a generic hot leg U-bend analysis to bound the 177 FA Lowered-Loop analyses
- Perform a limiting DB hot leg U-bend analysis for the 177 FA Raised-Loop plant



## 177 FA LL Clad Rupture Study

- Generically Applicable to Six Plants
  - ANO-1
  - CR-3
  - ONS-1
  - ONS-2
  - ONS-3
  - TMI-1
- Determine a limiting fuel type
- Determine the limiting fuel pin burnup and axial peaking
- Perform any sensitivity studies that may be needed to confirm bounding results were obtained

## 177 FA LL Clad Rupture Study

- Fuel Types Considered
  - Mark-B10 – zircaloy clad
  - Mark-B11 – M5 clad
  - Mark-B12 – M5 clad
  - Mark-B-HTP – M5 clad
- Fuel initial temperature, break size and the timing of CHF, and the CFT initial conditions are important considerations.
- The LOCA linear heat rate (LHR) limit is pushed to achieve a PCT of 2000 ± 50 F.
- The LHR limits to achieve the PCT effectively normalize out plant differences and CHF variations for CLPD breaks so there should be little change from plant to plant.



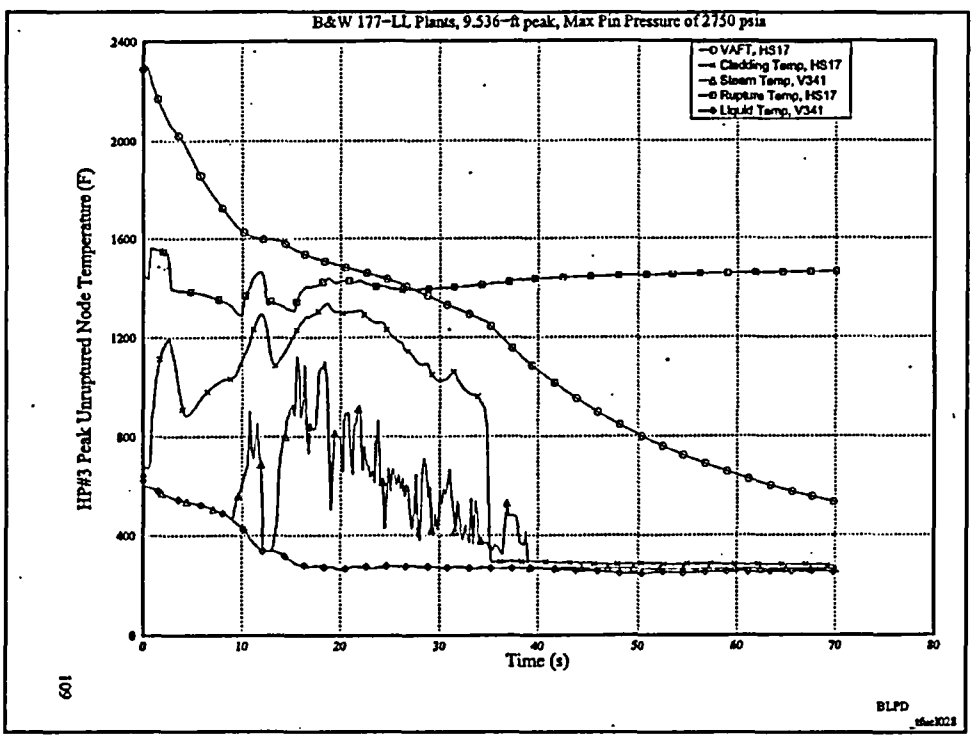
## 177 FA LL Clad Rupture Study

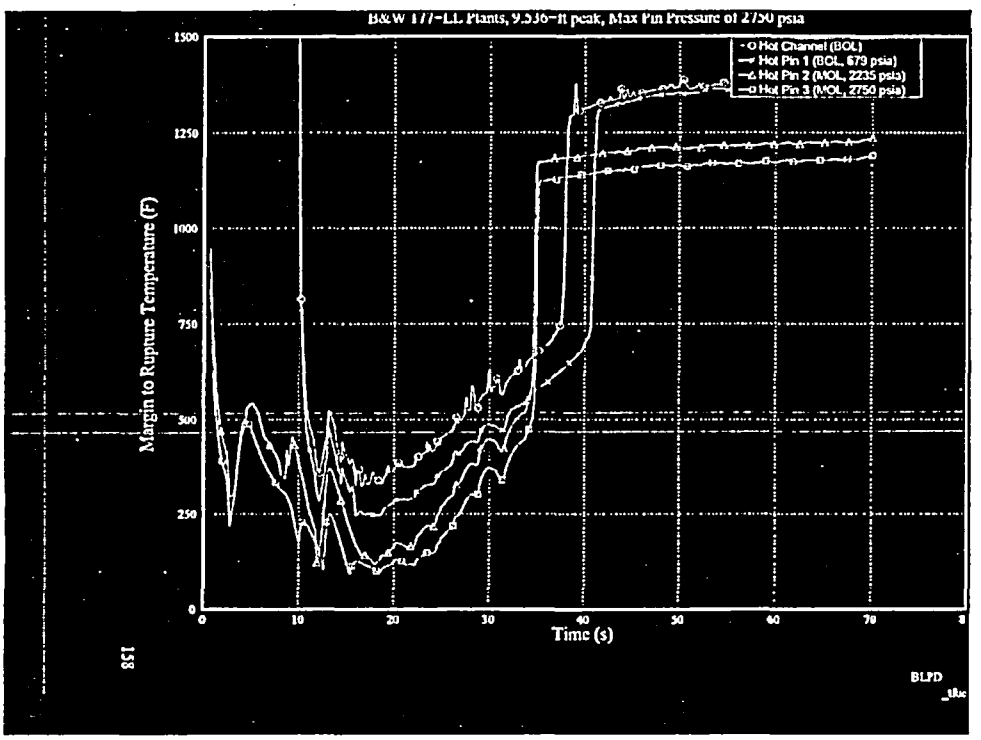
- The Mark-B-HTP fuel used in CR-3 has the lowest CHF performance so it was selected for this study of the 14.4 $ft^2$.
- The CFT line resistance and initial pressure and liquid volume conditions were set to bound all the LL plants for conservatism.
- Multiple hot pins with different pin pressures were used to simulate the TIL effects.
- The hot pin fuel stored energy EM approach that was approved in Rev 4 of RELAP5/ MOD2- B&W was used in the analyses.

## 177 FA LL Clad Rupture Study

- The core exit skewed power peaks produce earlier CHF than the middle or bottom skewed peaks and this presents the biggest challenge to clad rupture. Therefore the 9.536-ft elevation axial peak case was used.
- The limiting margin to rupture for a double-ended guillotine break was calculated as 105 F for the pressurizer in the intact hot leg and 99 F for the pressurizer in the broken hot leg.

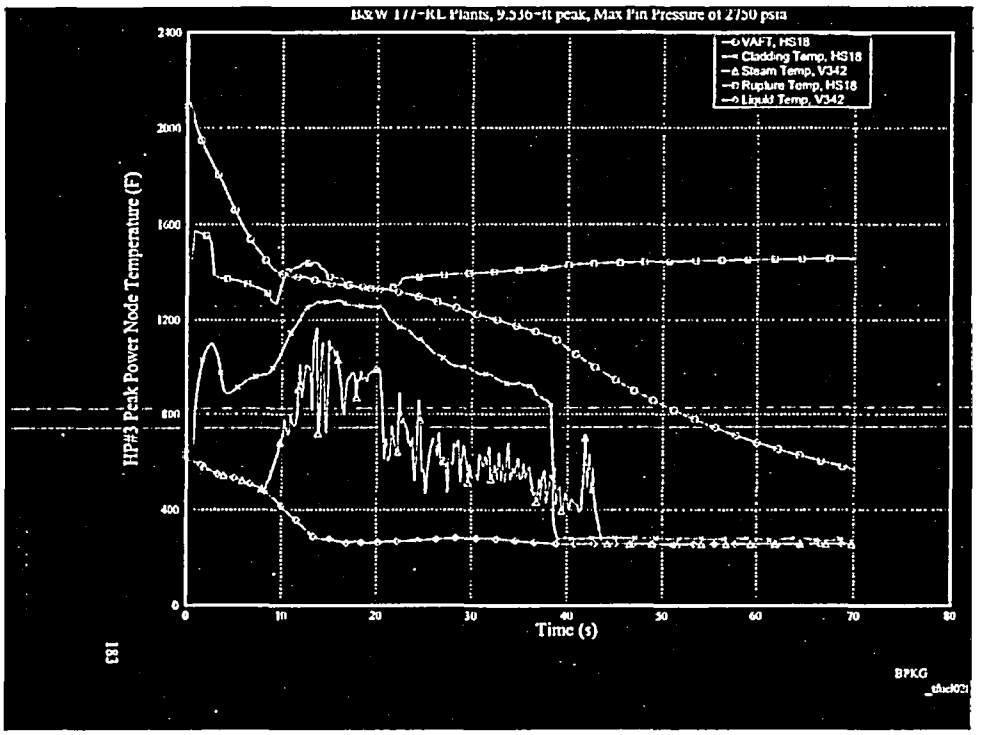


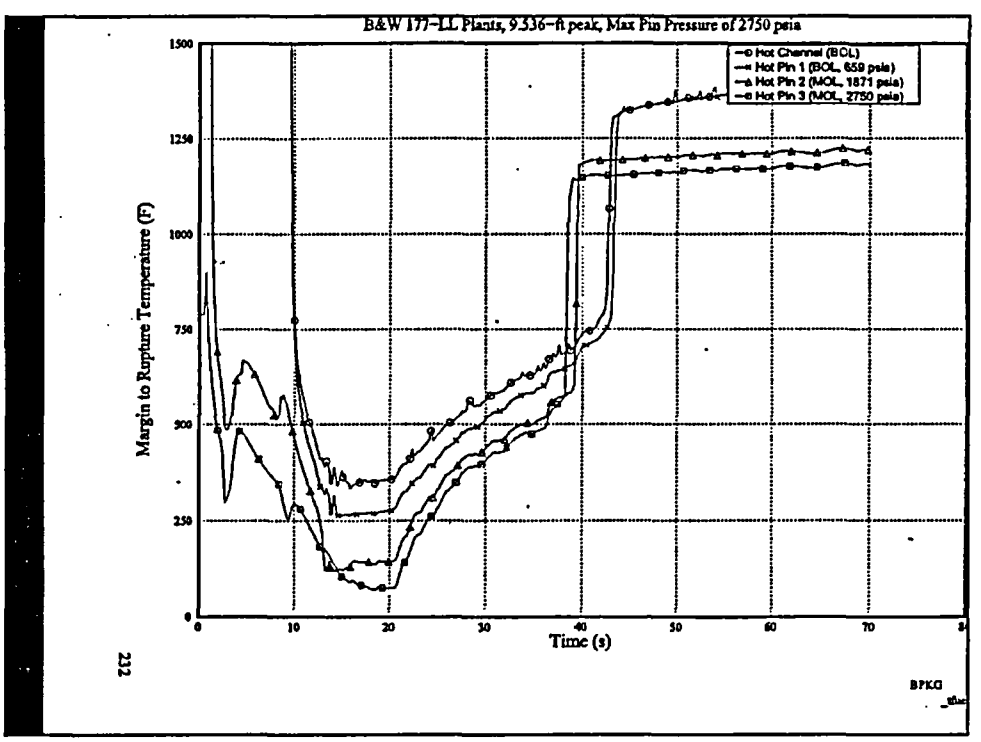





## 177 FA RL Clad Rupture Study

- DB Specific Plant Parameters
- Fuel types considered
  - Mark-B10 - zircaloy
  - Mark-B12 - M5
- Use multiple hot pins to simulate the time-in-life effects for the 9.536-ft axial peak
- Perform a pressurizer location sensitivity study
- The limiting margin to rupture for a double-ended guillotine break was calculated as 79 F for the pressurizer in the intact hot leg and 72 F for the pressurizer in the broken hot leg.


B&W 177-RL Plants, 9.536-ft peak, Max Pin Pressure of 2750 psia
VAFT, HS18
Cladding Temp, HS18
Steam Temp, V342
Rupture Temp, HS18
Liquid Temp, V342
HP#3 Peak Power Node Temperature (F)
Time (s)
183
BPKG


B&W 177-LL Plants, 9.536-ft peak, Max Pin Pressure of 2750 psia
Hot Channel (BOL)
Hot Pin 1 (BOL, 659 psia)
Hot Pin 2 (MOL, 1871 psia)
Hot Pin 3 (MOL, 2750 psia)
Margin to Rupture Temperature (F)
Time (s)
222
BPKG

## Clad Rupture Study Conclusions

- Cladding rupture was not be predicted for the LL or RL analyses for the double-ended hot leg U-bend break for the 9.536-ft axial peak.
- Cladding rupture will not occur for smaller break sizes or lower axial peaking elevations.
- These results can be used in defining the inputs to the dose evaluations.



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  - ONS-2
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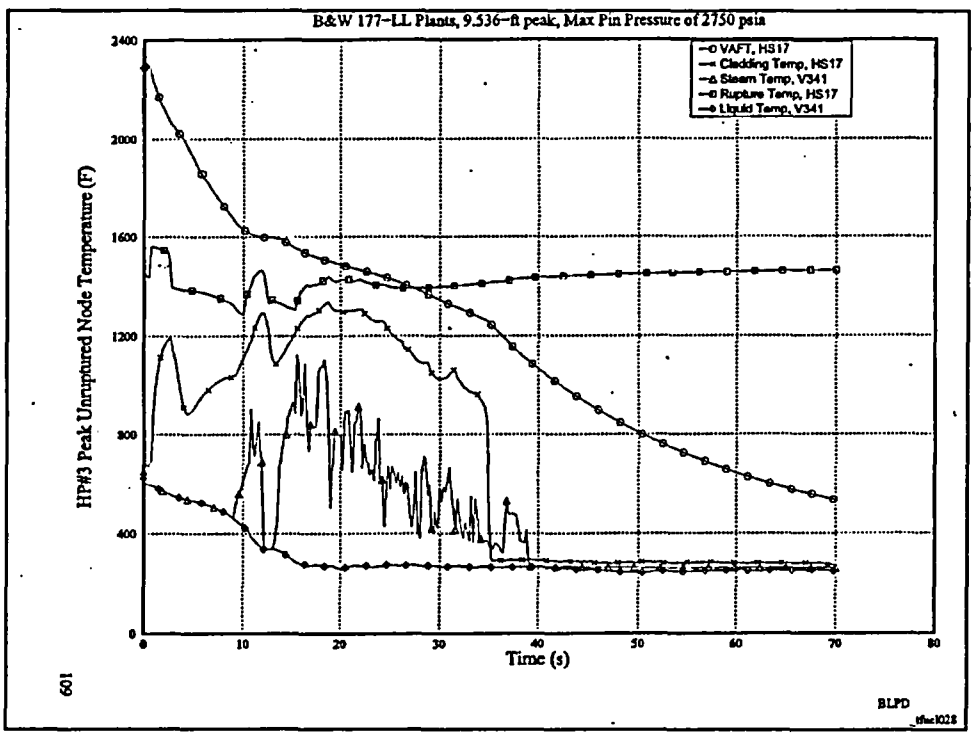

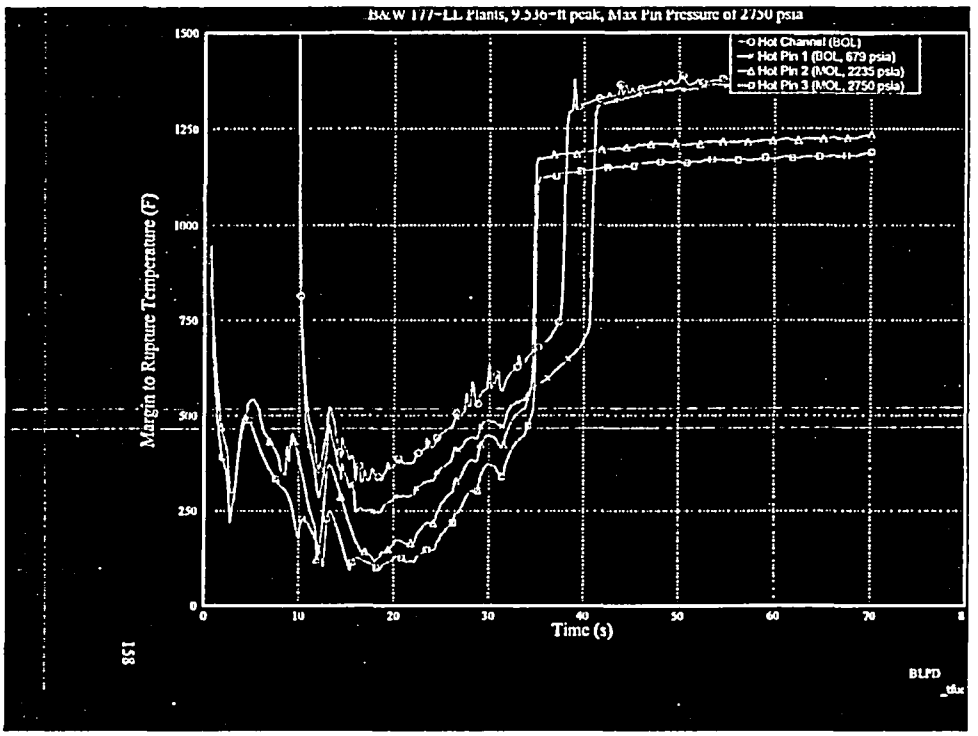


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- DB Specific Plant Parameters
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  - Mark-B10 - zircaloy
  - Mark-B12 - M5
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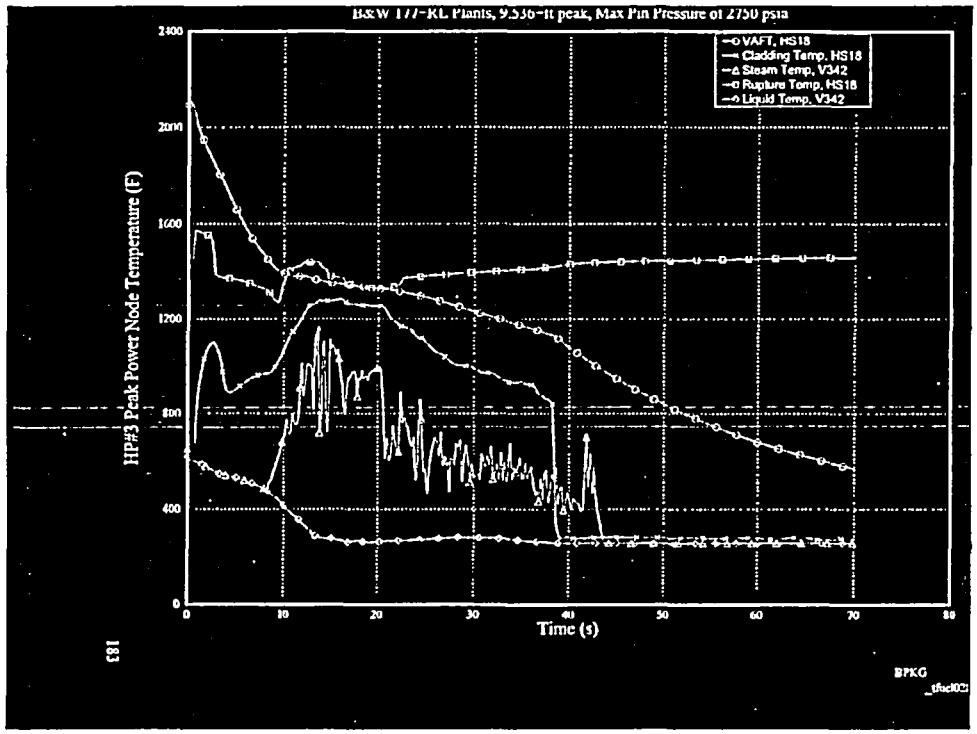
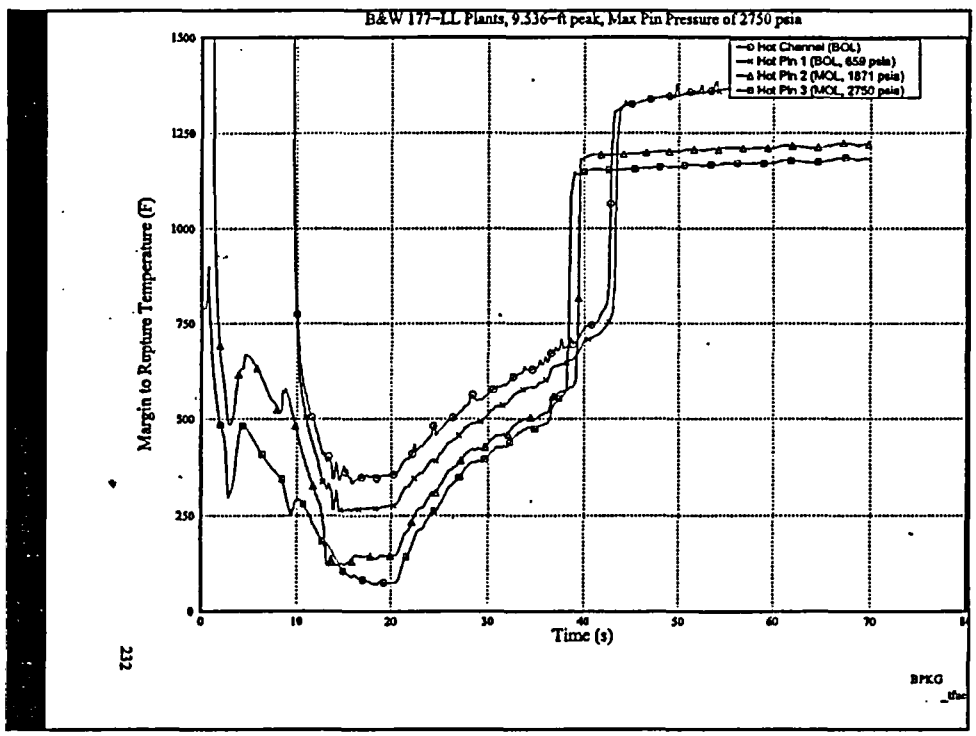

B&W 177-KL Plants, 9.536-ft peak, Max Pin Pressure of 2750 psia
VAFT, HS18
Cladding Temp, HS18
Steam Temp, V342
Rupture Temp, HS18
Liquid Temp, V342
HP#3 Peak Power Node Temperature (F)
Time (s)
183
BPKG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Hot Channel (BOL)
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Hot Pin 3 (MOL, 2750 psia)
Margin to Rupture Temperature (F)
Time (s)
212
BPKG

## Clad Rupture Study Conclusions

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