TRACE Developmental Assessment

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Objective

To become familiar with the code assessment effort and gain a basic understanding of the code strengths and weaknesses.

Outline

- Purpose of code assessment
- Identifying important processes and phenomena (PIRT)
- Processes and phenomena assessed
- Overall results of the assessment

Purpose of Code Assessment

TRACE is designed to perform best-estimate analysis of LOCAs, anticipated operational transients and other accident scenarios in PWR and BWR power plants.

It is also designed to model phenomena occurring in experimental facilities designed to simulate transients in reactor systems.

Because many of the models and correlations in TRACE used to represent the physical processes that occur during a transient are not based on first principles and may not always provide an accurate prediction of a given process, the code must be assessed against suitable experimental data.

Purpose of Code Assessment

Code assessments are made to:

- Evaluate the performance of TRACE in simulating the various anticipated phenomena occurring in a power plant or experimental facility.
- Provide valuable information into the capabilities and limitations of TRACE to the user community.
- Provide an insight into how well the various models and correlations work in concert with one another.

The assessment process may be viewed as consisting of the following tasks:

- Formulate assessment matrices for each class of transients studied, e.g. large-break LOCA, small-break LOCA, etc.
- Select key parameters for these classes.
- Perform assessment calculations. Compare the test data with the results of the calculations for the key parameters.

Identifying Important Processes and Phenomena (PIRT)

One of the most important tasks associated with the development of a best estimate thermal-hydraulic code is identification of the processes and phenomena that have the most dominate influence on transients of interest.

To identify the physical processes and thermal-hydraulic phenomena that are most important for TRACE assessment, Phenomena Identification and Ranking Tables (PIRTs) are reviewed for these intended applications.

The primary purpose of a PIRT is to rank, relative to a figure of merit, the physical processes and phenomena that affect plant behavior during a particular transient event.

Processes and Phenomena Assessed

Once the processes and phenomena of interest have been identified a selection of the available test data is made to cover models and correlations used in the code and that best approximate the behavior of a light water reactor.

The tests are categorized as:

- Fundamental Test Cases – basic tests, simple geometries, analytical solutions, directed toward specific models: Drain-Fill Problem, Oscillating Manometer, Single and Two-Phase Wall Friction, etc.
- Separate Effects Tests – produce detailed information on the behavior of individual system components or parts of the overall system, wide range of geometric scales: Marviken, Moby Dick, THTF, RBHT, GOTA, FRIGG, Bankoff CCFL, etc.
- Integral Tests – overall reactor coolant system thermal-hydraulic behavior for various postulated accidents for PWR and BWR: LOFT, CCTF, BETHSY, ROSA, FIST, SSTF, etc.

Overall Results of the Assessments

Key Assessment Parameters – define code's accuracy

Key Assessment Parameter	Large Break	Small Break
Continuous-Valued Key Parameters		
Cladding Temperature	X	X
System Pressure	X	X
Break Flow Rate	X	X
Break Flow Rate (integrated)	X	X
ECC Injection Flow Rate	X	X
Vessel or Core Collapsed Liquid Level		X
Secondary Side Pressure		X
Secondary Side Valve Flow		X
Single-Valued Key Parameters		
Blowdown Peak Cladding Temperature (PCT)	X	X
Loop Seal Clearance Period PCT		X
Reflood PCT	X	X
Boiloff Period PCT		X
Times of Blowdown and reflood PCT	X	X
Time of ECC injection initiation	X	X
Time of Signal Generation for MSIV Closure (BWR)	X	
Time of Rewet or Quench	X	X
Time of HPSI and/or LPSI Initiation		X
Time of Loop Seal Clearance		X
Time of Reverse Primary to Secondary Heat Transfer Initiation		X
Time of Core Uncovery and Recovery		X

Overall Results of the Assessments

Qualitative Characterization of Assessment Results Discussed Here

"Excellent" or "Outstanding" Agreement	No Code or Model deficiencies
	1. Major and minor trends predicted correctly
	2. Calculation usually within measurement uncertainty bounds
	3. TRACE can be used for similar transients
"Moderate" or "Reasonable" Agreement	Minor code or model deficiencies
	1. Major trends predicted correctly
	2. Calculation frequently outside measurement uncertainty bounds
	3. Correct conclusions can be obtained if TRACE is used for similar transients
"Minimal" or "Poor" Agreement	Significant core or model deficiencies
	1. Some major trends incorrectly predicted
	2. Some predicted values well outside measurement uncertainty bounds
	3. Incorrect conclusions may be reached if deficiencies are not considered
"Insufficient" or "Unacceptable" Agreement	Major code or model deficiencies
	1. Major trends not predicted
	2. Most predicted values well outside measurement uncertainty bounds
	3. Conclusions should not be based on code predictions

Quantitative Characterization of Assessment Results May Also Be Needed, But Success Criteria Can Be Difficult to Define Except for Single-Value Parameters

Overall Results of the Assessments

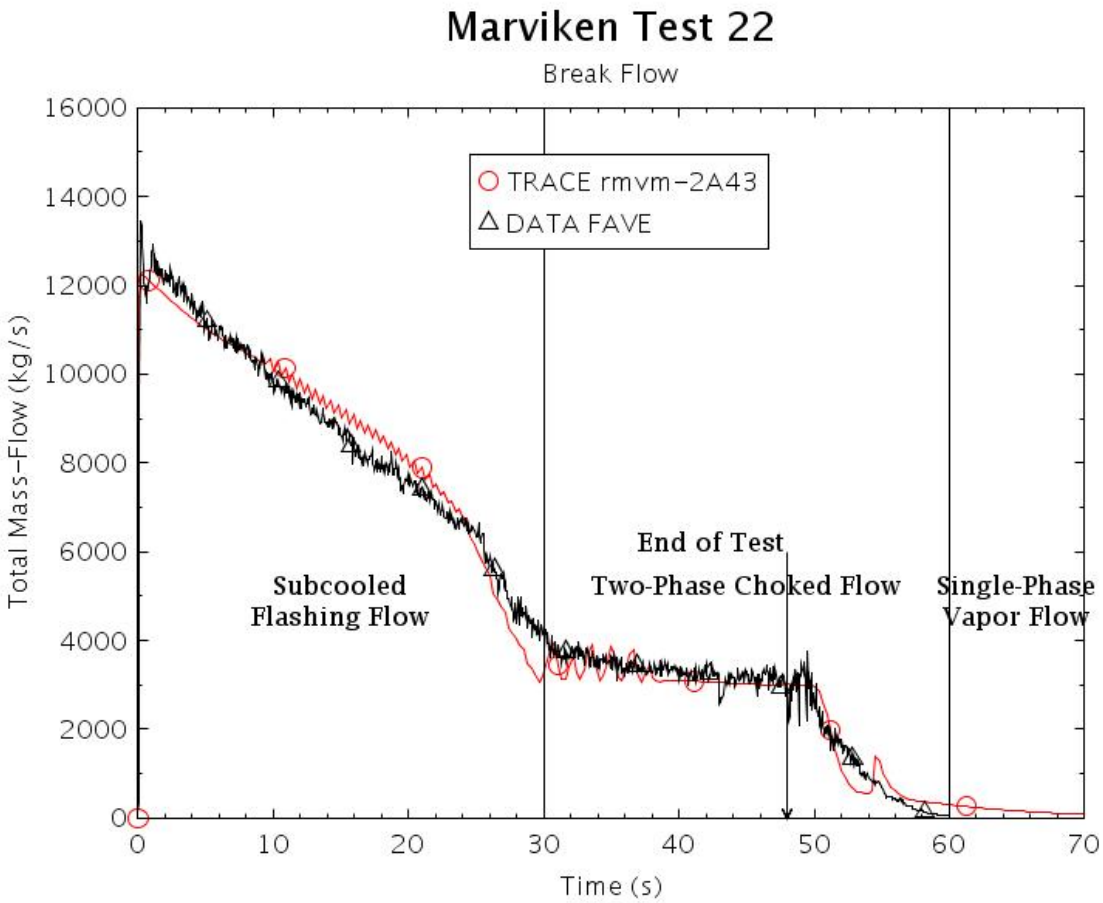
Separate Effects

Assessment Type	Experiments	Excellent	Reasonable	Minimal	Insufficient
Critical Break Flow	Marviken		X		
	Moby Dick		X		
	Super Moby Dick		X		
ECC Bypass	UPTF	saturated	saturated	highly subcooled	
Blowdown Heat Transfer	THTF Steady-State and Transient Blowdown		X		
Reflood Heat Transfer	FLECHT-SEASET Reflood	forced reflood	forced reflood		
	GOTA Reflood		X		
	GOTA Radiation	X			
	RBHT Reflood			X	
	RBHT Steam Cooling		X		
Void Fraction and Mixture Level Swell	FRIGG	X			
	THTF Core Uncovery and Level Swell		X		
	RBHT Mixture Level		X		
	GE Level Swell		X		
	Wilson Bubble Rise	X			
CCFL and Flooding	Bankoff CCFL Tests	X			
Condensation	Debhi-MIT	X			
	University of Wisconson	low steam velocities		high steam velocities	
	UCB-Kuhn	X			
Steam Generator Hydraulics	FLECHT-SEASET Steam Generator Separate Effects		X		
	MB-2		X		

Overall Results of the Assessments

Separate Effects – Critical Flow

V5.0 Patch 3

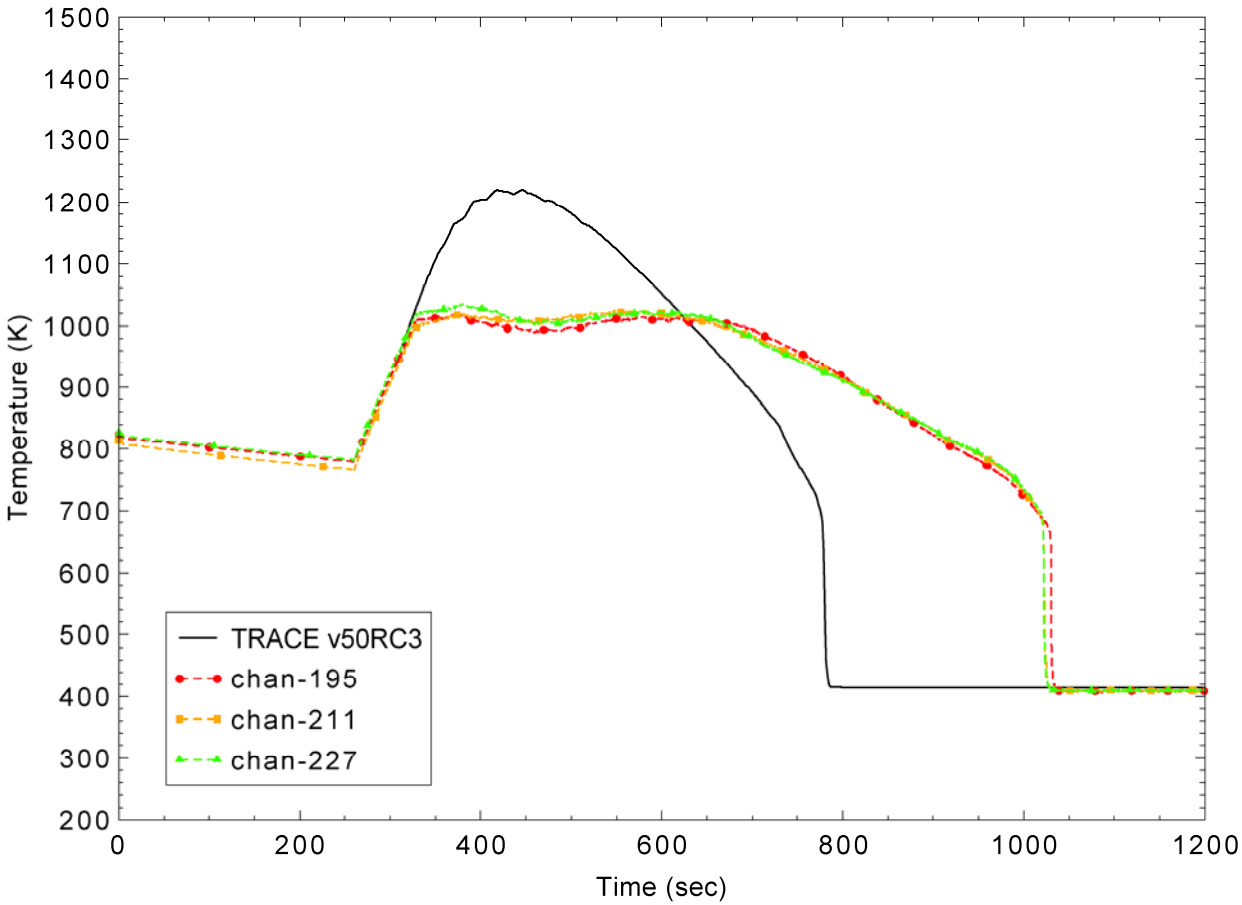


Overall Results of the Assessments

Separate Effects – Reflood Heat Transfer

V5.0 Patch 3

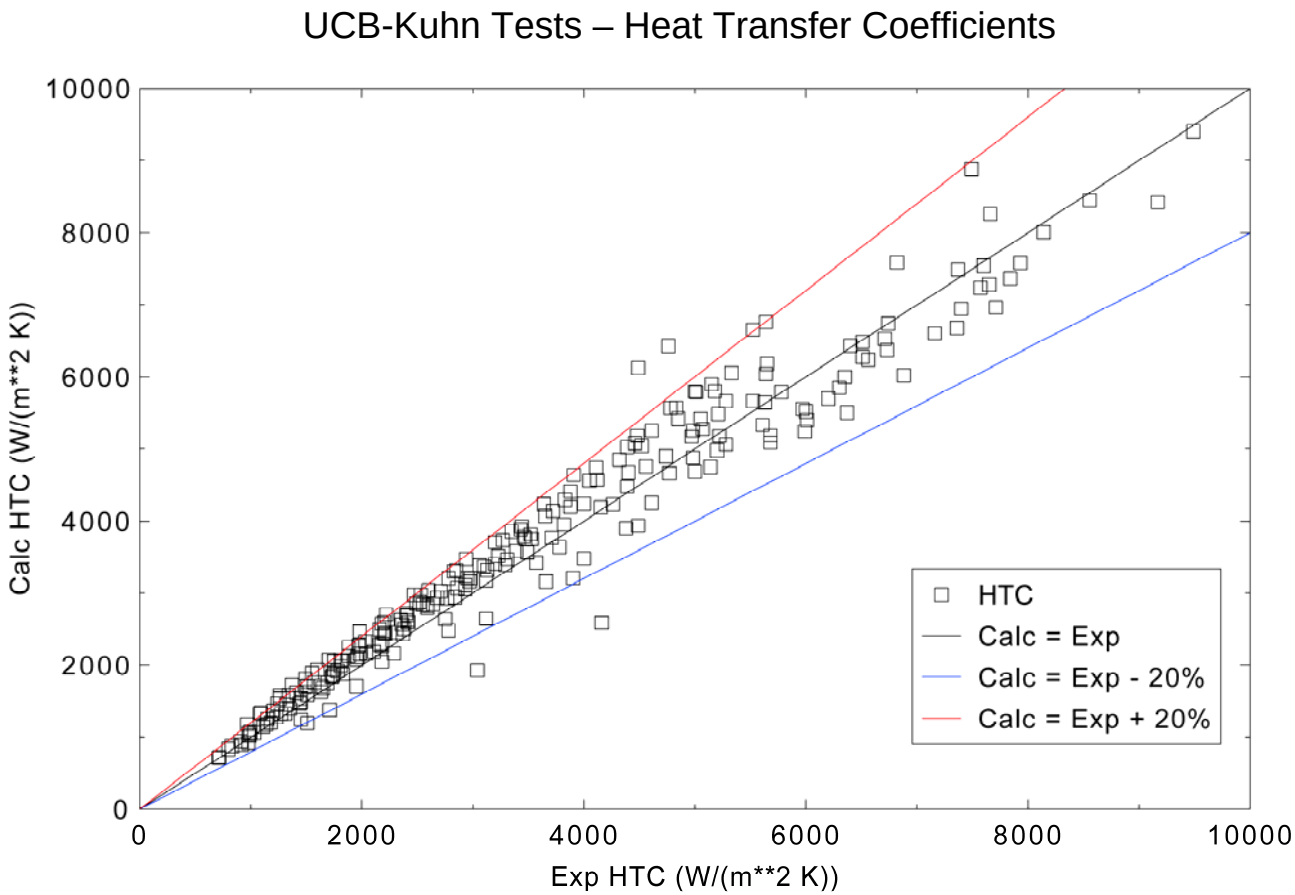
RBHT Reflood Test 1383 – Rod Surface Temperature @ 0.93 m



Overall Results of the Assessments

Separate Effects – Condensation

V5.0 Patch 3



Overall Results of the Assessments

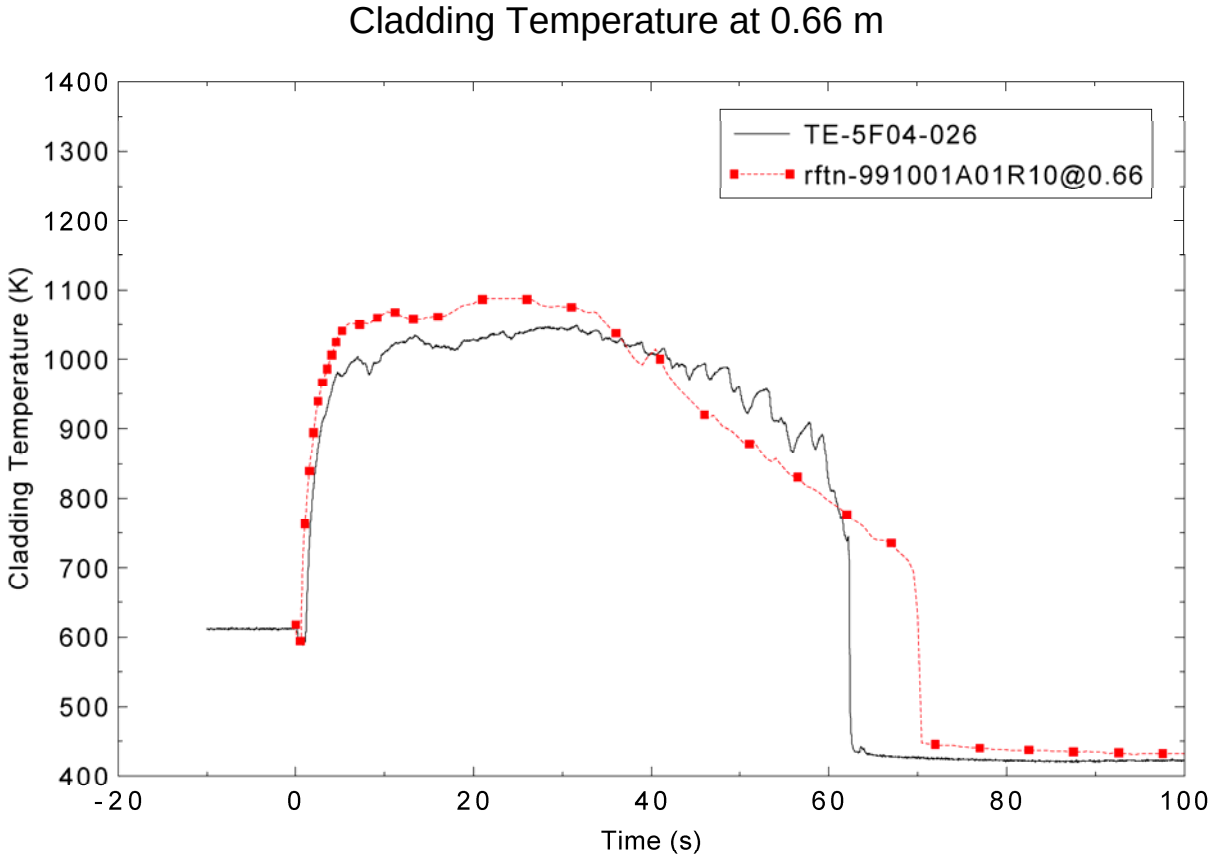
Integral Effects – Models and Correlations working in Concert

Experiment	Excellent	Reasonable	Minimal	Insufficient
LOFT Test L2-5 – Large Break		X		
CCTF Run 62 – Large Break		X - overall	upper core PCT	
SCTF Run 604 – Large Break		X - overall	upper core PCT	
BETHSY Test 6.2TC – Small Break		X		
ROSA-IV Test SB-CL-18 – Small Break		X		
FIST Test 6SB2C – Small Break (BWR)		X		
TLTA Test 6425 Run 2 – Large Break (BWR)		X		

Overall Results of the Assessments

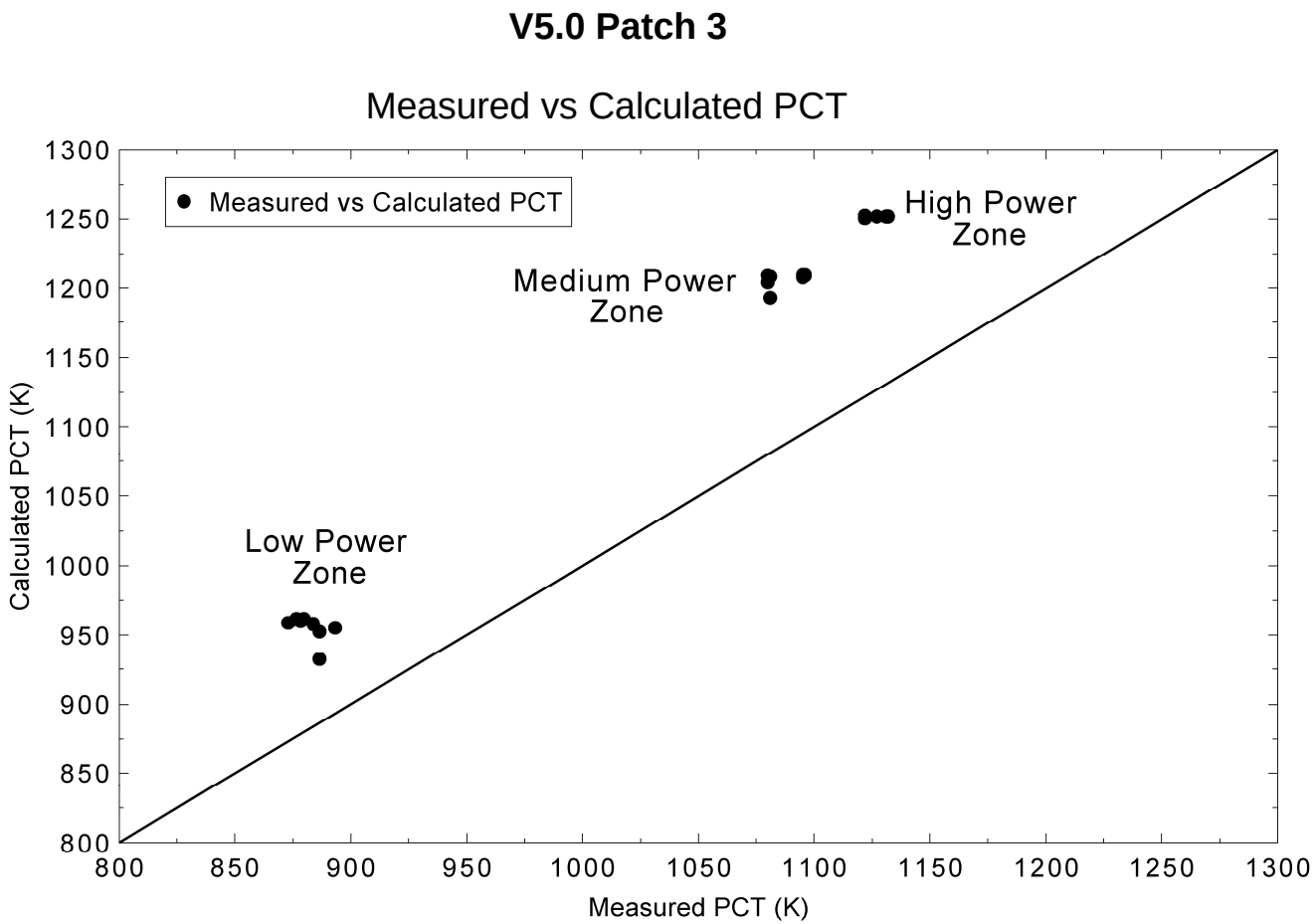
Integral Effects – LOFT L2-5 Large Break

V5.0 Patch 3



Overall Results of the Assessments

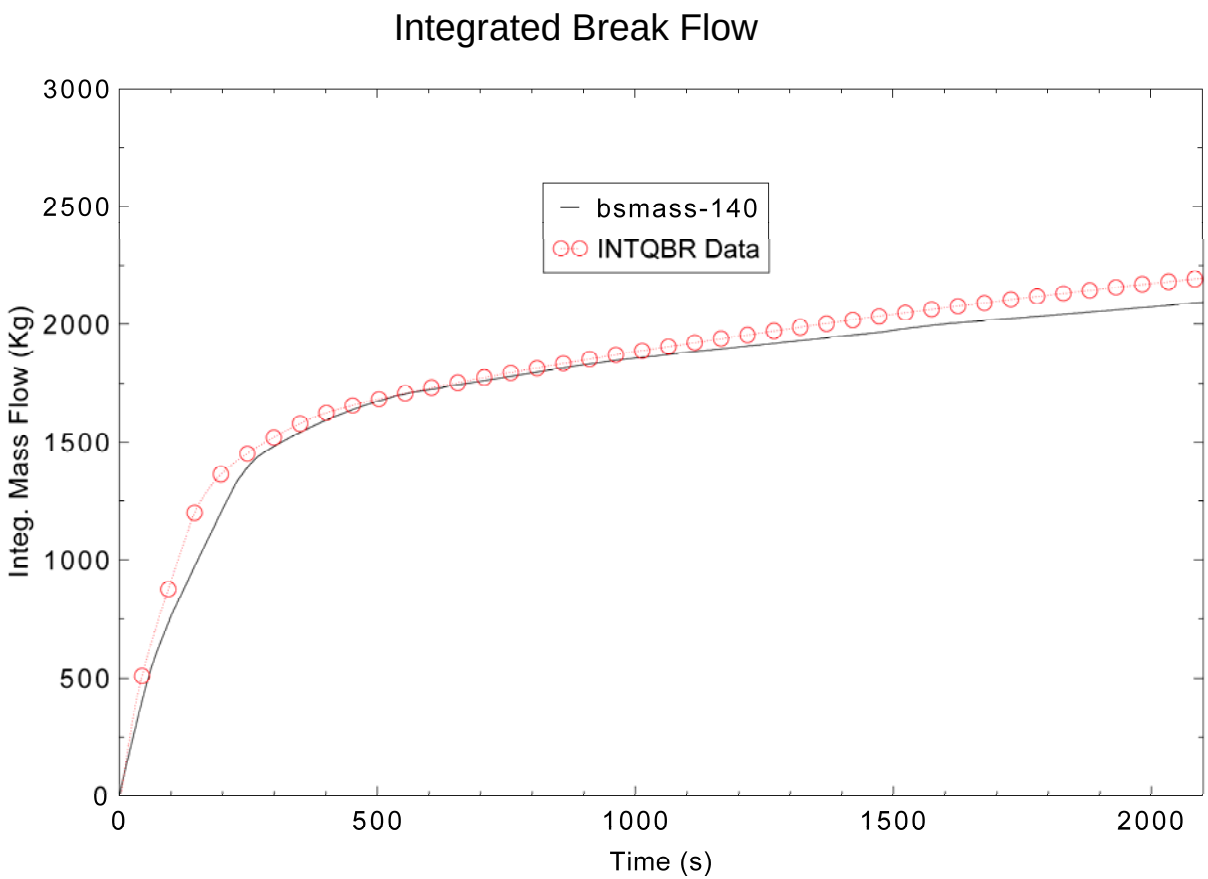
Integral Effects – CCTF Run 62 – Large Break



Overall Results of the Assessments

Integral Effects – BETHSY Test 6.2TC – Small Break

V5.0 Patch 3

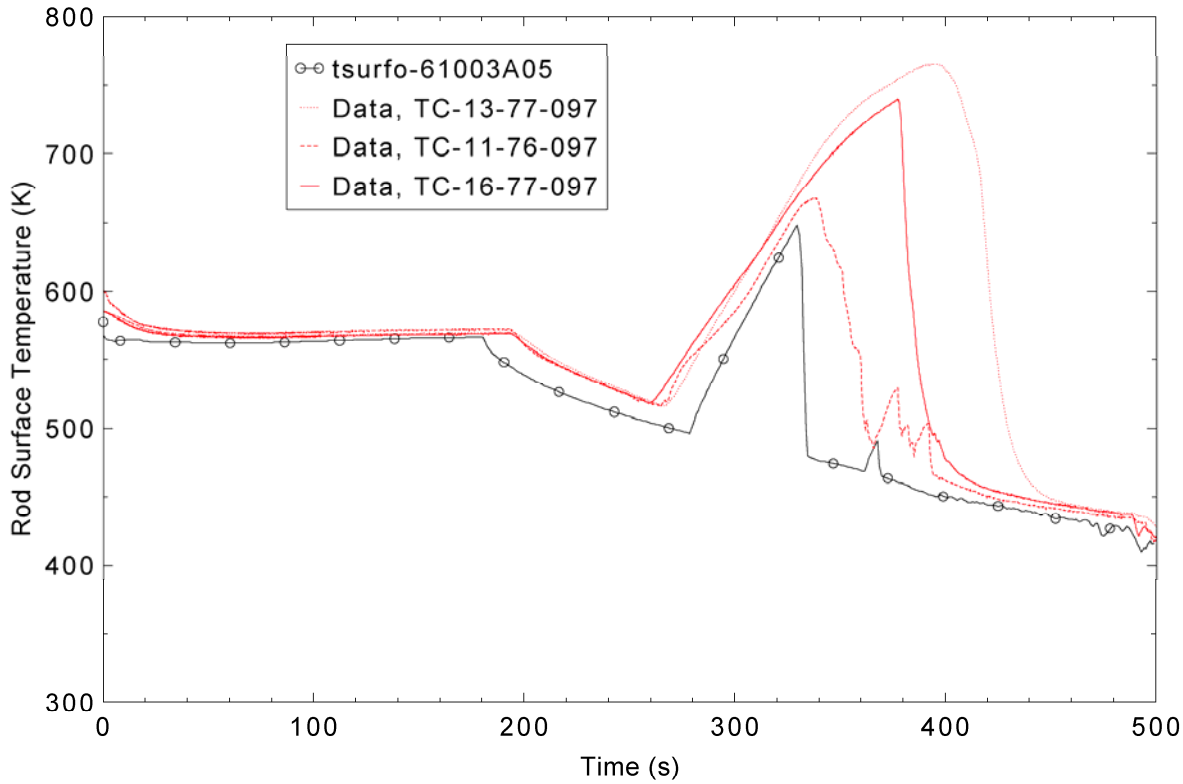


Overall Results of the Assessments

Integral Effects – FIST Test 6SB2C – BWR Small Break

V5.0 Patch 3

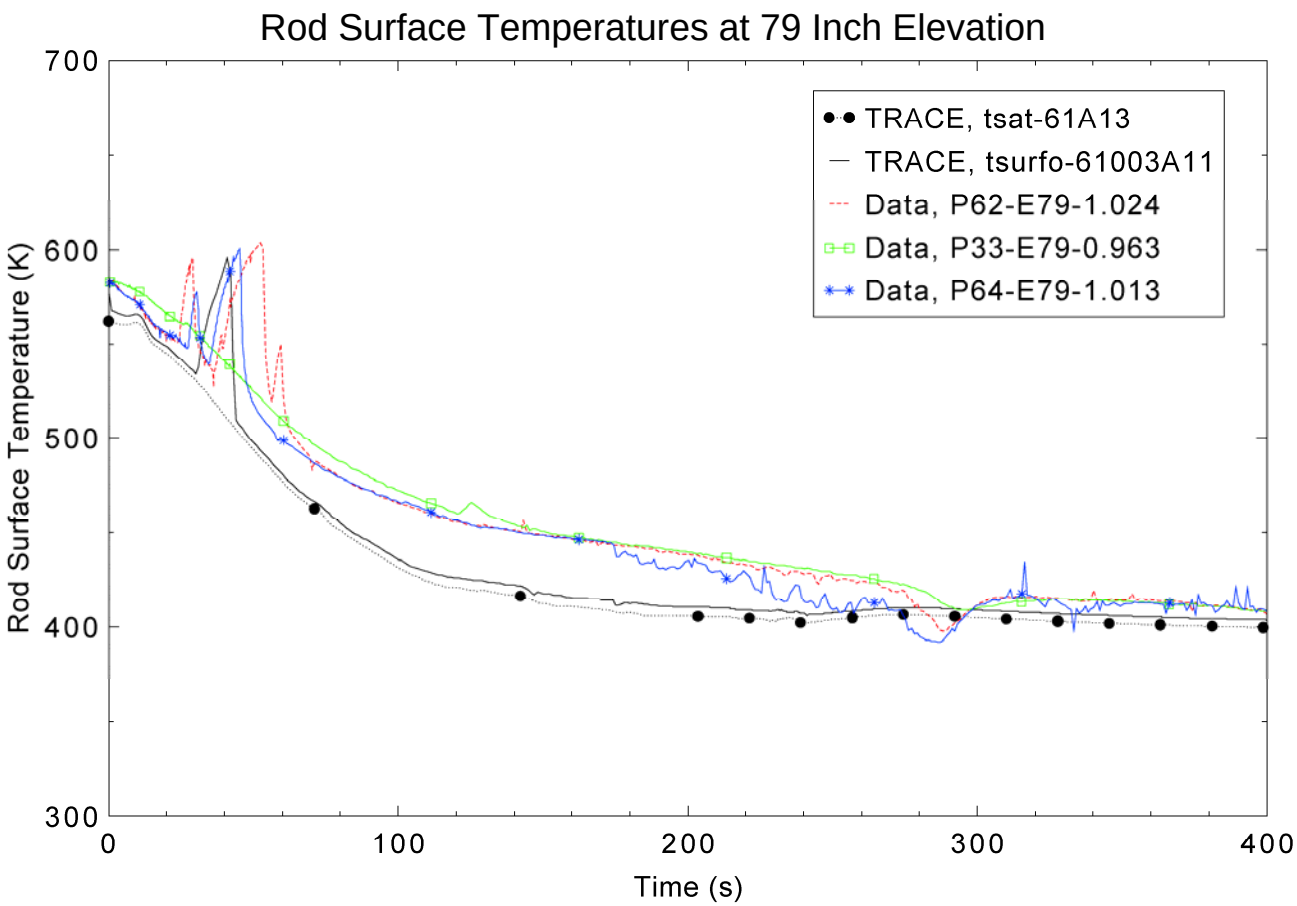
Rod Surface Temperatures at 97 Inch Elevation



Overall Results of the Assessments

Integral Effects – TLTA Test 6425 Run 2 – BWR Large Break

V5.0 Patch 3



Developmental Assessment Conclusions

TRACE Version 5.0 has undergone a thorough assessment and validation process to determine code accuracy and identify potential deficiencies.

- **In general, comparisons between code predictions and experimental results are found to be reasonable**
- **Major deficiencies are centered around PCTs in the upper core regions. These deficiencies are associated with droplet breakup due to spacer grid models and local convective enhancement. These deficiencies are being addressed.**
- **Based on the developmental assessment, TRACE can be used reliably for large and small break LOCA in conventional light water reactors**
- **Users should be aware of the problems observed in the assessments in order to assist in making conclusions based on plant analyses using TRACE**
- **TRACE can be used for some new and advanced plants. The basis for use of TRACE with those plants depends not only on the developmental assessments but also on tests specifically for those advanced plants**
- **The full developmental assessment manual and addendums can be obtained through the United States Nuclear Regulatory Commission**

Questions?

Any questions before moving on to the next segment?