Phenomena Review

OBJECTIVE

Each of the phenomena that play a significant role in predicting Peak Cladding Temperature (PCT) for an LBLOCA event have a specific set of dependencies that are necessary to calculate in order to get a realistic prediction of the phenomena. Often the dependencies can be reduced to a few key parameters, and a few system parameters impact many of the phenomena.

Much of the steady state focuses on achieving target flow rates, pressure losses, and thermodynamic conditions in the system. These particular values can have a large effect on the overall LOCA behavior. The objective of this exercise is to review the BWR PIRT[1] phenomena that is expected to have a high impact on Peak Cladding Temperature (PCT which is the Figure of Merit for the LBLOCA event) and consider how these phenomena are impacted by the steady state parameters listed below:

- Liquid or Vapor Flow Rates (Core Mass Flow, Steam flow)
- Flow Resistances (K losses or wall friction)
- Thermodynamic Properties (Temperature, Pressure, Void Fraction)

The example model does not necessarily model all of the important phenomena adequately. As you continue to make changes to the model, try to identify phenomena listed below that may not be adequately represented in the model. Note your concerns in the **Other** column.

As you go through the list, you might also note other model parameters that have a strong influence on a particular phenomena, and that you need to include in order to get a realistic prediction of the phenomena.

1 "BWR PIRT and Assessment Matrices for BWR LOCA and NON-LOCA Events" by M. Straka and L. W. Ward, SCIE-NRC-393-99, Contract NRC-04-96-060 Task 002, BWR_PIRT.pdf (on workshop CD)

INSTRUCTIONS

Review through the PIRT phenomena list below by component. For reference, the ranking (H)igh, (M)edium, (L)ow, or zero (0) is indicated for the three phases (B)lowdown / (R)eflood / (L)ong term cooling. Rankings which differ in the different plant types are shown in ***red italics***.

1. For each of the phenomenon place a check mark to indicate whether the phenomenon directly depends the flow:
   - Liquid or Vapor Flow Rates: $\dot{M}$
   - Flow Resistances: K
   - Local Thermodynamic Properties: TP
2. Identify some of the other primary model parameters that need to be modeled correctly in order to get a realistic prediction of the given phenomenon. You might list one or two in 'Other'. If there are things you can quickly check in the model, try to determine whether there are deficiencies that might lead you to suspect that a specific phenomenon is not adequately represented in the model. Circle phenomena that you have reason to believe is not modeled adequately.

CORE PHENOMENA

Phenomena	B/R/L	$\dot{M}$ /K/TP	Other
Boiling: film	H/H/H	☐/☐/☐	
Boiling: nucleate	L/L/H	☐/☐/☐	
CCFL: Core exit	L/H/L	☐/☐/☐	
CCFL: Core Inlet	***H***/***H***/0	☐/☐/☐	
Channel-bypass %	H/H/L	☐/☐/☐	

Phenomena	B/R/L	$\dot{M}$ /K/TP	Other
Cooling: steam flow	***M***/***H***/0	☐/☐/☐	
Dry-out	H/H/L	☐/☐/☐	
Flow: coastdown	H/0/0	☐/☐/☐	
Flow: natural circ.	L/H/H	☐/☐/☐	
Heat: Decay	H/H/H	☐/☐/☐	
Heat stored: fuel	H/L/L	☐/☐/☐	
Heat stored: metal	L/H/L	☐/☐/☐	
Heat transfer: fuel-clad gap	H/M/L	☐/☐/☐	
Heat transfer: radiation	L/***H***/0	☐/☐/☐	
Interphase Shear	H/H/L	☐/☐/☐	
Power Dist.: radial	M/H/L	☐/☐/☐	
Pressure Drop	H/M/L	☐/☐/☐	
Rewet: blowdown	H/0/0	☐/☐/☐	
Rewet: reflood	L/H/L	☐/☐/☐	
Rewet: spray	***M***/H/H	☐/☐/☐	
Void Distribution	H/H/M	☐/☐/☐	
2-Phase Level	L/H/H	☐/☐/☐	

Bypass

Phenomena	B/R/L	$\dot{M}$ /K/TP	Other
CCFL (Top)	H/H/0	☐/☐/☐	
Condensation: ECC water	L/***H***/L	☐/☐/☐	
Flashing	***H***/M/L	☐/☐/☐	
Heat stored: metal	M/***H***/L	☐/☐/☐	
2-phase level	L/H/H	☐/☐/☐	

Lower Plenum

Phenomena	B/R/L	$\dot{M}$ /K/TP	Other
Condensation: ECC water	L/***H***/L	☐/☐/☐	
Flashing	H/M/L	☐/☐/☐	
Flow Distribution	***H***/***M***/***L***	☐/☐/☐	
Heat stored: metal	L/H/L	☐/☐/☐	
Interphase shear	H/***H***/L	☐/☐/☐	
Void distribution	H/***H***/L	☐/☐/☐	
Jet Pump exit uncovery	***H***/***M***/***L***	☐/☐/☐	
Core inlet uncovery	***H***/***H***/L	☐/☐/☐	

Downcomer

Phenomena	B/R/L	$\dot{M}$ /K/TP	Other
Downcomer	***H***/M/L	☐/☐/☐	
Flashing	H/L/L	☐/☐/☐	
Interphase shear	H/H/L	☐/☐/☐	
Void distribution	H/***H***/L	☐/☐/☐	
HPCI sparger uncovery	***H***/***H***/***H***	☐/☐/☐	
Jet pump inlet uncovery	***H***/***L***/***L***	☐/☐/☐	
RCL suction uncovery	H/L/L	☐/☐/☐	

Guide Tubes

Phenomena	B/R/L	$\dot{M}$ /K/TP	Other
Condensation: ECC water	L/***H***/L	☐/☐/☐	

Upper Plenum

Phenomena	B/R/L	$\dot{M}$ /K/TP	Other
Condensation: ECC water	***H***/H/H	☐/☐/☐	
Pressure Drop	H/M/M	☐/☐/☐	
Spray distribution	***H***/***H***/***H***	☐/☐/☐	
Void distribution	***H***/H/H	☐/☐/☐	
2-phase level	***H***/H/H	☐/☐/☐	

Phenomena	B/R/L	Ṁ /K/TP	Other
3-D T/H effect	***H***/H/H	☐/☐/☐	

Separators

Phenomena	B/R/L	Ṁ /K/TP	Other
Pressure Drop	H/L/L	☐/☐/☐	

Jet Pumps

Phenomena	B/R/L	Ṁ /K/TP	Other
Condensation: ECC water	L/***H***/***H***	☐/☐/☐	
Flow: critical	***H***/L/L	☐/☐/☐	
Flow: forward	***H***/L/L	☐/☐/☐	
Flow: reverse	***H***/L/L	☐/☐/☐	

Recirculation Pumps

Phenomena	B/R/L	Ṁ /K/TP	Other
Coastdown	H/0/0	☐/☐/☐	

Recirculation Line

Phenomena	B/R/L	Ṁ /K/TP	Other
Flow: critical (break)	H/M/L	☐/☐/☐	
Flashing	H/L/L	☐/☐/☐	