PDR

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January 12, 1988
ESC-027

To: Technical Advisory Group

Subject: TAG Meeting Minutes

Gentlemen:

Attached are the minutes from the November 17, 1987 TAG meeting held in Charlotte, North Carolina. Comments have been incorporated and these minutes now constitute the official record of TAG Meeting #2.

Very truly yours,

J. R. Paljug
Project Manager
Owners Group Engineering Services

JRP/vtw

Attachment

cc: TAG Members

R. A. Dieterich - SMUD
Richard Lee - NRC
Jean-Pierre Sursock - EPRI

B&WOG TAG Subcommittee

S. Nesbit - DPC
C. Turk - AP&L
L. Lanese - GPU

DF02
1/1

Technical Advisory Group
TAG Meeting #2
Meeting Minutes
November 17, 1987
Charlotte, N.C.

The second meeting of the Technical Advisory Group (TAG) was held at the Duke Power Company offices in Charlotte, NC on November 17, 1987. All TAG members were present including support personnel as listed on Attachment #1. The meeting minutes from the October meeting were reviewed and comments incorporated for the record.

The primary purpose of this meeting was to discuss the various lists prepared by the members, consolidation ideas for the list items, and selection criteria for list reduction.

In response to the action item from the last meeting, all TAG members prepared lists of conditions and phenomena relating to the OTSG and AFW issues to be addressed by the TAG process. The members were requested to provide a brief discussion of their individual lists as a lead-in to the group consolidation effort. Four list were discussed, and are included to these notes as attachments.

B&WOG/B&W List (Attachment #2) - Marty Parece and Joe Paljug provided the information for this list. The first column includes events and items of concern. For instance, AFW Criteria is not an event, but is an item that should be considered in the TAG process. The second column includes issues and phenomena. Concerning AFW Criteria, wetting and penetration might be considered phenomena, whereas the effects of degraded and plugged tubes is more an issue. However, both wetting and tube degradation effects need to be considered for the AFW Criteria item.

B&WOG/EPRI List (Attachment #3) - Lou Lanese and Jean-Pierre Sursock explained the approach taken to produce this list of phenomena. The RELAP5/MOD2 code equation set was used to provide the source terms within the conservation equations. Next, the constitutive relations and models defined by the source terms were determined leading to the list of associated phenomena. This particular approach is not dependant on specific events and should cover a broad range of issues, including multiple component system effects. Attachment #3 includes definition of nomenclature and information provided by both Lou and Jean-Pierre.

B&WOG/DPCo List (Attachment #4) - The list was provided by Steve Nesbit of DPCo. The groundrules considered were; what conditions are the SG's operated within, what systems/boundary conditions are important, what can go wrong, what are reasonable states, and what are the effects on heat transfer, levels, etc. The information provided in this list covers a wide range of thermal-hydraulic conditions that might exist in the OTSG. The ranges for pressure, temperature, flow, etc. are based on engineering and operational experience, not Tech Spec or FSAR conservative limits or assumptions.

NRC/EG&G List (Attachment #5) - Keith Condie presented the NRC list. The list consisted of two matrices, one that related transients to OTSG states/conditions, and another that related the OTSG states/conditions to phenomena. The transients listed were basically those previously evaluated by EG&G for PTS concerns. The OTSG states included both primary and secondary side conditions. The group recommended that this category would best be renamed "OTSG processes" which would better relate to transients. The phenomena list was very comprehensive and a good starting point for the group consolidation effort.

During the list presentations various associated items were discussed. Warren Lyon inquired as to the relative importance of compound events (ie SGTR as a result of an overpressure transient), low pressure accidents, non-condensible gas effects, etc. The group is informed of these issues but doesn't necessarily feel the need to incorporate an all encompassing event list in this process. Steve Nesbit and Charles Turk responded that the most benefit for industry would come from consideration of safety, licensing and design basis type events.

The "inter-tube" circulation item brought some interest. The description is flow from cold SG tubes into hot SG tubes through the upper and lower SG plenums. This process has not been seen in MIST, but has been predicted by codes. The general opinion was that as long as a pool has been established, the necessary density gradient will not exist, and this process will not occur.

After the list presentations, the discussion centered on possible methods for combining the information into a usable form. The group unanimously agreed to adopt the matrix format used in the NRC/EG&G list. Three lists are necessary for this format; transients, processes and phenomena. Each member is to prepare their lists under those headings for the next meeting. It was suggested (Warren Lyon) to use PRA experience to help develop the lists. But the PRA process is not heavily involved in thermal hydraulics. However, probability could play a part in the selection criteria (addressed later).

Much time was denoted to the different ideas presented for the definitions. The following definitions were written down, but there was no consensus opinion, or agreement.

Phenomena	- Observation that requires a model (i.e. mass transfer, heat transfer).
Process	- A change from one state to another.
Property	- Can be measured or derived from measured quantities.
State/ Condition	- Function of Properties.
Constitutive Relation	- Model needed to represent phenomena in computer code.

Each member is to prepare a list of definitions for the next meeting. There did appear to be agreement on the hierarchy where transients are made up of processes which include phenomena.

At this point, a listing of transients began. The NRC/EG&G list was used as a starting point. Additions included; steady state power operation, low power events, SGTR from ICC, Reactor trip and MFW overfeed. It was decided that recovery procedures, which are a separate item in the NRC/EG&G list, should be included within the transient itself. There was no consensus opinion for ATWS, so it was left on the list. To help with the efficiency of this process, Lou Lanese suggested that the ATOG be used to define transients. The group was not too clear on this, but agreed that ATOG could be used as a check later on. John Klingenfus presented an idea on how to combine all three lists (transients, processes and phenomena) on one matrix. More discussion ensued on the process to follow and what definitions applied.

At Bob Dieterich's suggestion to move on, the discussion ended with the group agreeing to pursue the original thought of producing three lists (transients, processes, phenomena) along with their individual definition for the terms. Then, in a unified effort, the group could determine what processes make up the transients, and what phenomena make up the processes (two matrices).

Action: All members provide the three subject lists of transients, processes and phenomena to Joe Paljug by 12/2/87. B&W to attempt the consolidation of all lists, and distribute to members before next meeting. Lists are to include definition of terms.

The balance of the meeting was used to discuss selection criteria. Certain ideas were brought out, including; existing data base consideration, probability of occurrence, consequence, and sensitivity and risk. Hal Ornstein suggested three criteria that captured those thoughts, which were discussed by the group as follows:

Selection Criteria

- Uncertainty of phenomena and our ability to model (considering existing data base).

- Effect of phenomena on consequence, risk, etc.

- Sensitivity of analytical results to uncertainty of model.

The remaining discussion related to selection criteria and the application of "weighting factors" to each item. This was of some interest and the group elected to discuss it further at the next meeting.

Action: The members are to review the selection criteria and determine weighting factors for each item for discussion at the next meeting.

As a side note, some confusion arose as regards the terms "analytical methods" and "analysis needs" within the TAG Charter Objective and Scope. In clarification, a primary function of the TAG is not to determine the suitability of code models, but rather to focus on data needs for those phenomena determined to be important to transient analysis. The flavor of the "analysis" terms used in the Charter was to indicate that it may be possible to assess the importance of phenomena through analysis and sensitivity studies. Future Charter clarification may be necessary.

The next TAG meeting will be for two days, December 15 & 16, 1987 at the EPRI offices in Palo Alto, California. Jean-Pierre Sursock will be host and provide information on meeting location, hotel reservations, etc. in the near future. Agenda items will include; selection criteria, weighting factors, transient/process/phenomena list consolidation, and final report outline.

ATTACHMENT #1

TAG Meeting 2 - November 17, 1987

Name	Company	Telephone Number
Joe Paljug	B&W	804-385-3674
Bob Dieterich	SMUD	209-333-2935, x4008
Dennis Blakely	TED	419-249-5000, x4429
Steve Nesbit	DPCo	704-373-8197
Charles Turk	AP&L	501-377-5931
John Klingenfus	B&W	804-385-3294
Martin Parece	B&W	804-385-2183
Paul Guill	DPCo	704-373-2844
Tom Moskal	B&W	216-821-9110
T. K. Larson	INEL	208-526-9683
Thad Knight	LANL	505-667-3113
Jim Wolf	INEL	208-526-9768
Keith Condie	INEL	208-526-9383
Richard Lee	NRC	301-443-7915
Louis Shotkin	NRC	301-443-7825
Lou Lanese	GPUN	201-316-7127
Jean-Pierre Sursock	EPRI	415-855-2410
Warr n Lyon	NRC	301-492-7000
Hal Ornstein	AEOD	

ATTACHMENT #2

B&WOG/B&W List

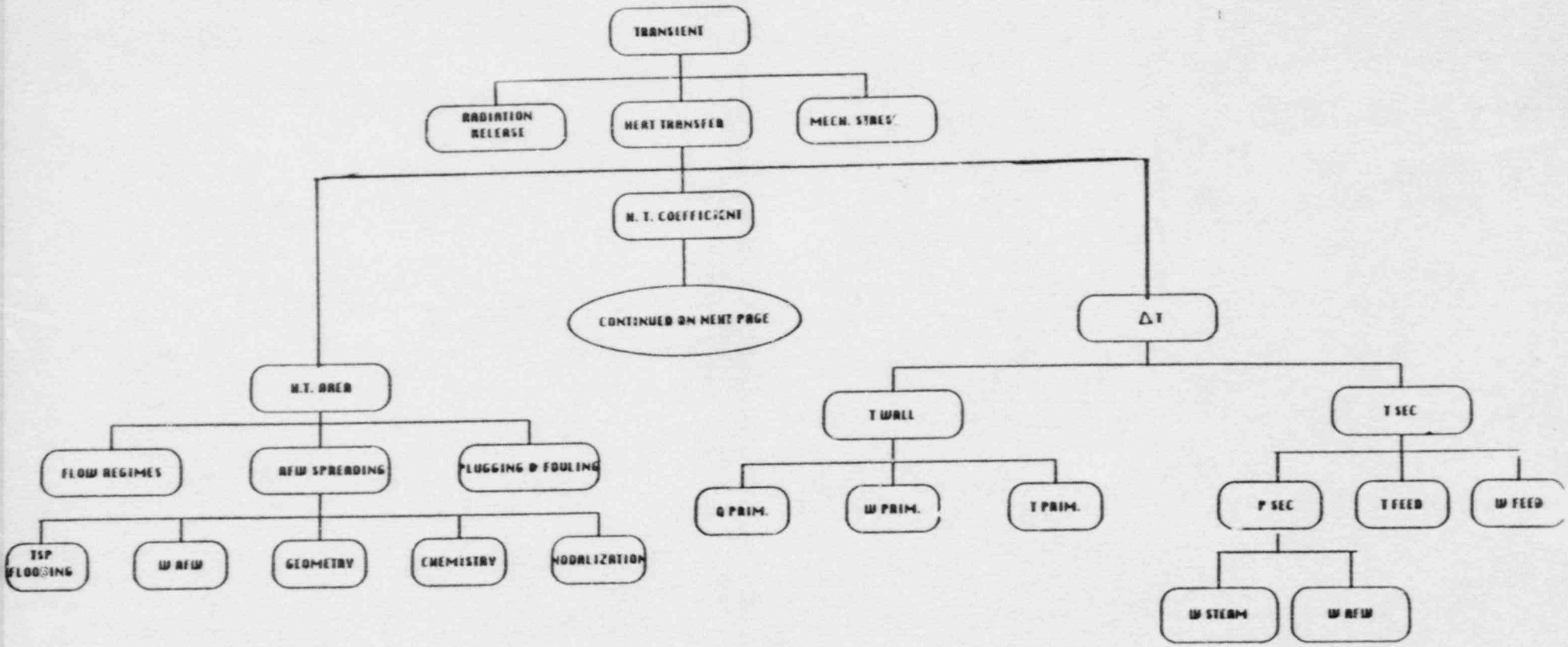
Event/Item	Issue/Phenomena
AFW Criteria	AFW wetting/penetration including degraded and plugged tubes.
SLB/Steam Flow	AFW Carryover/PTS
	Liquid Entrainment (Pool)
	Liquid Holdup (SG Spatial Variations)
	SG Heat Transfer (Level Swell)
Full Power Operation	Tube plugging effects. Local SG effects.
Station Blackout	AFW heat transfer, flow, spreading.
SG Refill (Dry, Depress.)	Interphase drag, direct contact heat transfer, film behavior on tubes, AFW heat transfer.
ICC	SG refill.
Over/Undercooling	PT Limits
	SG Heat Transfer, interphase drag, aspirator behavior, AFW carryover, dynamic boiling length.
SGTR	AFW wetting, carryover.
	SG decontamination factor, Leak carryout.
Natural Circulation	AFW wetting, heat transfer, Pool height.
SG Overfeed	Aspirator Behavior
	SG Heat Transfer
	Saturated Operation

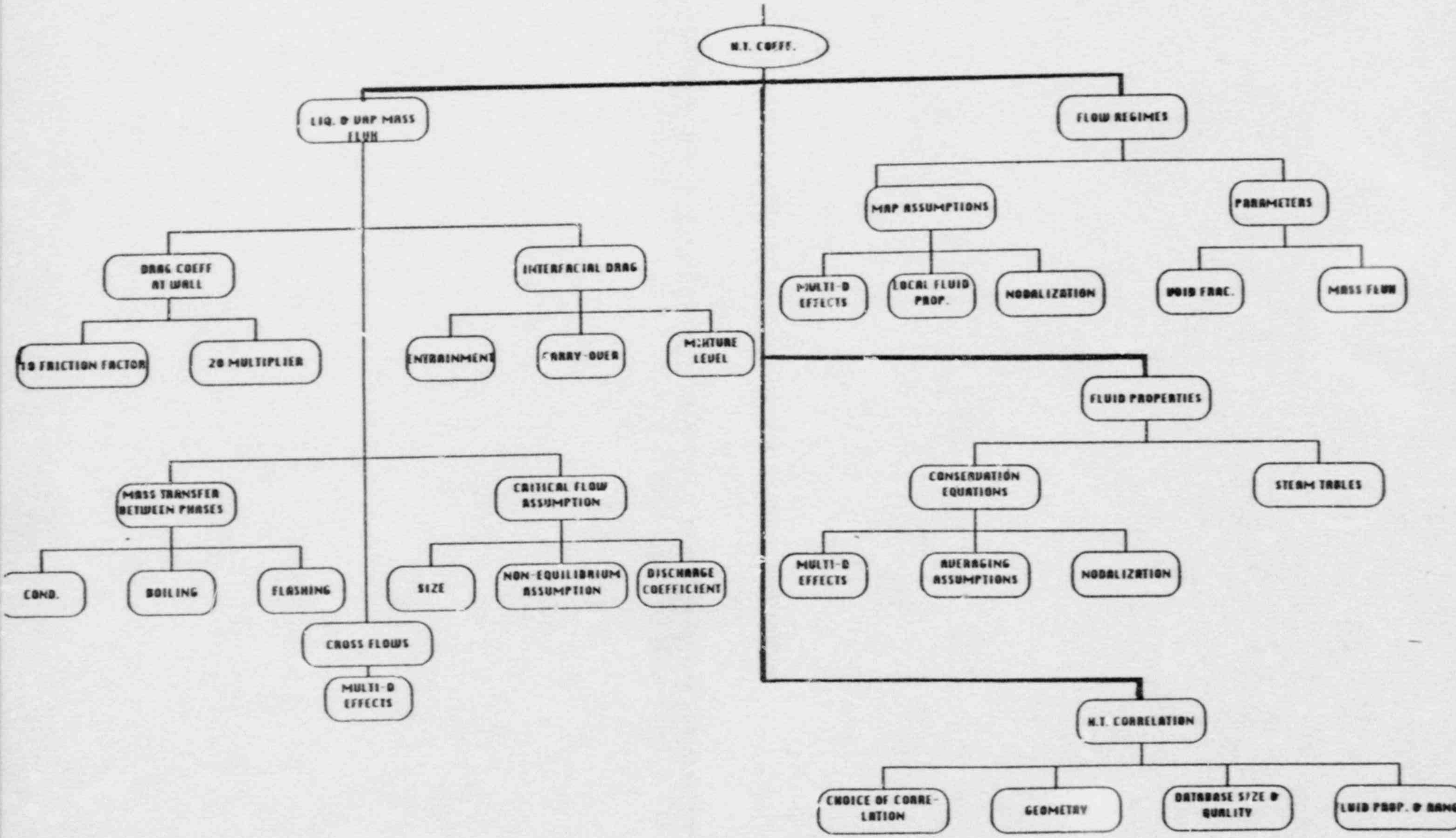
Attachment #3
B&WOG/EPRI List

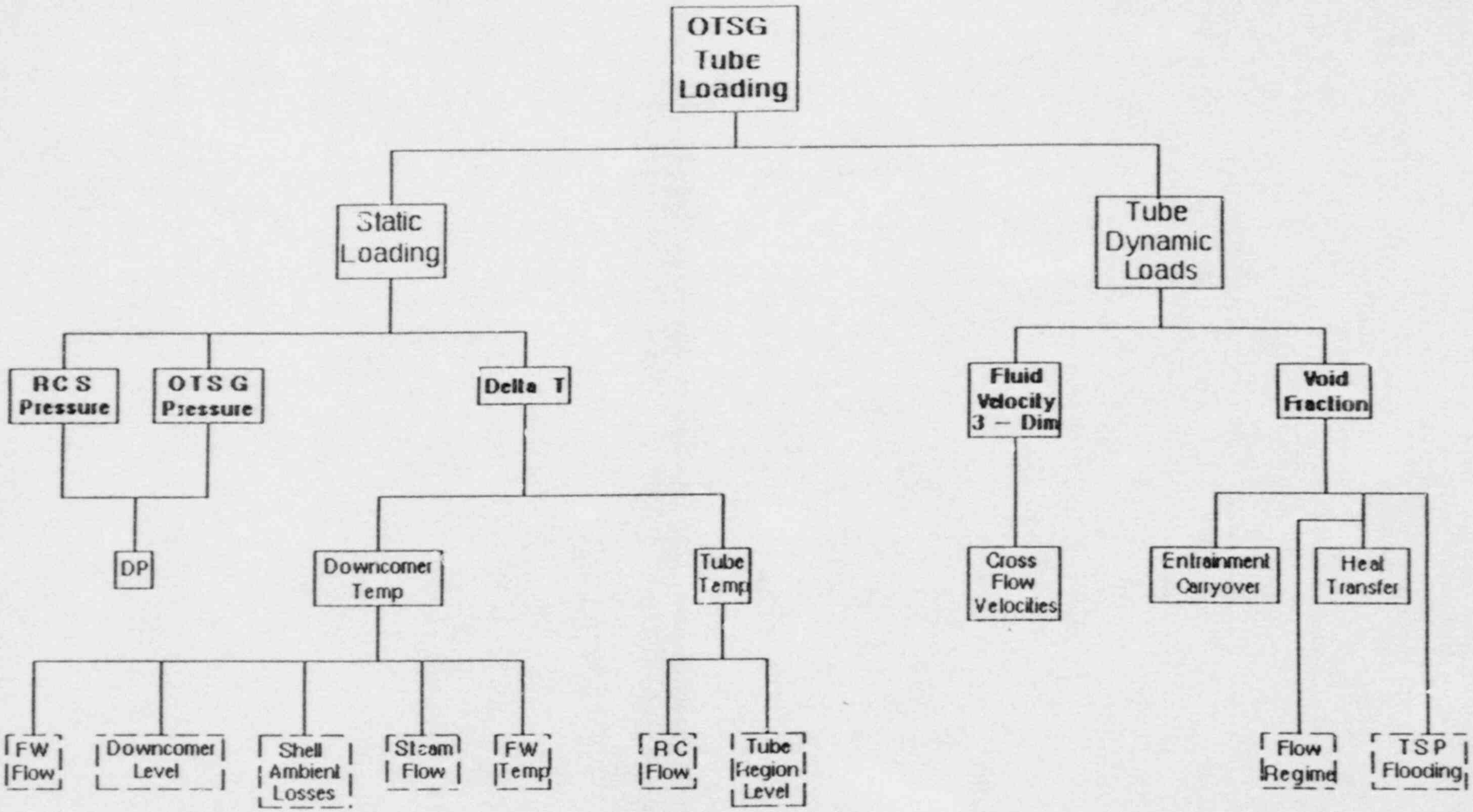
Phenomena	Constituitive Relations and Models Affected by Phenomena	Source/Sink Term in Conservation Equations
Entrainment Carry-Over Mixture Level	Interphase drag	FI
Non-Equilibrium Thermodynamics Condensation Boiling	Volumetric mass transfer between phases	Gamma I
Flashing	Radiation transport	PF
Critical Flow	Discharge coefficient	C
Non-Equilibrium	Critical Flow Model	WCRIT
Cross-Flow	Multi-dimensional approximations of conservation equations Flow regimes Nodalization Averaging of conservation equations	
Geometry	Choice of heat transfer correlation	HW HI
	Energy dissipation	EI
	Averaging of conservation equations	
Tube Support Plate Flooding	Heat transfer area calculation	A
Geometry	Nodalization	
Chemistry		
AFW Spreading	Radiation Transport	PF
Fouling		
Plugging		

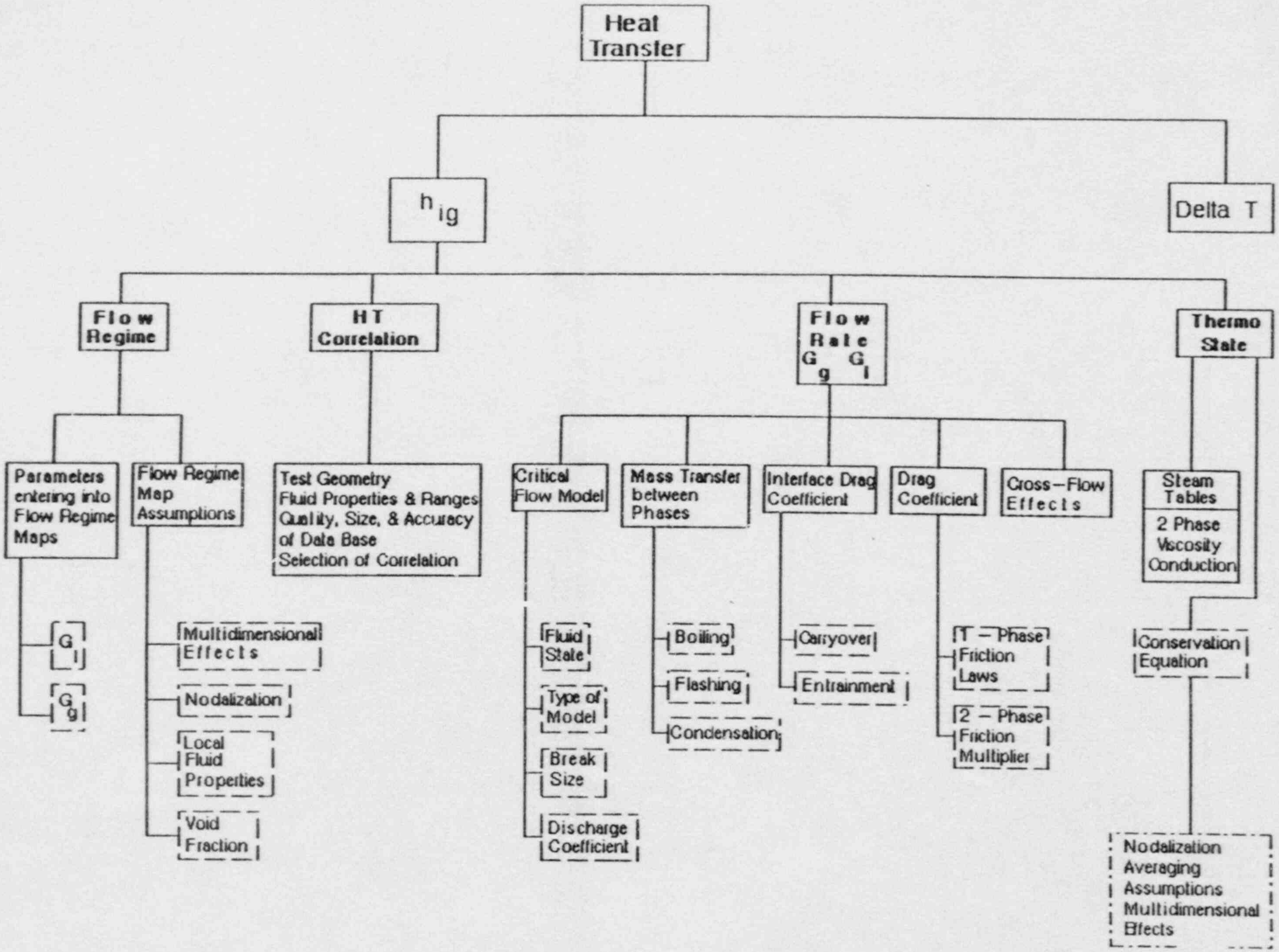
NOMENCLATURE

FI	-	Interphase drag coefficient
Gamma I	-	Interphase mass transfer
PF	-	Iodine partition factor
C	-	Discharge coefficient
WCRIT	-	Critical flow rate
HW	-	Wall heat transfer coefficient
HI	-	Interphase heat transfer coefficient
EI	-	Energy dissipation
A	-	Heat transfer area
HI	-	Interphase heat transfer coefficient

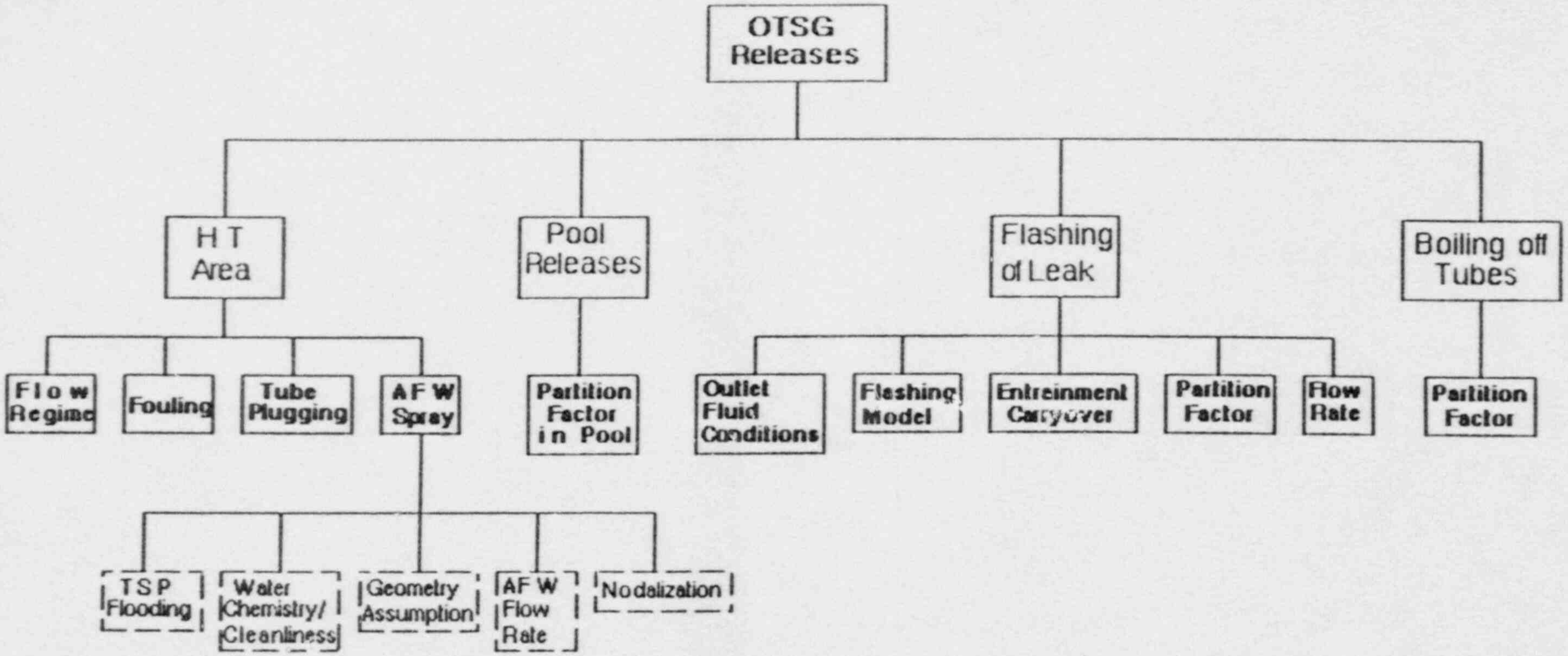

TRANSIENT
RADIATION RELEASE
HEAT TRANSFER
MECH. STRESS
H. T. COEFFICIENT
CONTINUED ON NEXT PAGE
H.T. AREA
FLOW REGIMES
AFW SPREADING
PLUGGING & FOULING
TSP FLOODING
W AFW
GEOMETRY
CHEMISTRY
NODALIZATION
ΔT
T WALL
Q PRIM.
W PRIM.
T PRIM.
T SEC
P SEC
T FEED
W FEED
W STEAM
W AFW


H.T. COEFF.
LIQ. & VAP MASS FLUX
DRAG COEFF AT WALL
1D FRICTION FACTOR
2D MULTIPLIER
INTERFACIAL DRAG
ENTRAINMENT
CARRY-OVER
MIXTURE LEVEL
MASS TRANSFER BETWEEN PHASES
COND.
BOILING
FLASHING
CRITICAL FLOW ASSUMPTION
SIZE
NON-EQUILIBRIUM ASSUMPTION
DISCHARGE COEFFICIENT
CROSS FLOWS
MULTI-D EFFECTS
FLOW REGIMES
MAP ASSUMPTIONS
MULTI-D EFFECTS
LOCAL FLUID PROP.
NODALIZATION
PARAMETERS
VOID FRAC.
MASS FLUX
FLUID PROPERTIES
CONSERVATION EQUATIONS
MULTI-D EFFECTS
AVERAGING ASSUMPTIONS
NODALIZATION
STEAM TABLES
H.T. CORRELATION
CHOICE OF CORRE-LATION
GEOMETRY
DATABASE SIZE & QUALITY
FLUID PROP. & RANGE


OTSG Tube Loading
Static Loading
Tube Dynamic Loads
RCS Pressure
OTSG Pressure
Delta T
Fluid Velocity 3 – Dim
Void Fraction
DP
Downcomer Temp
Tube Temp
Cross Flow Velocities
Entrainment Carryover
Heat Transfer
FW Flow
Downcomer Level
Shell Ambient Losses
Steam Flow
FW Temp
RC Flow
Tube Region Level
Flow Regime
TSP Flooding



Heat Transfer
h ig
Delta T
Flow Regime
HT Correlation
Flow Rate G g G l
Thermo State
Parameters entering into Flow Regime Maps
Flow Regime Map Assumptions
Test Geometry
Fluid Properties & Ranges
Quality, Size, & Accuracy of Data Base
Selection of Correlation
Critical Flow Model
Mass Transfer between Phases
Interface Drag Coefficient
Drag Coefficient
Cross-Flow Effects
Steam Tables
2 Phase Viscosity Conduction
G l
G g
Multidimensional Effects
Nodalization
Local Fluid Properties
Void Fraction
Fluid State
Type of Model
Break Size
Discharge Coefficient
Boiling
Flashing
Condensation
Carryover
Entrainment
1 - Phase Friction Laws
2 - Phase Friction Multiplier
Conservation Equation
Nodalization
Averaging
Assumptions
Multidimensional Effects


OTSG Releases
H T Area
Pool Releases
Flashing of Leak
Boiling off Tubes
Flow Regime
Fouling
Tube Plugging
AF W Spray
Partition Factor in Pool
Outlet Fluid Conditions
Flashing Model
Entreinment Carryover
Partition Factor
Flow Rate
Partition Factor
TSP Flooding
Water Chemistry/ Cleanliness
Geometry Assumption
AF W Flow Rate
Nodalization

Attachment #4

B&WOG/DPCo List

I. Power Operation

A. RCS

1. Subcooled
2. High pressure (2100-2200 psi)
3. High temperature (550-605°F)
4. Forced flow (20000 lbm/sec per SG)

B. SG secondary

1. High pressure (900 psi)
2. Medium level (25-30 ft)
3. High superheat (55-60°F)
4. Nominal flow (1500 lbm/sec per SG)

II. Normal Post Trip Operation

A. RCS

1. Subcooled
2. High pressure (1800-2200 psi)
3. High temperature (550°F)
4. Forced flow (20000 lbm/sec per SG)

B. SG secondary

1. High pressure (1100 psi peak, 1000 psi nominal)
2. Low level (2 ft)
3. Essentially no superheat
4. Low flow (<50 lbm/sec per SG)

III. MFW Overfeed

A. RCS

1. Subcooled
2. Medium pressure (1500-2000 psi)
3. High temperature (500-550°F)
4. Forced flow (20000 lbm/sec per SG)

B. SG secondary

1. High pressure (800-900 psi)
2. Medium to high level (25-50 ft)
3. Essentially no superheat
4. High MFW flow (1500 lbm/sec per SG)
5. Low steam flow (<50 lbm/sec per SG)

IV. EFW Operation (Normal)

A. RCS

1. Subcooled
2. High pressure (1800-2200 psi)
3. High temperature (525-550°F)
4. Forced flow (20000 lbm/sec per SG)

B. SG secondary

1. High pressure (800-1000 psi)
2. Low level (2 ft)
3. Essentially no superheat
4. Low flow (<50 lbm/sec per SG)

V. EFW Operation (Natural Circulation)

A. RCS

1. Subcooled
2. High pressure (1800-2200 psi)
3. High temperature (525-580°F)
4. Natural circulation flow (800 lbm/sec per SG)

B. SG secondary

1. High pressure (800-1000 psi)
2. Medium level (20 ft)
3. Essentially no superheat
4. Low flow (<50 lbm/sec per SG)

VI. EFW Overfeed

A. RCS

1. Subcooled or possibly saturated
2. Medium pressure (800-2000 psi)
3. Medium temperature (350-500°F)
4. Forced flow or natural circulation flow

B. SG secondary

1. Medium pressure (400-900 psi)
2. Medium to high level (25-50 ft)
3. Essentially no superheat
4. Low EFW flow (<50 lbm/sec per SG)
5. Essentially no steam flow

VII. SG Depressurization

A. RCS

1. Subcooled
2. Medium pressure (1000-2000 psi)
3. High temperature (500-550°F)
4. Forced flow (20000 lbm/sec per SG)

B. SG secondary

1. Medium to low pressure (0-800 psi)
2. Low level (2 ft)
3. Possibly some superheat
4. Low FW flow
5. High steam flow (as much as 10000 lbm/sec per SG)

VIII. SG Depressurization with SG Overfeed from MFW

A. RCS

1. Saturated
2. Medium to low pressure (500-1500 psi)
3. Medium to low temperature (250-450°F)
4. Forced flow (20000 lbm/sec per SG) or natural circulation flow (1500 lbm/sec)

B. SG secondary

1. Medium to low pressure (0-800 psi)
2. Low to medium level (2-25 ft)
3. Possibly some superheat
4. Low to high FW flow (50-1500 lbm/sec per SG)
5. Medium to high steam flow (as much as 5000 lbm/sec per SG

IX. SG Depressurization with SG Overfeed from EFW

A. RCS

1. Saturated
2. Medium to low pressure (500-1500 psi)
3. Medium to low temperature (250-450°F)
4. Forced flow (20000 lbm/sec per SG) or natural circulation flow (1500 lbm/sec)

B. SG secondary

1. Medium to low pressure (0-800 psi)
2. Low to medium level (2-25 ft)
3. Possibly some superheat
4. Low to high FW flow (50-1500 lbm/sec per SG)
5. Medium to high steam flow (as much as 5000 lbm per second per SG

X. SG Depressurization Via MFW Line Break

A. RCS

1. Subcooled
2. Medium to high pressure (1600-2200 psi)
3. High temperature (525-550°F)
4. Forced flow (20000 lbm/sec per SG)

B. SG secondary

1. Medium to low pressure (0-800 psi)
2. Low level (2 ft)
3. No superheat
4. Low EFW flow (50 lbm/sec per SG)
5. Medium to high break flow (as much as 3000 lbm per sec per SG

XI. SG Dryout

A. RCS

1. Subcooled
2. High pressure (1800-2500 psi)
3. High temperature (550-600°F)
4. Forced flow (20000 lbm/sec per SG)

B. SG secondary

1. High to low pressure (0-1000 psi)
2. Low to medium level (0-25 ft) during dryout
3. Possibly some superheat
4. No FW flow
5. Low steam flow

XII. Restoration of MFW to a Dry SG

A. RCS

1. Subcooled, saturated or superheated
2. Any pressure
3. Probably high temperature (550-650^{o}F)
4. Forced flow (20000 lbm/sec per SG) or natural circulation flow (essentially stagnant)

B. SG secondary

1. Low to high pressure (0-1000 psi)
2. Zero level
3. Possibly some superheat
4. Low FW flow (50 lbm/sec per SG)
5. Low steam flow (50 lbm/sec per SG)

XIII. Restoration of EFW to a Dry SG

A. RCS

1. Subcooled, saturated or superheated
2. Any pressure
3. Probably high temperature (550-650^{o}F)
4. Forced flow (20000 lbm/sec per SG) or natural circulation flow (essentially stagnant)

B. SG secondary

1. Low to high pressure (0-1000 psi)
2. Zero level
3. Possibly some superheat
4. Low FW flow (50 lbm/sec per SG)
5. Low steam flow (50 lbm/sec per SG)

XIV. SBLOCA / High Elevation Boiler-Condenser Cooling

A. RCS

1. Saturated
2. Medium to high pressure (600-2500 psi)
3. Medium to high temperature (450-650°F)
4. Essentially no flow

B. SG secondary

1. Low to high pressure (0-1000 psi)
2. Medium level
3. No superheat
4. Low EFW flow (50 lbm/sec per SG)
5. Low steam flow (50 lbm/sec per SG)

XV. Steam Generator Tube Rupture

A. RCS

1. Subcooled or saturated
2. Low to high pressure (300-2000 psi)
3. Low to high temperature (250-550°F)
4. Forced flow or natural circulation flow

B. SG secondary

1. Low to high pressure (0-1000 psi)
2. Low to high level (2-50 ft)
3. No superheat
4. Low FW flow (less than 50 lbm/sec per SG)
5. Primary System radionucleide contamination present

Primary System Phenomena	Condition
1) Subcooled high flow heat transfer	I-IV, VI-XIII, XV
2) Subcooled low flow heat transfer	V, VI, VIII, IX, XII, XIII, XV
3) Inter-tube circulation and flow patterns	V-VI, IX, XIII-XV
4) Condensation of voids inside SG tubes	VI, VIII, IX, XII-XV
5) Natural circulation flow degradation due to two-phase conditions	VIII, IX, XII, XIII, XV
6) Two-phase flow through small tubes	XV

SG Secondary Side Phenomena	Condition
1) Saturated boiling (high flow rate)	I, VII-X, XII, XIII, XV
2) Saturated boiling (low flow rate)	II-XV
3) Departure from nucleate boiling	I, VIII, IX, XI-XIII
4) Film boiling	Same as (3)
5) Heat transfer to superheated steam	Same as (3)
6) Interphase drag	I-XV
7) Interphase heat transfer	I-XV
8) Tube support plate separation	I, II, VIII-X, XII, XV

SG Secondary Side Phenomena	Condition (continued)
9) Subcooled heat	III-X, XII-XIV
10) EFW wetting	IV-VII, IX, XIII, XIV
11) EFW radial spreading	IV-VII, IX, XIII, XIV
12) Tube support plate pooling	IV-VII, IX, XIII, XIV
13) Heat transfer to passive heat structures	XII
14) Separation and transport of iodine while steaming	XV

Attachment #5
NRC/EG&G List

TABLE I. OTSG STATE OR CONDITION FOR IDENTIFIED TRANSIENTS

TRANSIENT \ OTSG STATE OR CONDITION	PRIMARY SIDE	Forced Convection	Single Phase NC	Two Phase NC	Boiler Condenser Mode NC	SECONDARY SIDE	Main Feedwater Injection	Auxiliary Feedwater Injection	No Feedwater	Open (or broken) Steam Line	Broken Main Feedwater Line	Steam Generator Tube Leak	Isolated
Small Break Loss of Coolant Accident		X	X	X	X		X	X	X	X			X
Large Break Loss of Coolant Accident		X					X						
Main Steam Line Break		X	X				X	X	X	X			
Main Feed Line Break		X					X		X		X		
Loss of Main Feedwater		X	X	X				X	X	X			
Steam Generator Tube Rupture		X	X	X			X	X	X	X		X	X
Steam Generator Overfill		X	X	X			X	X		X			
Station Blackout		X	X	X				X	X	X			X
SBLOCA Without High Pressure Injection		X	X	X	X		X	X	X	X			X
Recovery Procedures								X	X	X			X
Anticipated Transient Without Scram													

TABLE 11 IDENTIFICATION OF PHENOMENA FOR OTSG OPERATING CONDITIONS

OTSG STATE OR CONDITION \ PHENOMENA: PRIMARY SIDE	1 phase pressure drop	2 phase pressure drop	1 phase convective heat transfer	2 phase convective heat transfer	parallel channel flow	condensation	boiling	level tracking	phase separation
PRIMARY SIDE									
Forced Convection	X	X	X	X	X				
Single Phase NC	X		X		X				
Two Phase NC		X		X	X	X		X	X
Boiler Condenser Mode NC		X		X	X	X		X	X
SECONDARY SIDE									
Main Feedwater Injection									
Auxiliary Feedwater Injection									
No Feedwater									
Open (or broken) Steam Line									
Broken Main Feedwater Line									
Steam Generator Tube Leak									
Isolated									

OTSG STATE OR CONDITION \ PHENOMENA: SECONDARY SIDE	1 phase pressure drop	2 phase pressure drop	1 phase convective heat transfer	2 phase convective heat transfer	subcooled flow boiling	saturated flow boiling	pool natural convective heat transfer	pool boiling	rivulet heat transfer	falling film heat transfer	non-equilibrium heat transfer	flashing	interphase heat transfer	interphase mass transfer	phase separation
PRIMARY SIDE															
Forced Convection															
Single Phase NC															
Two Phase NC															
Boiler Condenser Mode NC															
SECONDARY SIDE															
Main Feedwater Injection	X	X	X	X	X	X					X		X	X	X
Auxiliary Feedwater Injection	X	X					X	X	X	X	X		X	X	X
No Feedwater		X					X	X							X
Open (or broken) Steam Line		X		X		X					X	X	X	X	
Broken Main Feedwater Line	X	X	X	X		X					X	X	X	X	
Steam Generator Tube Leak											X	X	X		
Isolated							X	X				X	X		

OTSG STATE OR CONDITION \ PHENOMENA: SECONDARY SIDE (cont.)	vessel wall heat transfer	state relationships	void distribution	level tracking	TSP AFW spreading	axial AFW profile	TSP flooding	CCFL	interfacial drag	tube wetting	liquid entrainment	liquid carryover	deentrainment	aspirator behavior
PRIMARY SIDE														
Forced Convection														
Single Phase NC														
Two Phase NC														
Boiler Condenser Mode NC														
SECONDARY SIDE														
Main Feedwater Injection		X	X	X										X
Auxiliary Feedwater Injection		X	X		X	X	X	X	X	X				
No Feedwater		X	X	X										
Open (or broken) Steam Line	X	X	X								X	X	X	
Broken Main Feedwater Line	X	X										X		
Steam Generator Tube Leak		X		X										
Isolated		X	X	X										