

***ESBWR Test & Analysis Program  
Description***

***ACRS TH Subcommittee  
Meeting  
Closed Session  
July 8, 2003***

***Bharat Shiralkar***

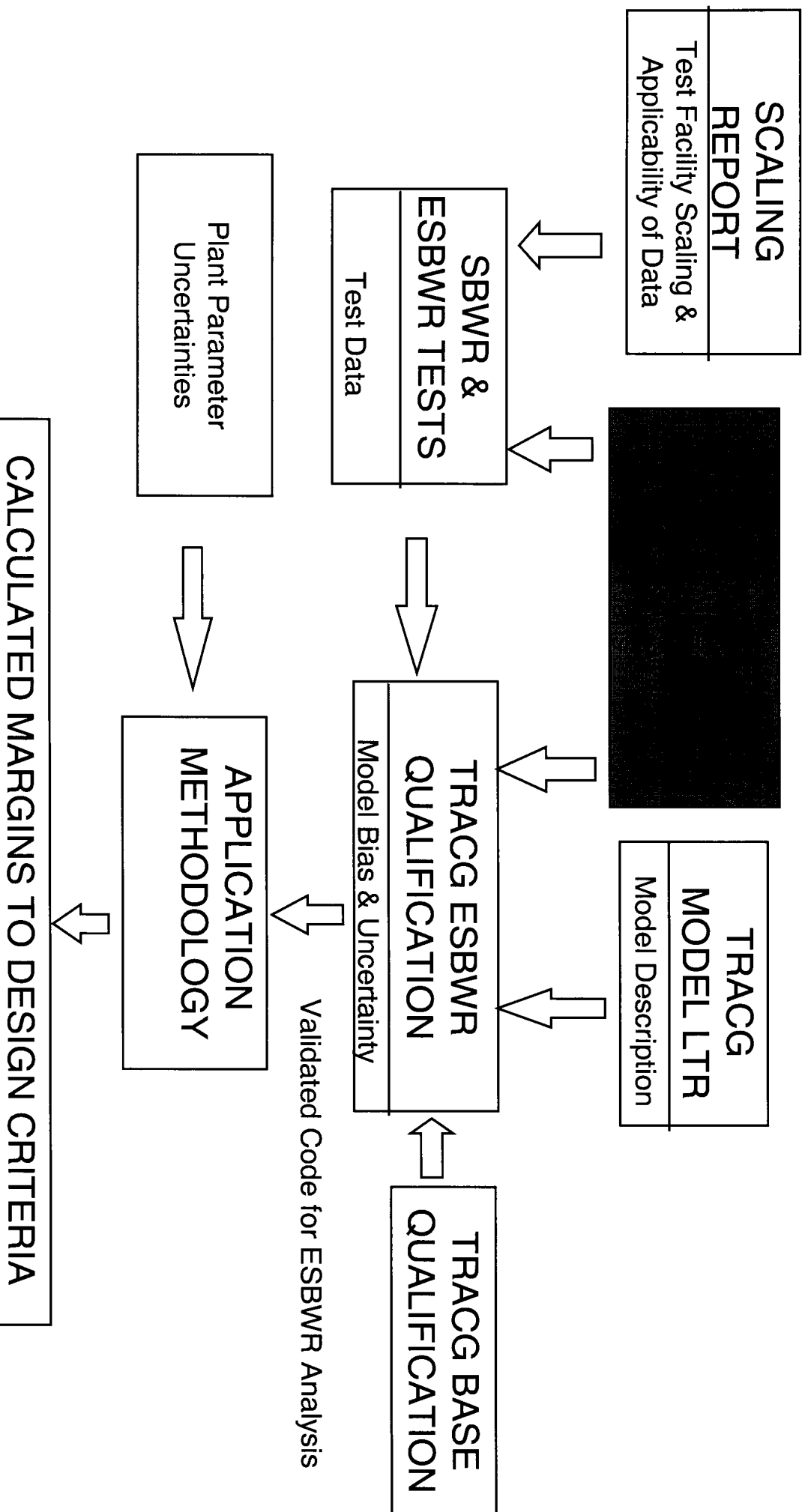


# ***Test and Analysis Program Description (TAPD)***

---

- **Purpose**
  - ***To provide a comprehensive, integrated plan that addresses the testing and analysis elements needed for analysis of ESBWR steady state and transient performance***
  - Study of calculated ESBWR transients and identification of important phenomena (PIRT)***
  - Systematic definition of experimental and analytical modeling needs***
  - Evaluation of testing and analysis plan against these needs to establish adequacy of program***

# ESBWR Technology Program Elements



## **ESBWR Test and Analysis Program (TAPD) Evolution**

- **Based on SBWR TAPD**
  - *Transient response and governing phenomena are the same*
- **SBWR TAPD updated through a review of differences between SBWR and ESBWR features**
  - *No differences in PIRTs other than those related to specific ESBWR features e.g. no containment sprays in ESBWR*
- **NRC review comments on SBWR TAPD addressed**
  - *No requirements for additional testing or qualification*
  - *Differences in ranking of some phenomena resolved*

# **TAPD Scope**

---

- ***Prediction of ESBWR system performance during normal operation, transients and LOCA***
  - ***Includes: Steady state operation and plant startup; anticipated operational transients (AOOs) and ATWS; LOCA (vessel and containment); stability***
  - ***Excluded: Severe accidents are considered separately (design requirements for containment to handle hydrogen generation assuming metal-water reaction are considered). Non-thermal hydraulic issues (structural integrity, seismic response; etc.) are not covered other than as input parameters for system response evaluations.***

# ***ESBWR and BWR Analysis Methods***

---

# ***Strategy for Determination of Test & Analysis Needs***

---

- ***Develop list of governing phenomena and system interactions***
  - ***Top-Down process***
  - ***Bottom-Up process***
- ***Top-Down Process***
  - ***Calculate scenarios for transients/LOCAs***
  - ***Determine key phases of transients***
  - ***List potentially important phenomena***
  - ***Expert Group ranking phenomena (PIRT)***
- ***Bottom-Up process***
  - ***List all unique ESBWR design features***
  - ***Determine associated phenomena/system interactions***
  - ***Evaluate and rank issues by importance***
  - ***Supplements PIRT ranking approach to fill any gaps by focusing on ESBWR-unique features***
- ***Consolidate highly ranked phenomena and system interactions from both approaches***

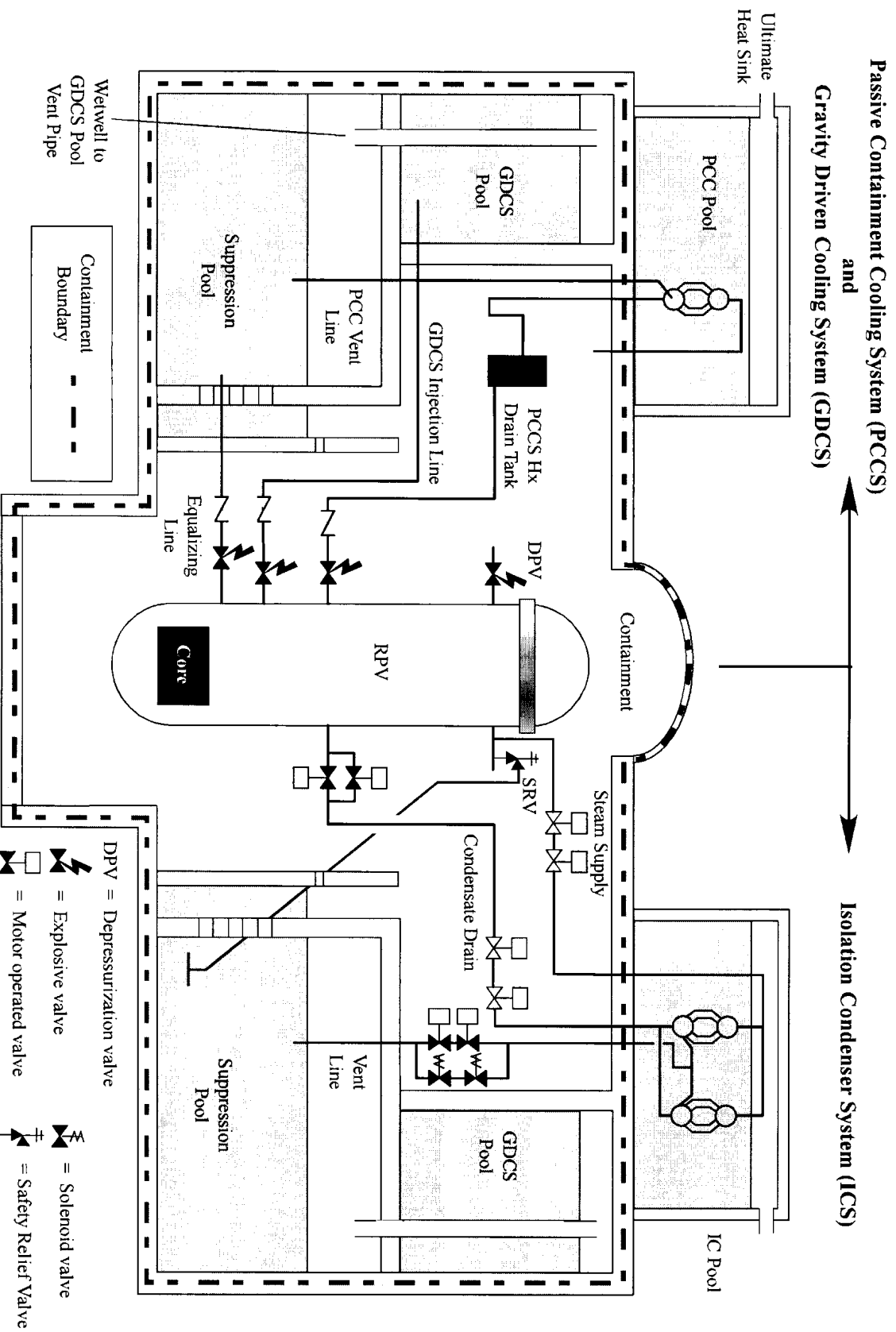
## ***Strategy for Determination of Test & Analysis Needs (contd)***

---

- ***Use high ranked phenomena lists to:***
  - ***Evaluate capability/applicability of analysis models (TRACG)***  
***Implement any needed models or bounding modelling procedures***
  - ***Evaluate test coverage***  
***Plan for tests to fill in gaps***
  - ***Evaluate uncertainties to establish appropriate design margins***
- ***Medium ranked phenomena also evaluated***



# ESBWR Passive Systems



## ***Differences between ESBWR and SBWR***

---

7/8/03

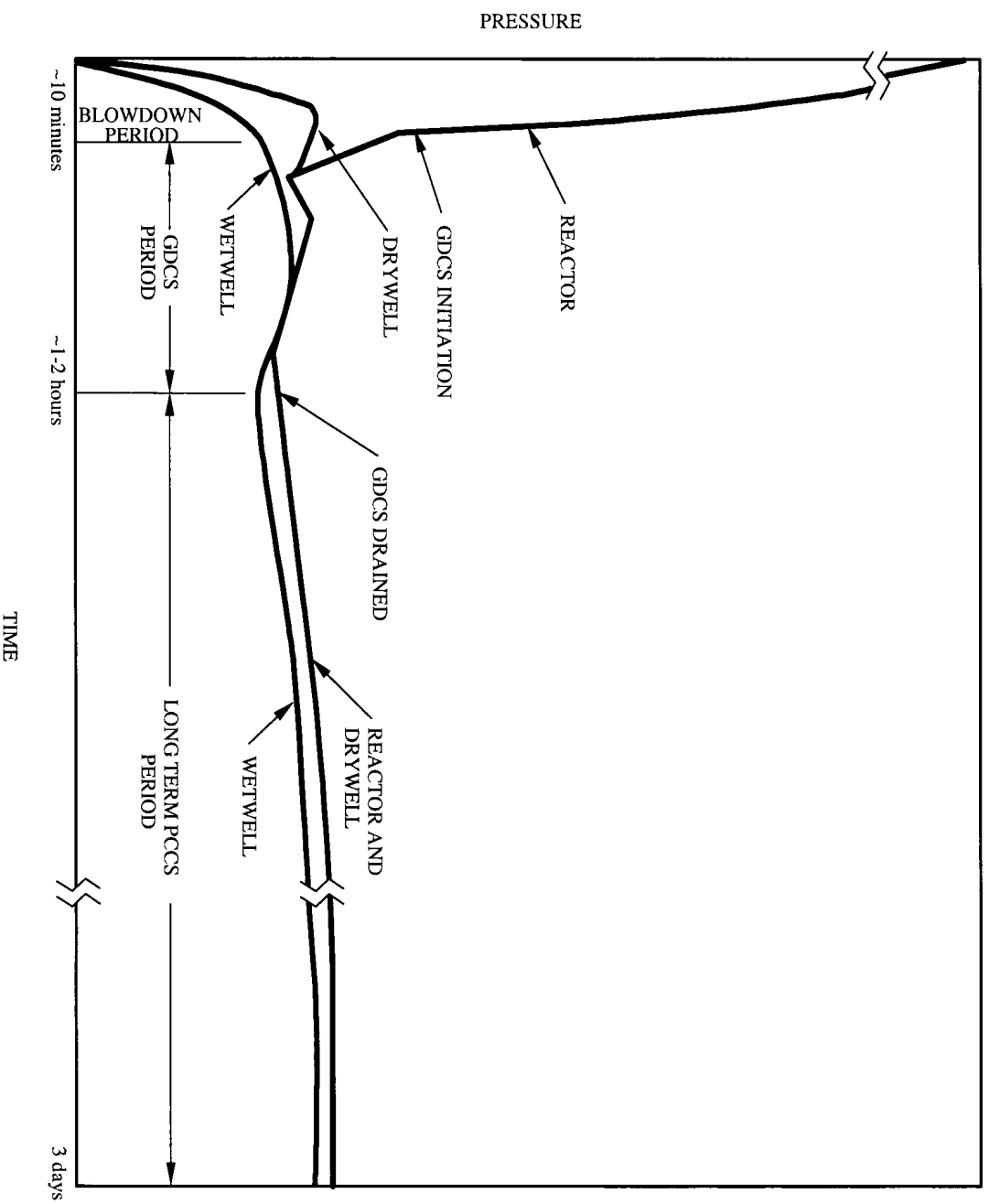
BSS-10

# ***TAPD Results***

---

- ***Lists of Highly Ranked Phenomena and System Interactions***
  - ***Consolidated from Top-Down and Bottom-Up processes***
- ***Lists of Medium Ranked Phenomena also maintained***
- ***Grouped by transient type***
  - ***ECCS/LOCA***
  - ***Containment/LOCA***
  - ***AOOs***
  - ***ATWS***
  - ***Stability***
- ***Separated by phase of transient for LOCA***
  - ***Blowdown***
  - ***GDCS***
  - ***Long term PCCS***

# Phases of ESBWR LOCA Transient



***GDCS Line Break – Chimney Level***

---

7/8/03

BSS-13

## **Steam Line Break – RPV and Containment Response**

7/8/03

BSS-14

# ***PCCS Heat Removal***

---

7/8/03

BSS-15

## ***Example of List of Highly Ranked Phenomena (Containment/ LOCA)***

---



# ***Evaluation of System Interactions***

---

7/8/03

BSS-17

## ***Test Coverage of Qualification Needs***

---

- ***Matrix of Test Data vs. Qualification Needs (High Ranked PIRTs)***
  - ***Qualification Needs grouped by Reactor Core/ Vessel and Containment***
  - ***Test Data grouped by Separate Effects, Component, Integral System Tests and BWR Operating Plant Data***
- ***Qualification Plan was developed to supplement existing data base where needed***
- ***Objective: Every Qualification Need covered by at least one test***

# ***Overview of SBWR-specific Test Programs***

---

7/8/03

BSS-19

# ***Overview of SBWR-specific Test Programs***

---

7/8/03

BSS-20

## ***Other Applicable Test Programs***

---

7/8/03

BSS-21

## ***Additional Test Programs***

---

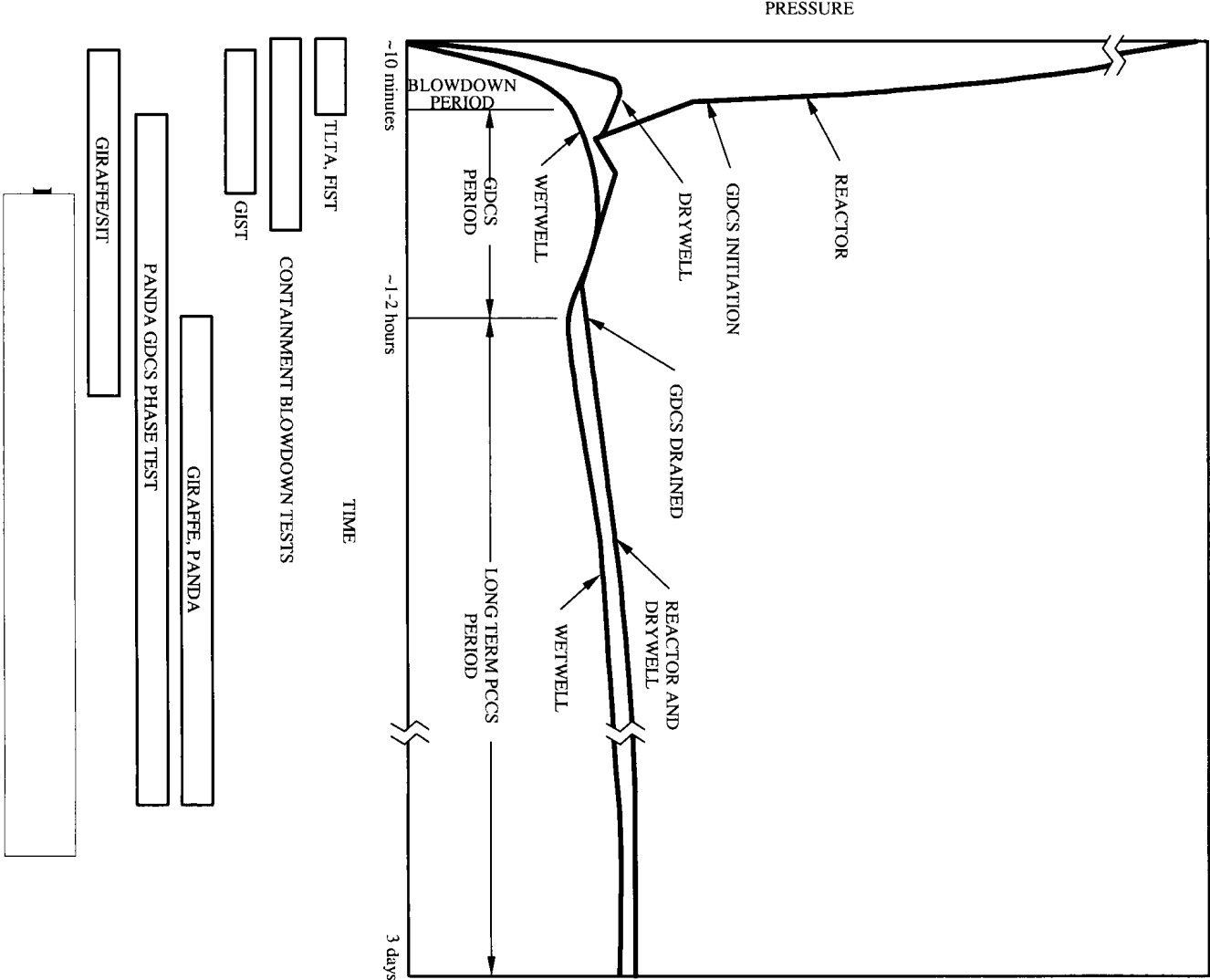
7/8/03

BSS-22

# ***Example of Qualification Coverage by Component Tests***

---

# Integral Test Coverage for ESBWR LOCA





## ***Summary of Test Coverage***

---

7/8/03

BSS-25

# ***TAPD Summary***

---

- ***TAPD provides sound technology basis for ESBWR design certification***
  - ***Test and analysis needs systematically defined***
- ***TAPD addresses 10CFR52.47 requirements***
  - ***Performance of each safety feature of the design evaluated***
    - All unique features evaluated***
    - Important phenomena identified***
    - Test and analysis basis established***
  - ***Interdependent effects among safety features of the design evaluated***
- Important interactions identified and studied***
  - Tests added to program to cover needs***
- ***Sufficient data exist on the safety features of the design to assess analytical tools (TRACG) used for safety analysis***
- TRACG modeling and qualification needs assessed***
- Test and analysis plans developed to address these needs***
- Test coverage detailed in Qualification Plan***