ESBWR Test & Analysis Program Description

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Test and Analysis Program Description (TAPD)

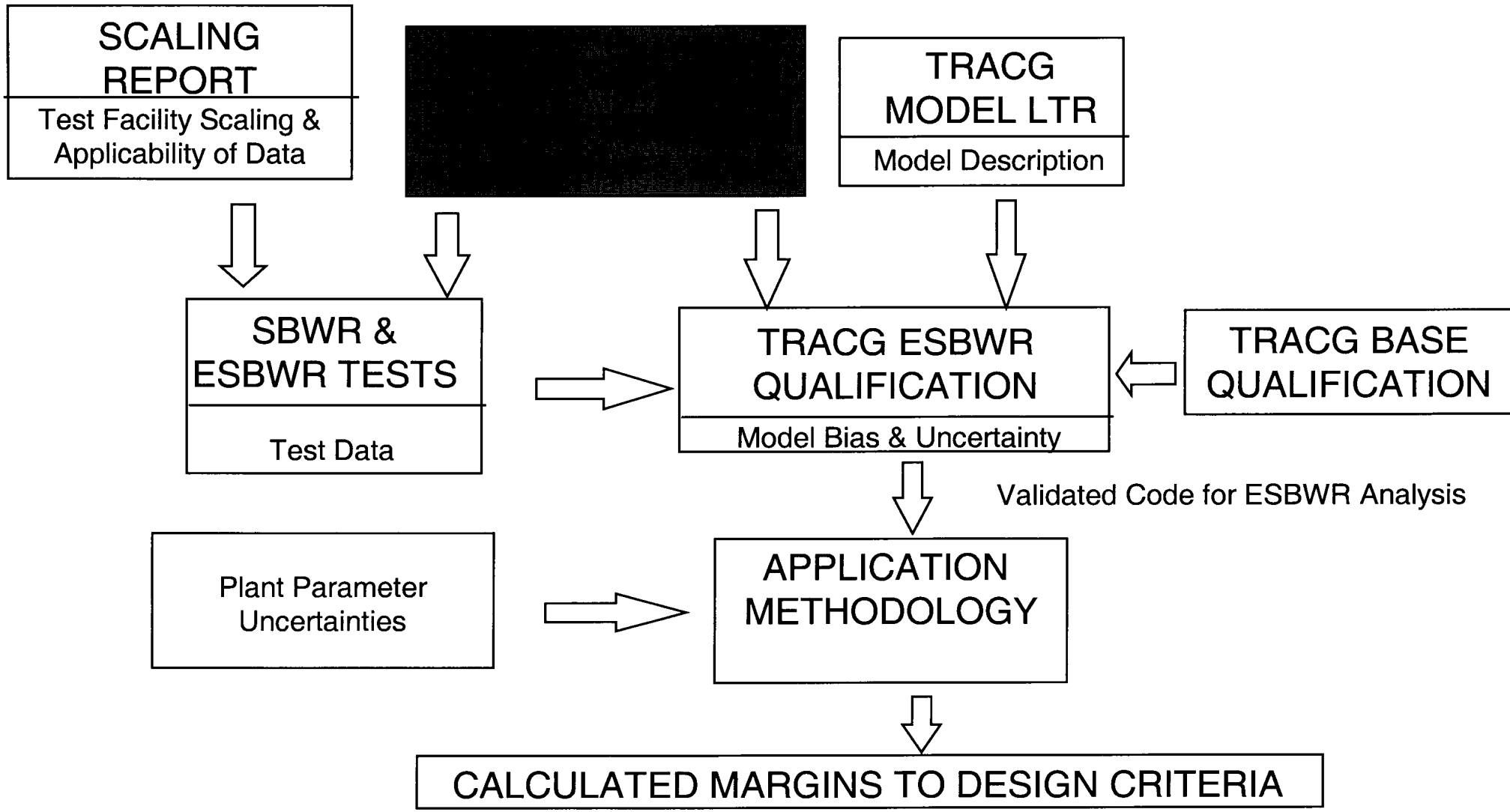
- ***Purpose***
  - ***To provide a comprehensive, integrated plan that addresses the testing and analysis elements needed for analysis of ESBWR steady state and transient performance***

    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 LOCAs*
  - *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

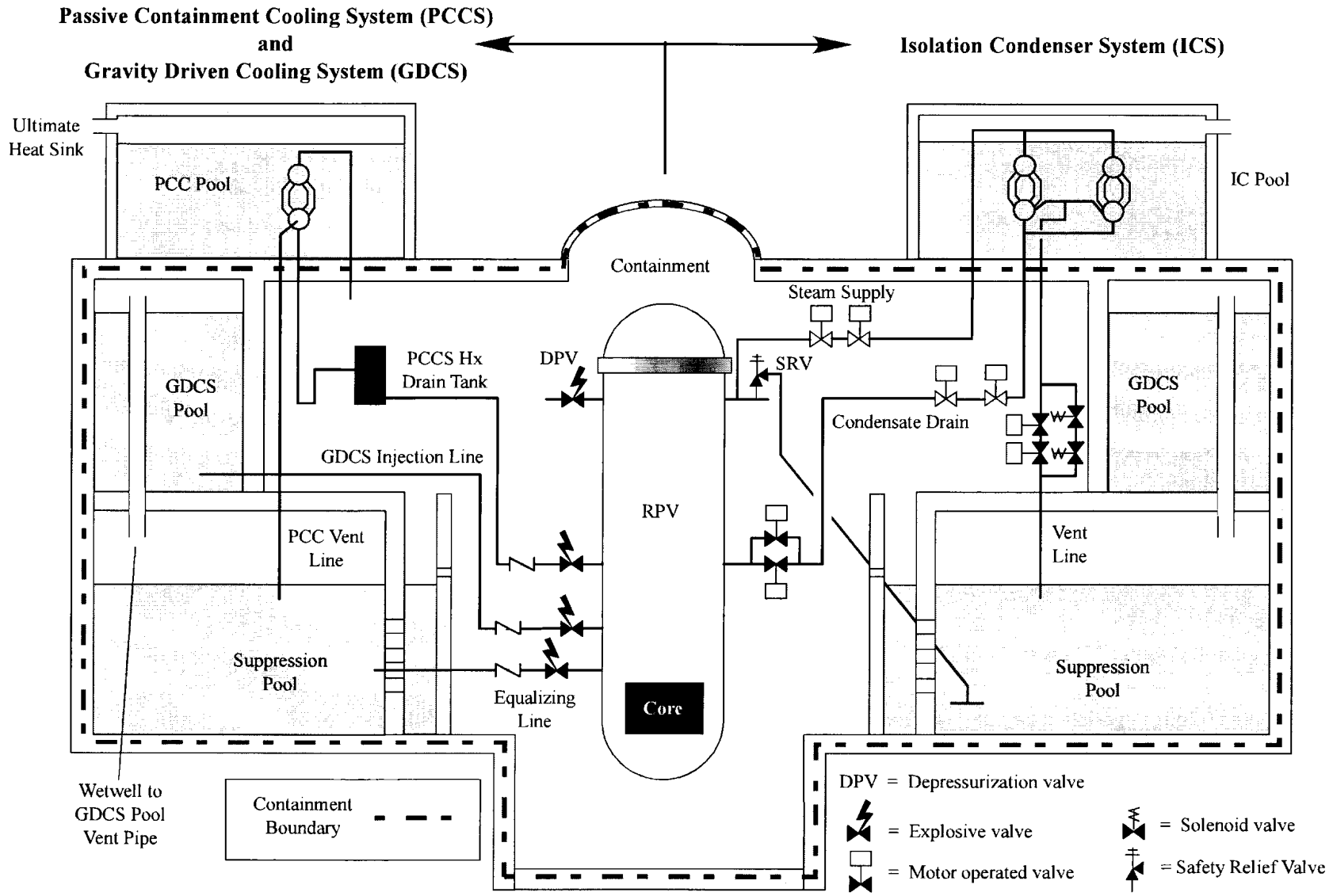
Strategy for Determination of Test & Analysis Needs

- 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 modeling 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

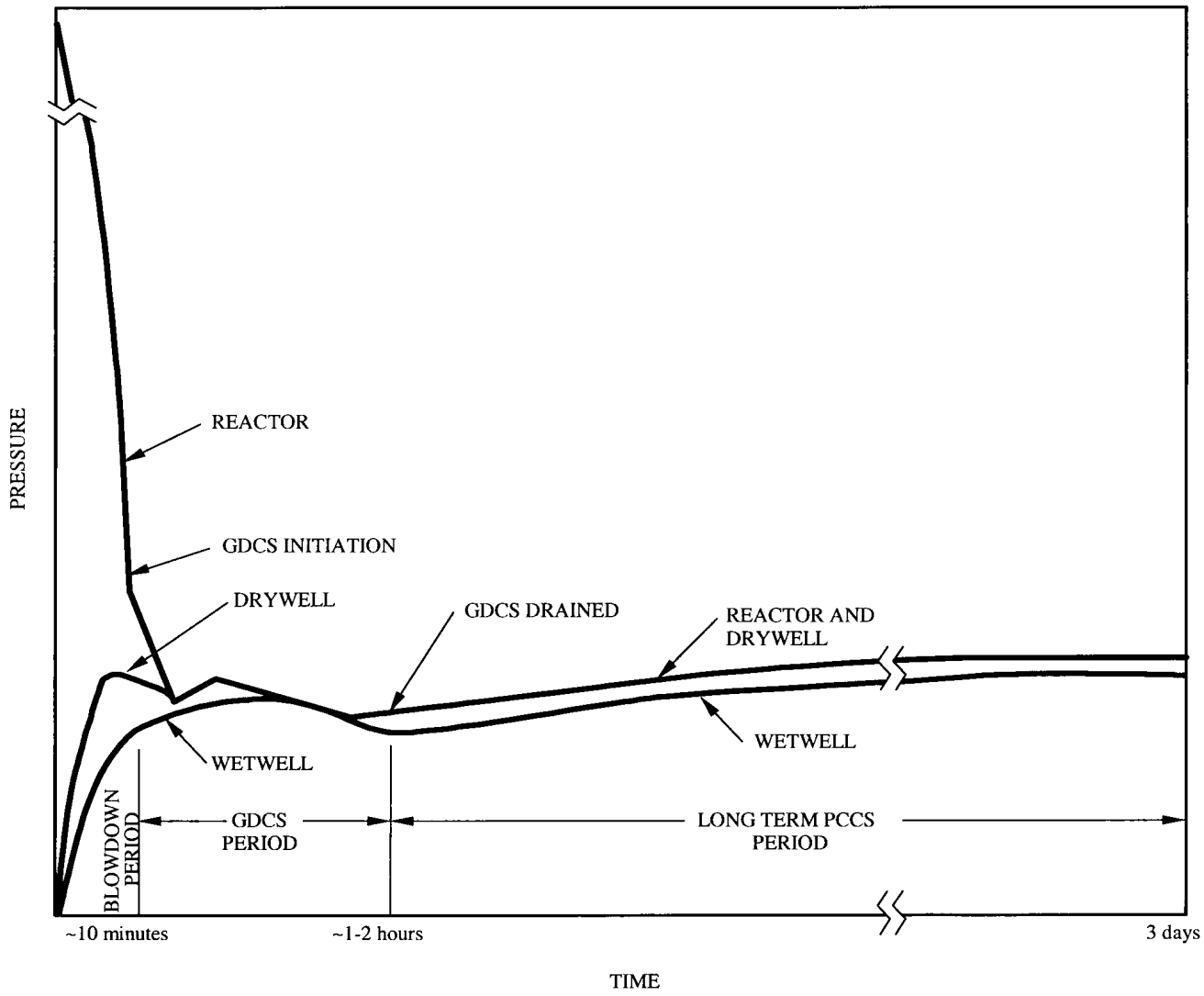


Differences between ESBWR and SBWR

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

Steam Line Break – RPV and Containment Response

PCCS Heat Removal

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

Evaluation of System Interactions

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

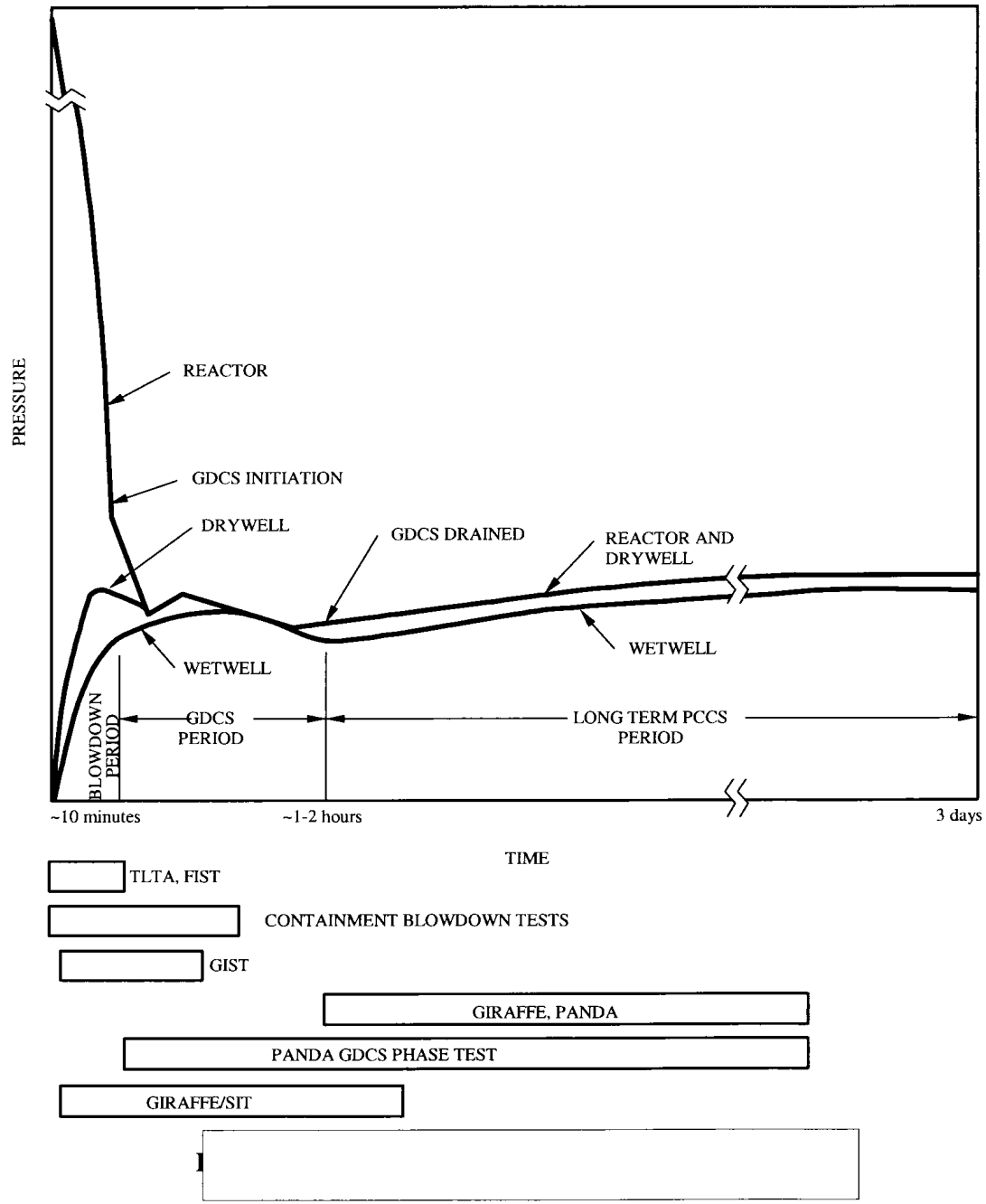
Overview of SBWR–specific Test Programs

Other Applicable Test Programs

Additional Test Programs

Example of Qualification Coverage by Component Tests

Integral Test Coverage for ESBWR LOCA



Summary of Test Coverage

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