



Integrated System Test Program Update

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This is a pre-application document and includes preliminary B&W mPower Reactor design or design supporting information and is subject to further internal review, revision, or verification.

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[Proprietary per Affidavit 4(a)-(f)]

Integrated System Test Program

IST Objectives

- Integrated system performance
- Steam generator and component performance
- Evaluation model development support
- Licensing support
- Insights
 - Control and protection systems development
 - Design enhancements
 - Simulator development
 - Operating procedures and training development
- Demonstration to potential customers



A broad spectrum of objectives identified

IST Approach

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[Proprietary per Affidavit 4(a)-(f)]



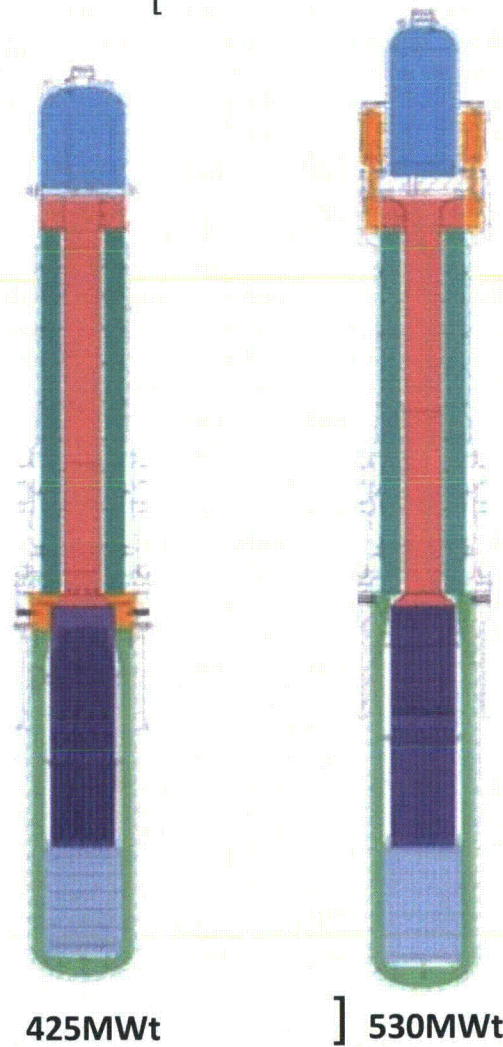
B&W mPower – IST Design

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[Proprietary per Affidavit 4(a)-(f)]

IST – mPower Design Comparison



425MWt

530MWt

[Proprietary per Affidavit 4(a)-(f)]



Systems Included in the IST

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[Proprietary per Affidavit 4(a)-(f)]

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Current Status

ECCS Changes

Original IST Design

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NEW ECCS IST Design

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[Proprietary per Affidavit 4(a)-(f)]

IST Systems Diagram

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Pressurizer

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RWST []

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IPIT Tanks

IST Quality Assurance Program

- IST Quality Assurance Program Plan (QAPP):
 - Represents the top-level IST quality document
 - Defines the QA criteria that are implemented at the IST
 - 18 implemented (through specific commitments / exceptions) by the B&W mPower Quality Assurance Program Description (QAPD)
 - 6 of the above not implemented at the IST
 - Design Control(3), Identification and Control of Materials, Parts, and Components (8), and Control of Special Processes (9)
 - Inspection (10), Handling, Storage and Shipping (13), and Inspection, Test, and Operating Status (14)
 - Documents IST commitments / exceptions for the implemented QA criteria, as addressed by Part III, Section 1 (Non-Safety-Related SSCs - Significant Contributors to Plant Safety) of the B&W mPower QAPD.
 - Defines the set of controls that collectively establish the IST augmented-quality (IST-AQ) designation for selected IST testing and test data.

Quality Designations of IST Programs

- **IST Non-Quality Programs:**
 - Conduct of Operations
 - Conduct of Engineering
 - Conduct of Maintenance
- **IST Quality-Related Programs:**
 - Conduct of Training Program governs processes that qualify IST test engineers to perform IST-AQ testing.
 - Conduct of Testing Program governs processes that control IST-AQ testing and the production of IST-AQ test data, as well as measuring and test equipment (M&TE) that support such activities.

IST Conduct of Training Program

- Establishes an IST-AQ designation for the following processes:
 - Definition of test-engineer training matrices
 - Initial qualification of test engineers against the above training matrices
 - Requalification of test engineers against the above training matrices
- Defines the IST-AQ documents that govern the above processes:
 - Qualification records for test engineers
- Governs the nonquality-related training and qualification of IST Operators

IST Conduct of Testing Program

- Establishes an IST-AQ designation for the following processes:
 - Configuration control of the computer hardware / firmware / software that comprises the IST traceable data stream (i.e., the pathway for acquired test data from analog signal input through digital data storage)
 - Calibration and control of M&TE (including IST instruments)
 - Development, execution and documentation of testing, whose specifications are developed by the B&W mPower design organization
 - Establishment of archive coordinates (i.e., instrument tags and start / stop times) that allow digitally-stored test data to be retrieved and subsequently qualified by the B&W mPower design organization
- Defines the IST-AQ documents that govern the above processes:
 - Test control test package and completion record
 - Test report and production of the electronic data set
 - Approved electronic data set (MS Excel spreadsheet)
 - Each completed document is maintained as a quality record.

IST Electronic Test Data

- Data acquisition system [

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[Proprietary per Affidavit 4(a)-(f)]

IST Measuring and Test Equipment (M&TE)

- This procedure establishes controls for– both Calibrators and Instruments
- Four subordinate IST M&TE procedures exist under this procedure to control the calibration of specific types of M&TE Instruments used at the IST.
- The IST performs on-going calibrations of vendor-supplied M&TE Instruments
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• Specific sections of the B&W mPower Quality Assurance Program Description (QAPD) are implemented (per the commitments / exceptions defined in the IST QAPP)

Integrated System Test Scaling Update

Previously Scaled Tests

- OTSG Design and Verification Tests
- MIST Test Facility (BAW-2021, NUREG/CR-5395)
 - Lowered Loop Once Through Steam Generator (OTSG)
 - Test Objectives
 - Small Break Loss of Coolant Accident (SBLOCA)
 - Power (Pilot) Operated Relief Valve – High Pressure Injection (PORV-HPI)
 - Abnormal Transient Operating Guidelines (ATOG)
 - Scaling
- OTIS Tests (BAW-1905, NUREG/CR-4567)
 - Raised Loop OTSG
 - SBLOCA
 - ATOG
- GERDA
 - Integral Economizer Once Through Steam Generator (IEOTSG)
 - SBLOCA

IST Phenomena / Scaling

- Ishii & Kataoka Report, “Scaling Criteria for LWRs Under Single-Phase and Two-Phase Natural Circulation, CONF-820962-04, September 1982”
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IST Phenomena / Scaling (cont.)

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IST Scaling Differences

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Power Up-Grade Effects

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Use of IST Data in Evaluation Model Development

EM Development

IST is a component of the Evaluation Model
(EM) Adequacy Assessment (RG 1.203)

The mPower EM is developed using:

- Expert judgment and elicitation (PIRT)
- Additional assessments to expand and complete data base
- Uncertainty, scaling, and importance analysis
- Methodology guidelines

*Establishes the basic principles important for the development,
assessment, and review of safety analysis methods*



EM Development Using IST

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Safety Analysis & Methods and IST Interface

Process for Obtaining IST Data for the EM Assessment

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IST Testing

The IST Conduct of Testing (CoTST) Program

- Develops / controls / performs / documents IST experimental testing
- Supports mPower design / performance / licensing efforts
- Defines test descriptions and objectives
- Produces unambiguous test procedures with acceptance criteria
- Acquires and archives data with traceability and uncertainty
- Resolves discrepancies between data and expected performance
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IST Steam Generator Testing

- Define the forced circulation thermal/hydraulic performance of the B&W mPower once-through steam generator.
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Test Objectives created by SG analysts, executed by IST Test Engineering

IST Steam Generator Testing

Nominal	Low SG Pressure	High SG Pressure	Low FW Temp	High FW Temp	RCS Average Temp	Constant Minimum Super - heat	Low Power
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[] Test Packages defined to create a thorough understanding of SG performance.





Startup and Power Range Temperature Trends

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SG operational experience input to mPower



Isokinetic Steam Sampling

Proven ASME method of steam sampling



Steam Generator Performance

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Steam Generator– RELAP Comparison

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[Testing]

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Modes []

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IST []



IST operation compared to RELAP modeling [

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Modes of []

Flow signatures vary based on mode of Natural Circulation

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IST-RELAP Model: []

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Testing Currently in Progress

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Planned Testing

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IST Operational Experience



IST Operational Experience

IST Declared “Operable” March 16, 2012; Commenced Startup / Heat-up

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Achieved full operating temperature and pressure on July 12, 2012

IST Operation

- The IST has operated well from initial start-up

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IST Program Summary

- IST fully operational and testing is well underway
- Quality program operative
- Completed steam generator performance [] tests
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