MILLSTONE UNIT 3 SIMULATOR

QUADRENNIAL CERTIFICATION REPORT

OCTOBER, 1998

Approved:

Manager, Operator Training	9/29/98 Date
Manager, Process Computers & Simulators	9/29/98 Date
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QUADRENNIAL CERTIFICATION REPORT SUMMARY

The Millstone Unit 3 simulator was initially certified on October 31, 1990. Certification was accomplished through the Northeast Utilities Simulator Certification Program, which is also the vehicle for ensuring continued certification. Based on the performance testing results for the last four years, the Millstone Unit 3 simulator continues to demonstrate excellent physical and functional fidelity when compared to the reference unit. The Simulator Certification Program includes a comprehensive testing program, as well as procedural controls to ensure the Millstone Unit 3 simulator retains high fidelity to the plant.

This report contains the following sections and two attachments:

- Section 1 provides an overview of the simulator certification program.

- Section 2 provides a description of the performance testing covering the four-year cycle ending October 1998.

    - Sub-section A provides a description of testing methodology and assumptions.

    - Sub-sections B through G review and summarize the individual tests that make up the Millstone Unit 3 simulator performance and operability tests.

- Section 3 provides a summary of open discrepancies on the Millstone Unit 3 simulator.

- Section 4 discusses the testing sequence for the next four-year certification period (November 1998 through October 2002).

- Section 5 discusses plant design changes that were not completed within 24 months of installation in the plant.

- Section 6 provides a description of the new simulator platform and the testing performed to accept the new platform for use. A description of upgrades presently in progress is also included.

- Attachment A lists the open performance test discrepancies and their projected resolution date.

- Attachment B lists the next four-year performance test schedule.

    - The performance tests described in section 2 were all performed by presently or previously SRO qualified individuals. Any discrepancies identified during performance testing will be corrected in accordance with the Nuclear Simulator Engineering Manual (NSEM) NSEM-5.01, "Simulator Modification Control."

1. SIMULATOR CERTIFICATION PROGRAM OVERVIEW

The mission of the certification program is to:

- Ensure that the simulator has the capability to support the operator training programs.
- Provide for certification in a timely, cost-effective manner, addressing the specific requirements of NRC 10CFR55.45 (b), and the methodology recommended in Regulatory Guide 1.149, 1987.
- Ensure ongoing compliance with the requirements set forth in ANSI/ANS 3.5, 1985.

The effort required to accomplish this mission has been grouped into three main components: Definition of the Scope of Simulation, Validation of the Scope of Simulation, and Configuration Management. NU has put in place a collection of formal processes called the Nuclear Simulator Engineering Manual (NSEM), to direct all aspects of certification and ensure compliance to the regulatory requirements. The NSEM is a departmentally controlled document.

The Scope of Simulation that NU certifies is based upon the NU Simulator Training Guides, which encompass:

- The general requirements specified in ANSI/ANS-3.5, 1985 and Regulatory Guide 1.149, 1987.
- The training requirements for performing the various plant start-up, shutdown, operating and emergency procedures.
- Outside events (e.g., selected LERs, plant design changes, etc.) that affect the training programs and/or the simulator configuration.

Specific performance tests were developed for the Millstone Unit 3 simulator, which fulfill the testing requirements of ANSI/ANS 3.5, 1985, and recommended testing in Regulatory Guide 1.149, 1987. Included are the following test categories:

- Malfunctions

- Normal operations and surveillances
- Instructor station
- Annual operability
- Real-Time
- Physical fidelity verification

The Millstone Unit 3 simulator performance tests are dynamic documents and are the primary mechanism for validating simulator performance and fidelity. As such, they are updated to reflect modifications made to the simulator and/or new reference plant performance data. The performance tests are repeated over a four-year period at the rate of approximately 25 percent per year. The operability test and physical fidelity evaluation portions are performed annually.

NU's Simulator Certification Program provides control over the configuration of the Millstone Unit 3 simulator to ensure that it can effectively support the training mission and that regulatory commitments are satisfied. The main components of simulator configuration management are: 1) Design Data Base, 2) Documentation, and 3) Modification Control and Scope of Simulation Expansion.

1. The intent of the Simulator Design Data Base is to have available the complete data on which the simulator is designed, and on which upgrading is based. The specific data which forms the design basis for the current Millstone Unit 3 simulator hardware configuration and software models has been identified and validated. As such, we utilize the latest revision of plant documents and rely on the formal plant design change process for notification of modifications and transmittal of pertinent information. Open Simulator Discrepancy Reports constitute the Updated Design Data Base described in ANSI/ANS 3.5, 1985.

2. Simulator-specific documentation is needed for certification and/or maintenance of the simulator. While this documentation is controlled and updated, it is not considered to be part of the Simulator Design Data Base.

3. NU has in place a modification control process to implement design changes on the Millstone Unit 3 simulator and to ensure that the simulator fully complies with ANSI/ANS 3.5 (1985), Reg. Guide 1.149, and 10 CFR 55.45. The following procedural controls have been implemented:

   <u>Major Plant Modifications</u> - The Millstone Unit 3 simulator was certified as a plant referenced simulator. Significant reference plant control room changes, such as control room design review modifications, must receive special consideration due to their potential major impact on training. NSEM 6.04, "Major Plant Modifications," addresses this concern. This process guideline ensures that major

plant modifications affecting the reference plant control room are reviewed and acted on in a timely manner. This ensures that training and exams continue to be performed on a valid plant referenced Simulator.

Plant Design Changes/Procedure Changes - Plant design changes and procedure changes are sent to the training department to be reviewed for training impact and simulator impact. This assures that both training and the simulator are continually evaluated and updated as plant changes occur. Procedural controls covering this review process are in training procedures. Plant design changes requiring simulator modifications are handled within the time allowed by ANSI/ANS 3.5 Section 5.2 and 5.3.

Student Feedback - Student (licensee) feedback is an important input to simulator fidelity. Student feedback on simulator performance is requested. If there is a simulator discrepancy it is noted and provided to the Simulator Operations Assistant for dispositioning.

Reference Plant Performance Data - As plant events occur, data is retrieved and evaluated to validate simulator fidelity. NSEM 6.03, "Collection of Plant Performance Data," covers the collection of reference plant performance data.

Development of New Simulator Training Guides - Nuclear Training Procedure, NTP 134, "Developing Simulator Training and Examinations," covers requirements for validating new simulator training guides. This ensures that new simulator training guides use only certified remote functions, certified malfunctions, certified initial conditions, and do not exceed any simulator operating limits.

Simulator Certification Documentation - As the Millstone Unit 3 simulator is modified, appropriate simulator certification documentation needs to be updated. NSEM 5.02, "Retest Guidelines," covers updating of the performance tests.

A Simulator Configuration Control Committee (SCCC) has been established to provide overall simulator design control and management of resources involved in simulator modifications. The SCCC is chaired by the Operations Manager (or designee) for Millstone Unit 3 and includes representatives from the Operator Training Branch and Process Computers and Simulators department.

2. DESCRIPTION OF PERFORMANCE TESTING FOR THE FOUR YEAR CYCLE: November, 1994 - October, 1998

A. TESTING GOALS, METHODOLOGY, AND ASSUMPTIONS

The NU Simulator Certification Program, goals, methodologies, and assumptions were established to ensure an efficient, effective, and comprehensive approach to testing. Certain elements of this testing philosophy are worthy of mention here:

- Testing should be conducted for normal, abnormal, and emergency conditions.

- The simulator response, as verified by testing, during normal, abnormal, and emergency conditions shall meet the following criteria necessary to support the contents of the training curriculum:

  - Correct diagnosis of events by the operator is possible.

  - Capabilities exist for the operator to intervene and mitigate events.

  - Actions or inaction taken by operators shall result in similar response as in the reference plant.

  - Alarms and automatic system actuation's shall occur such that operator diagnosis and response is not adversely affected.

- Any discrepancies found during testing that violate these criteria shall be documented by generating a Trouble Report (TR), to be dispositioned in accordance with the NSEM.

- The requirements of ANSI/ANS 3.5 shall be implemented.

- Simulator controls used in training, such as, switches, annunciators, meters, controllers, recorders, lights, keylocks, pushbuttons, etc., should be tested.

- Personnel, presently or previously SRO qualified, are used for performance and operability testing.

- In the absence of finite data, a combination of operating experience, engineering judgment and analytical results shall be used to test the simulator response to major malfunctions such as large break LOCA, steam line break, etc.

- Testing shall be conducted whenever a modification is made to the simulator that affects its fidelity relative to the reference unit or its functional operation as a simulator. Modifications to the simulator design shall be validated through testing prior to use in training and examination.

During the development and conduct of specific testing it became necessary to establish additional guidance. This was done to more effectively apply the requirements of ANSI/ANS 3.5 and respond to the unique attributes of each test. This additional guidance or deviation from the general philosophy is summarized below:

1) NORMAL OPERATIONS TESTING

- Testing of surveillances on redundant equipment or flowpaths is not required if the primary piece of equipment or flowpath is tested. For example, if the Train I Service Water Pump surveillance is performed, the Train II Service Water Pump surveillance need not be performed.

- The simulator's capability of performing a reactor scram followed by recovery to rated (full) power (ANSI/ANS 3.5, Section 3.1.1, Item 4) is tested by testing:

  - a plant startup to 100% power, followed by
  - a reactor trip, then
  - an increase to power

2) OPERABILITY TESTING

- Boron Concentration for the Steady State tests was not recorded. The equipment for monitoring boron concentration was removed from the control room in 1995. This parameter will be added to the test procedure prior to performing the Steady State test for the upcoming four-year cycle.

- Control Rod Position for the Steady State tests was not recorded. Selected controlling bank rod positions will be added to the test procedure prior to performing the Steady State test for the upcoming four-year cycle.

B. NORMAL OPERATIONS AND SURVEILLANCE TESTING

The normal operations and surveillances required by ANSI/ANS 3.5 Section 3.1.1(1), (2), (3), (4), (5), (6), (7), (8), and (10) were performed using controlled copies of Millstone Unit 3 operating procedures and surveillances. ANSI/ANS 3.5, Section 3.1.1 (9) was tested using a separate reactor core test procedure. NSEM 4.10, "Normal Operations Verification," contains the generic guidance used to write and perform the Millstone Unit 3 simulator normal operations and surveillance test.

Using controlled copies of Millstone Unit 3 operating procedures, the following sequence of operations was tested on the Millstone Unit 3 Simulator:

1. The simulator was initialized to Cold Shutdown conditions
2. Plant heatup
3. Nuclear startup
4. Plant Startup
5. Load increase to 100% power
6. Reactor trip initiated
7. Reactor trip recovery
8. Nuclear startup
9. Plant startup
10. Load increase to power
11. The simulator was reinitialized to 100% power.
12. Plant shutdown to hot standby
13. Reactor shutdown
14. Plant cooldown to cold shutdown

C. MALFUNCTION TESTING

The Millstone Unit 3 simulator is certified for 239 malfunctions, which meet the requirement for 25 types of malfunctions specified in section 3.1.3 of ANSI/ANS 3.5, (1985).

Each certified malfunction has its own test. Guidance for writing and conducting malfunction tests is contained in:

- NSEM 4.04, Major Malfunction Testing
- NSEM 4.05, Malfunction Testing

Malfunctions which cause major integrated plant effects, such as loss of coolant, loss of normal power, etc., have their respective malfunction tests written and tests conducted per the guidance in NSEM 4.04. For these "major" malfunctions, computer data, analytical data, or actual plant response data (if available) is typically used to verify correct malfunction response. Analytical data was obtained from the following documents/sources:

- Millstone Unit 3 Updated Final Safety Analysis Report (UFSAR)
- Westinghouse WCAP-11145-P-A (NOTRUMP Best Estimate LOCA Analysis)
- Millstone Unit 3 Reference Plant Data Book
- Cycle 6 Reload Analysis Report

All other malfunctions that are not classified as a major malfunction have their respective malfunction tests written and tests conducted per the guidance in NSEM 4.05. This type of malfunction is typically an instrument malfunction, a controller malfunction, a pump trip, etc. Malfunction tests in this category are typically "Best Estimate" Analysis. "Best Estimate" Analysis means an NRC licensed or SRO certified instructor or previously licensed or certified individual utilizes his experience, operating procedures, piping and instrument drawings, electrical drawings, and possibly hand calculations to estimate proper simulator response.

ANSI/ANS 3.5 (1985), Section 3.4.2, requires that provisions be available for incorporating additional malfunctions. As an example, a malfunction for failure of the RHR pump to trip on low RWST level (RH06) was added during the last four-year certification cycle to the simulator to reflect changes in the Millstone Unit 3 plant design.

All certified malfunctions are retested over a four year interval, as described in Section 4 of this document.

D. <u>ANNUAL OPERABILITY TESTING</u>

ANSI/ANS 3.5 (1985) Section 5.4.2 and Appendix B specify annual operability testing requirements. The methodology used to write and conduct operability tests is described in NSEM 4.09, "Simulator Operability Testing." Using the guidance provided in NSEM 4.09, an annual operability test specific to the Millstone Unit 3 simulator was performed.

Annual operability testing consists of the following items:

- Steady state testing at 25% power, 75% power and 100% power
- Stability testing at 100% power
- Performance testing for ten (10) transients

Reference plant data obtained at 25%, 75% and 100% power during the various plant startups and power reductions was used as the basis for steady state testing. Utilizing the reference plant data, comparisons were made between the simulator and reference plant for approximately 50 selected critical and non-critical points. These 50 points include all those listed in ANSI/ANS 3.5 Section B1.1.

A stability test was performed at 100% power for 50 points over a one hour period. This test was in conformance with ANSI/ANS 3.5 Section B1.1. Acceptance criteria for the steady state and stability tests were based on ANSI/ANS 3.5 Section 4.1. The ten transients described in ANSI/ANS 3.5 Section B1.2 were analyzed using the parameters indicated in ANSI/ANS 3.5 Sections B1.2.1, 2, or 3, as appropriate.

E. PHYSICAL FIDELITY VERIFICATION

ANSI/ANS 3.5 (1985) Sections 3.2 and 3.3.1 require sufficient panels and controls for simulation to conduct normal operations and malfunction response. Further, the simulator instrumentation and controls are required to duplicate the physical characteristics of the reference plant. In response to the issuance of 10CFR55.45, a two step evaluation process was employed for the existing Millstone Unit 3 simulator to ensure compliance with the ANSI/ANS 3.5 Section 3.2 and 3.3.1 requirements.

NU has a strong commitment to maintain the Millstone Unit 3 simulator up to date with the reference plant control boards in a timely manner. NSEM 6.04, "Major Plant Changes," addresses controls on major design changes (such as control room design review) that challenge a "plant referenced simulator" to remain an effective training tool. Minor plant changes are addressed within the time constraints of ANSI/ANS 3.5 Sections 5.2 and 5.3.

F. INSTRUCTOR STATION TESTING

Simulator instructor station testing was performed as described in NSEM 4.11, "Instructor Station," in September, 1998.

Instructor station testing verified correct operation of the following features of the Millstone Unit 3 instructor station:

- Backtrack
- Fast Time
- Slow Time
- Boolean Trigger
- Composite Malfunction
- Variable Parameter Control

- Freeze
- Snapshot

To verify the I/O override feature of the Millstone Unit 3 simulator, a sampling of the following points were tested to verify proper operation.

- Analog Outputs
- Analog Inputs
- Digital Inputs
- Digital Outputs
- "Crywolf" Annunciator feature
- Annunciator Override

The purpose of the I/O override feature testing was to verify the feature itself, not every I/O override point. The Millstone Unit 3 simulator has the ability to I/O override essentially every point on the simulator. While this is a great capability, there are thousands of I/O override points. Curriculum testing of a simulator lesson plan requires the testing of any individual I/O override point to be used in training or exams, thereby verifying the individual I/O override points to be used prior to training.

G. REAL TIME TESTING

Real time testing was performed in August 1996, per NSEM 4.13, "Real Time Simulator Verification."

The purpose of this test was to verify that all simulation models are running in real time. Verification was accomplished by:

- Monitoring the operations of the real time executive and ensuring it is running in real time.

- Running the following complex scenarios and measuring the time used by each of the frames.
  - ATWS (stuck rods)
  - Turbine load reject/trip
  - Steam-Line Break
  - Loss of Coolant Accident

Results: Of the 50 milliseconds available no more than 25.7 msec was ever required, leaving greater than 48.6% spare time at all times.

- Installing software counters to run at the end of each frame and comparing their actual value with values expected to ensure there was no lapse in real time.

The results of these tests show that the Millstone Unit 3 simulator performs in real time.

This test will be repeated once every four years or at any time a question exists that the Millstone Unit 3 simulator is not running in real time.

3. DESCRIPTION OF UNCORRECTED PERFORMANCE TEST FAILURES AND SCHEDULE FOR CORRECTION

NSEM 5.01, "Simulator Modification Control," establishes controls for the coordination, resolution, and documentation of identified differences between the simulator and its reference plant. A Trouble Report (TR) is a form used by the Operator Training Branch and the Process Computers and Simulators department to record all identified discrepancies and ensure that the requirements of ANSI/ANS 3.5 are satisfied. TRs are resolved in accordance with NSEM 5.01, "Simulator Modification Control," and NSEM 6.04, " Major Plant Modifications."

As of September 24, 1998, there are fifty (50) open discrepancies on the Millstone Unit 3 simulator of which three (3) are from performance tests. These three (3) open performance discrepancies are listed in Attachment A. The open discrepancies have been evaluated for training impact. Since each scenario is validated prior to its approval and use, the impact on training is minimal and controlled. Scenarios with unacceptable simulator performance are not used in training. Approximately three hundred (300) discrepancies of all types (e.g. plant design changes) were dispositioned over the past four years.

The previous quadrennial report mentioned the possible resolution of an open DR "with a new NSSS model in 1995-1996." This model upgrade was delayed and has been rescheduled to be completed by December 31, 1998. The upgrade of the NSSS model expands our training capability by increasing the scope of simulation, and reduces the software maintenance effort required to tune transient responses to newly acquired reference plant data. This upgrade of the NSSS model is voluntary and not for the purpose of meeting the requirements of ANSI/ANS-3.5, 1985 (as endorsed by Regulatory Guide 1.149, Revision 1), but will be installed solely as a training enhancement by December 31, 1998. Additionally, the presently installed NSSS model fully supported restart of the unit from the recent extended shutdown.

4. NEXT FOUR-YEAR SCHEDULE, (NOVEMBER, 1998 TO OCTOBER, 2002)

The Millstone Unit 3 performance tests will be repeated over a four year interval as described in Attachment B. This schedule has been written based on the guidance provided in NSEM 4.07, "Master Test Schedule." This four-year interval will start on November 1998.

The following tests must be performed each year:

- Annual operability
- Physical fidelity verification

The following tests must be performed over a four- year interval:

- Normal operations and surveillances
- Malfunctions
- Instructor station
- Real time

5. PLANT DESIGN CHANGES NOT INSTALLED WITHIN 24 MONTHS

There were two plant design changes that were not incorporated within the 24 month time frame per ANSI/ANS 3.5. They were both discovered via in-house audits. One dealt with an indicating light that had not been removed. The other dealt with setpoint changes on the OPDT or OTDT turbine runbacks. Both had minimal to no impact on operator training and have since been incorporated.

6. MAJOR SIMULATOR UPGRADES

In the first quarter of 1996, the Gould 32/87 processors and peripherals were replaced with a SUN SPARCcenter 2000 platform and new peripherals. The re-host included complete benchmark testing against the previous platform by using the simulator operability test. These tests included an instructor station test and all annual operability tests. Any difference in the two benchmarks were resolved before the simulator with the new platform was placed in service.

Millstone Unit 3 Simulator Computer System Configuration

(A) Hardware

- SUN SPARCcenter 2000 dual40-MHz XDBus
- Fast SCSI-2Buffered Ethernet SBus Card (FSBE/S)
- Internal SunCD Drive, 14-Gbyte 8mm Internal Tape Drive

- Three 40 MHz System Boards with Four 85 MHz SuperSPARC-II Modules

- 192 MByte of ECC Memory SIMMs
- DSCSI Drive Tray with 3-2.1 GB drives
- 2 SBus Differential Fast/Wide Intelligent SCSI-2 Host Adapters (DWIS/S)

- Three 20-inch Color Monitors
- Three TurboGX Frame Buffers

(B) Software

- SUN Solaris 2.4 operating system
- Sybase 4.9.2 relational database management system
- Dataview 9.5 graphical tool runtime
- NUSE (Northeast Utilities Simulation Environment)
- NUXIS (Northeast Utilities X-Window Instructor Station)

NUSE

The Northeast Utilities Simulation Environment (NUSE) was developed in-house by the Simulators and Computer Engineering (SCE) staff. The real time portion of NUSE includes the real time executives (MainExec, Rtexec), interactive debugging task (IDT), I/O module, etc. and provides the model execution sequencing, scheduling , panel interfacing and on-line parameter monitoring. The off-line portion of NUSE includes tools and utilities used by engineers to develop, debug and maintain the simulation models.

NUXIS

Northeast Utilities X-Window Instructor Station (NUXIS) was also developed in-house by the SCE staff using Dataview's graphic tools. NUXIS provides a window based, point and click, graphical user interface for instructors. The new instructor station is capable of storing 98 initial conditions versus the 59 which is what was available on the previous model.

(C) Hardware and Software

In 1998 SCE took on the task of updating the hardware to a new SUN Enterprise 3000 server along with incorporating a new NSSS model. This model upgrade was delayed and has been rescheduled to be completed by December 31, 1998. The upgrade of the NSSS model expands our training capability by increasing the scope of simulation, and reduces the software maintenance effort required to tune transient responses to newly acquired reference plant data. This upgrade of the NSSS model is voluntary and not for the purpose of meeting the requirements of ANSI/ANS-3.5, 1985 (as endorsed by Regulatory Guide 1.149, Revision 1), but will be installed solely as a training enhancement by December 31, 1998. Additionally, the presently installed NSSS model fully supported restart of the unit from the recent extended shutdown.

ATTACHMENT A

Millstone Unit 3

OPEN PERFORMANCE TEST DISCREPANCIES

September 24, 1998

The discrepancies identified during the performance testing are listed herein. The discrepancies are annotated as to the proposed schedule for resolution based on Operator Training needs. This schedule is our best estimate at this time, however, it is subject to change based on resources, emergent work, and Millstone Unit 3's needs.

ATTACHMENT A

Millstone Unit 3
Open Performance Test Discrepancies
September 24, 1998

DR Number	Discipline	Due Date	DR Title
1998-3-0130	SW	6/1/99	DRPI Alarms (RD12) Do Not Actuate
1998-3-0167	SW	7/1/99	Malfunction SW06 (SW HDR Failure) Severity Not Correct
1998-3-0170	SW	7/1/99	SW HX Fouling (SW07) Malfunction No Response

ATTACHMENT B

Millstone Unit 3

PERFORMANCE TEST

SCHEDULE

Performance Test:	START	END
Year One:	11/1/1998	10/31/1999
Year Two:	11/1/1999	10/31/2000
Year Three:	11/1/2000	10/31/2001
Year Four:	11/1/2001	10/31/2002

APPROVED: Original signed by MP3 ASOT on 9/11/98
ASOT

YEAR ONE

TEST	DATE	INITIALS
Annual Operability NSEM-4.09		
25% Steady State Accuracy	______	______
75% Steady State Accuracy	______	______
100% Steady State Accuracy	______	______
100% Stability	______	______
Transient #1: Manual Reactor Trip	______	______
Transient #2: Simultaneous Trip of All Feed Water Pumps	______	______
Transient #3: Simultaneous Closure of All Main Steam Isolation Valves	______	______
Transient #4: Simultaneous Trip of All Reactor Coolant Pumps	______	______
Transient #5 Trip of Any Single Reactor Coolant Pump	______	______
Transient #6 Main Turbine Trip at Power Less than P9	______	______
Transient #7 Large Load Rejection	______	______
Transient #8 Maximum Size LOCA with a Loss of Offsite Power	______	______
Transient #9 Maximum Size Main Steam Line Rupture Inside Containment	______	______
Transient #10 Reactor Coolant System Depressurization to Saturation Conditions Using PORV	______	______

YEAR ONE

TEST	DATE	INITIALS
Physical Fidelity Verification NSEM-4.12	_____	_____
Major Malfunctions NSEM-4.04		
• ED01	_____	_____
• FW10A(B)(C)(D)	_____	_____
• MS01A(B)(C)(D)	_____	_____
Malfunctions NSEM-4.05		
• CC System Malfunctions		
CC01 - RPCCW Pump Trip	_____	_____
CC02 - RHR HX CC VV Failure	_____	_____
CC03 - Loss of RCP Cooling Water Supply	_____	_____
CC04 - RPCCW Pipe Leak	_____	_____
CC05 - RPCCW Surge Tk M/U VV Failure	_____	_____
CC06 - RPCCW HX Outlet TCV Failure	_____	_____
CC07 - Safety Injection PP Clr Blockage	_____	_____
CC08 - Charging PP Clg Wtr Sys Blockage	_____	_____
• CH System Malfunctions		
CH02 - CTMT Air Recirculation Fan Trip	_____	_____
CH03 - Chilled Wtr Circulating PP Trip	_____	_____

YEAR ONE

TEST	DATE	INITIALS
CH04 - Loss of CTMT Vacuum	______	______
CH05 - Breach of CTMT Integrity	______	______
CH06 - Control Rod Drive Cooling Fan Trip	______	______
CH07 - Loss of Reactor Plant Chilled Water	______	______
• CR System Malfunctions		
CR01 - Fuel Cladding Failure	______	______
• CS System Malfunctions		
CS01 - Quench Spray PP Trip	______	______
CS03 - CTMT Recirc PP Trip	______	______
CS04 - RWST Leak	______	______
• CV System Malfunctions		
CV01 - Letdown Leak Inside CTMT	______	______
CV02 - Letdown Leak Outside CTMT	______	______
CV03 - Letdown HX Tube Leak to RPCCW	______	______
CV04 - Letdown Temp Transmitter Failure	______	______
CV05 - Letdown Press Transmitter Failure	______	______
CV06 - M/U Control Failure	______	______

YEAR ONE

TEST	DATE	INITIALS
CV07 - RCS Uncontrolled Dilution	______	______
CV08 - M/U Water PP Trip	______	______
CV09 - Volume Control Tank Leak	______	______
CV10 - VCT Lvl Transmitter Failure	______	______
CV11 - Charging Pump Trip	______	______
CV12 - Charging Line Leak Inside CTMT	______	______
CV13 - RCP #1 Seal Failure	______	______
CV14 - RCP #2 Seal Failure	______	______
CV15 - RCP #3 Seal Failure	______	______
CV16 - RCP Thermal Barrier Tube Failure	______	______
CV18 - Charging Flow Control VV Failure	______	______
CV19 - BTRS TCV Failure	______	______
• CW System Malfunctions		
CW01 - Circulating Water PP Trip	______	______
CW02 - Main Condenser Tube Leak	______	______
CW03 - Station Vacuum Priming PP Trip	______	______
CW04 - Traveling Screen High DP	______	______
CW05 - Condenser Tube Sheet Plugging	______	______

YEAR ONE

TEST	DATE	INITIALS
CW06 - Main Condenser Tube Rupture	______	______
• ED System Malfunctions		
ED02 - Unit Service Transformer Failure	______	______
ED03 - Loss of 6.9 KV Bus	______	______
ED04 - Loss of 4160 V Bus	______	______
ED05 - Loss of 480 V Load Center	______	______
ED06 - Loss of Emergency Bus MCC	______	______
ED07 - Automatic Bus Fast Transfer Failure	______	______
ED08 - Loss of Instrument Bus	______	______
ED09 - Loss of Battery Bus	______	______
ED10 - Degraded 345KV System Voltage	______	______
ED11 - EDG Sequencer A Failure	______	______
ED12 - EDG Sequencer B Failure	______	______
ED13 - Loss of Selected Non-Vital MCC	______	______
ED14 - Loss of Annunciator Panel Power Bus	______	______

Normal Plant Evolutions NSEM-4.10

• Plant Startup Normal Ops Test	______	______

YEAR ONE

TEST	**DATE**	**INITIALS**
• Nuclear Startup Normal Ops Test	______	________

YEAR TWO

TEST	DATE	INITIALS
Annual Operability NSEM-4.09		
25% Steady State Accuracy	_____	_____
75% Steady State Accuracy	_____	_____
100% Steady State Accuracy	_____	_____
100% Stability	_____	_____
Transient #1: Manual Reactor Trip	_____	_____
Transient #2: Simultaneous Trip of All Feed Water Pumps	_____	_____
Transient #3: Simultaneous Closure of All Main Steam Isolation Valves	_____	_____
Transient #4: Simultaneous Trip of All Reactor Coolant Pumps	_____	_____
Transient #5 Trip of Any Single Reactor Coolant Pump	_____	_____
Transient #6 Main Turbine Trip at Power Less than P9	_____	_____
Transient #7 Large Load Rejection	_____	_____
Transient #8 Maximum Size LOCA with a Loss of Offsite Power	_____	_____
Transient #9 Maximum Size Main Steam Line Rupture Inside Containment	_____	_____
Transient #10 Reactor Coolant System Depressurization to Saturation Conditions Using PORV	_____	_____

YEAR TWO

TEST	DATE	INITIALS
Physical Fidelity Verification NSEM-4.12	______	______
Major Malfunctions NSEM-4.04		
• MS02A(B)(C)(D)	______	______
• MS03	______	______
• RC02A(B)(C)(D)	______	______
Malfunctions NSEM-4.05		
• EG System Malfunctions		
EG01 - Main Generator Trip	______	______
EG02 - Main Generator Voltage Regulator Fails to Manual	______	______
EG03 - Main Generator Output Bkr Fail to Open	______	______
EG04 - Main Generator Exciter Bkr Trip	______	______
EG05 - SBO Diesel Output Bkr Trip	______	______
EG06 - Diesel Generator Trip	______	______
EG07 - Diesel Generator Fail to Start	______	______
EG08 - Diesel Generator Load Limiter Failure	______	______
EG09 - Main Gen Auto Voltage Regulator Swing	______	______
EG10 - Main Gen Manual Voltage Regulator	______	______

TEST	DATE	INITIALS
Failure		
EG11 - Diesel Generator Fuel Oil Transfer PP Trip	______	______
EG12 - SBO Diesel Supply Bkr Trip	______	______
EG13 - EDG Auto Start Failure	______	______
• FW System Malfunctions		
FW01 - Lowering Condenser Vacuum	______	______
FW02 - Condenser Hotwell Lvl Xmtr Failure	______	______
FW03 - Condensate PP Trip	______	______
FW04 - Condensate Recirc VV FV48 Failure	______	______
FW05 - Condensate Demin DP Increase	______	______
FW06 - LP Htr Byp VV MOV88 Fail open	______	______
FW07 - Feed Water PP Trip	______	______
FW08 - Feed Water Regulating VV Failure	______	______
FW09 - Feed Water Line Rupture Outside CTMT	______	______
FW11 - Feed Water Line Leak Inside CTMT	______	______
FW13 - LP Heater Tube Rupture	______	______
FW14 - HP Heater Tube Rupture	______	______

YEAR TWO

TEST	DATE	INITIALS
FW15 - LP Heater Hi-Hi Lvl Switch Actuates	______	______
FW16 - Fourth Point Htr Drn PP Trip	______	______
FW17 - Moisture Separator Drn PP Trip	______	______
FW18 - MDAFW Pump Trip	______	______
FW19 - TDAFW Pump Trip	______	______
FW20 - AFW Pump Fails to Auto Start	______	______
FW21 - AFW PP Discharge VV Closed	______	______
FW22 - AFW Pipe Rupture Inside CTMT	______	______
FW23 - DWST Rupture	______	______
FW24 - Condensate Storage/Surge Tk Leak	______	______
FW25 - Condenser Air Removal PP Trip	______	______
FW26 - LP Htr Byp VV MOV88 Leakage	______	______
FW27 - Main FW PP Spd Control Fails in Auto	______	______
FW28 - Main Feed PP Recirc VV Fails Open	______	______
FW29 - Main Feed PP Recirc VV Fails Closed	______	______
FW31 - Main Feed Reg VV Byp VV Failure	______	______
FW32 - MSR Drn Tank Dump VV Failure	______	______
FW33 - Condensate PP Coupling Shear	______	______

YEAR TWO

TEST	DATE	INITIALS
FW34 - Hotwell Leakage		
FW35 - Main Feed Reg VV Seat Leakage		
• IA System Malfunctions		
IA01 - Service Air Compressor Trip		
IA02 - Instrument Air Compressor Trip		
IA03 - Loss of Instrument Air		
IA05 - CTMT Instrument Air Supply VV PV15 Fails Closed		
IA06 - Shutdown Instrument Air Compressor Trip		
• MS System Malfunctions		
MS04 - Reheater Stm Sply Press Controller Fail		
MS05 - Moisture Separator Reheater Tube Leak		
MS06 - Main Steam Isolation VV Trip		
MS07 - Main Steam Safety VV Failure		
MS08 - Gland Seal Regulator Failure		
MS09 - Pressure Relieving VV Failure		
MS10 - Extraction Stm NRV Fails In Position		

YEAR TWO

TEST	DATE	INITIALS
• NI System Malfunctions		
NI01 - Source Range Channel Failure	______	______
NI02 - Source Range Channel Noisy	______	______
NI03 - Incorrect Source Range Channel Response	______	______
NI04 - Source Range High Voltage Fails to De-Energize	______	______
NI05 - Intermediate Range Channel Failure	______	______
NI06 - IRNI Channel Improper Compensation	______	______
NI07 - Power Range Channel Failure	______	______
NI08 - PRNI Upper Detector Failure	______	______
NI09 - PRNI Lower Detector Failure	______	______
NI10 - P6 Bistable Failure	______	______
NI11 - P10 Interlock Failure	______	______
NI12 - Power Range Channel Random Noise	______	______

Normal Plant Evolutions Tests NSEM-4.10

TEST	DATE	INITIALS
• Turbine Startup and Generator Synchronization Normal Ops Test	______	______
• Power Ascension Normal Ops Test	______	______
• Reactor Trip and Recovery Normal Ops Test	______	______

YEAR TWO

TEST	DATE	INITIALS
Real Time Simulation Verification NSEM-4.13	______	______

YEAR THREE

TEST	DATE	INITIALS
Annual Operability NSEM-4.09		
25% Steady State Accuracy	______	______
75% Steady State Accuracy	______	______
100% Steady State Accuracy	______	______
100% Stability	______	______
Transient #1: Manual Reactor Trip	______	______
Transient #2: Simultaneous Trip of All Feed Water Pumps	______	______
Transient #3: Simultaneous Closure of All Main Steam Isolation Valves	______	______
Transient #4: Simultaneous Trip of All Reactor Coolant Pumps	______	______
Transient #5 Trip of Any Single Reactor Coolant Pump	______	______
Transient #6 Main Turbine Trip at Power Less than P9	______	______
Transient #7 Large Load Rejection	______	______
Transient #8 Maximum Size LOCA with a Loss of Offsite Power	______	______
Transient #9 Maximum Size Main Steam Line Rupture Inside Containment	______	______
Transient #10 Reactor Coolant System Depressurization to Saturation Conditions Using PORV	______	______

YEAR THREE

TEST	DATE	INITIALS
Physical Fidelity Verification NSEM-4.12	______	______
Major Malfunctions NSEM-4.04		
• RC03A(B)(C)(D)	______	______
• RC09A(B)(C)(D)	______	______
• RC10A(B)(C)(D)	______	______
Malfunctions NSEM-4.05		
• PC System Malfunctions		
PC01 - Loss of Plant Computer	______	______
• RC System Malfunctions		
RC01 - RCS Crud Burst	______	______
RC04 - Reactor Vessel Head Flange Leak	______	______
RC05 - Reactor Vessel Head Vent Leak	______	______
RC06 - Pressurizer Safety Valve Leakage	______	______
RC07 - Pressurizer PORV Leakage	______	______
RC08 - Pressurizer PORV Fails Closed	______	______
RC12 - RCP Oil Leak, Upper Reservoir	______	______
RC13 - RCP Oil Lift PP Failure	______	______
RC14 - RCP Upper Oil Reservoir Clg Wtr Leak	______	______

YEAR THREE

TEST	DATE	INITIALS
RC15 - Pressurizer Safety VV Fails to Open	______	______
RC18 - PORV Fails Open	______	______
• RD System Malfunctions		
RD01 - Rod Bank Continuous Withdrawal	______	______
RD02 - Rod Bank Continuous Insertion	______	______
RD03 - Dropped Control Rod	______	______
RD04 - Stuck Control Rod	______	______
RD05 - Control Rods Fail to Move in Auto	______	______
RD06 - Control Rods Fail to Move in Manual	______	______
RD07 - Controlling Rod Bank Moves Opposite to Auto Demand Signal	______	______
RD08 - Control Rod Speed Failure in Auto	______	______
RD09 - Control Rod Block Failure to Block	______	______
RD10 - Control Rod Position Failure Data A	______	______
RD11 - Control Rod Position Failure Data B	______	______
RD13 - Broken Control Rod	______	______
RD14 - Group Rod Position Failure	______	______
RD15 - Step Cntrs Move One Half Normal Spd	______	______

YEAR THREE

TEST	DATE	INITIALS
RD16 - Control Rods Fail to Fully Insert	______	______
• RH System Malfunctions		
RH01- Residual Heat Removal PP Trip	______	______
RH02 - Loss of RHR PP Suction	______	______
RH03 - RHR Flow Transmitter Failure	______	______
RH04 - RHR Heat Exchanger Tube Failure	______	______
RH05 - RHR PP Seal Failure	______	______
RH06 - RHR PP Fail to Trip on RWST Level Low	______	______
• RM System Malfunctions		
RM01 - Area Rad Mon Failure (CTMT)	______	______
RM02 - Area Rad Mon Failure (Aux & ESF Bldg)	______	______
RM03 - Area Rad Mon Failure	______	______
RM04 - Process Rad Mon Failure (Aux Bldg)	______	______
RM05 - Process Rad Mon Failure	______	______
• RP System Malfunctions		
RP01 - RCS Flow Transmitter Failure	______	______
RP02 - Reactor Trip Actuation	______	______

YEAR THREE

TEST	DATE	INITIALS
RP03 - Phase A CTMT Isolation Actuation	______	______
RP04 - CTMT Spray Actuation	______	______
RP05 - Safety Injection Actuation	______	______
RP06 - CTMT Spray Auto Actuation Failure	______	______
RP07 - Safety Injection Auto Actuation Failure	______	______
RP08 - Main Steam Line Auto Actuation Failure	______	______
RP09 - Manual Reactor Trip Failure	______	______
RP10 - Auto Reactor Trip Failure	______	______
RP11 - Failure of Safety Sys to Auto Actuate	______	______
RP12 - C5 Interlock Failure	______	______
RP13 - P12 Interlock Failure	______	______
RP14 - CBI Auto Actuation Failure	______	______

Normal Plant Evolutions NSEM-4.10

• Surveillance Testing Normal Ops Test	______	______
• Plant Shutdown Normal Ops Test	______	______

YEAR FOUR

TEST		DATE	INITIALS
Annual Operability NSEM-4.09			
25% Steady State Accuracy		______	______
75% Steady State Accuracy		______	______
100% Steady State Accuracy		______	______
100% Stability		______	______
Transient #1:	Manual Reactor Trip	______	______
Transient #2:	Simultaneous Trip of All Feed Water Pumps	______	______
Transient #3:	Simultaneous Closure of All Main Steam Isolation Valves	______	______
Transient #4:	Simultaneous Trip of All Reactor Coolant Pumps	______	______
Transient #5	Trip of Any Single Reactor Coolant Pump	______	______
Transient #6	Main Turbine Trip at Power Less than P9	______	______
Transient #7	Large Load Rejection	______	______
Transient #8	Maximum Size LOCA with a Loss of Offsite Power	______	______
Transient #9	Maximum Size Main Steam Line Rupture Inside Containment	______	______
Transient #10	Reactor Coolant System Depressurization to Saturation Conditions Using PORV	______	______

YEAR FOUR

TEST	DATE	INITIALS
Physical Fidelity Verification NSEM-4.12	______	______
Major Malfunctions NSEM-4.04		
• RC11A(B)(C)(D)	______	______
• RC17	______	______
• RD12	______	______
• SG01A(B)(C)(D)	______	______
Malfunctions NSEM-4.05		
• RX System Malfunctions		
RX01 - RCS Wide Range Press Xmtr Failure	______	______
RX02 - RCS WR Cold Leg Temp Xmtr Failure	______	______
RX03 - RCS WR Hot Leg Temp Xmtr Failure	______	______
RX04 - RCS NR Cold Leg Temp Xmtr Failure	______	______
RX05 - RCS NR Hot Leg Temp Xmtr Failure	______	______
RX06 - Pressurizer Spray VV Auto Cont Failure	______	______
RX07 - Pressurizer Heaters Fail	______	______
RX08 - Failure of RCS Loop Isol VV Temp Interlock to Prevent Opening	______	______
RX09 - Pressurizer Press Xmtr Failure	______	______
RX10 - Pressurizer Lvl Xmtr Failure	______	______

YEAR FOUR

TEST	DATE	INITIALS
RX11 - Steam Generator Press Xmtr Failure	______	_______
RX12 - Steam generator NR Lvl Xmtr Failure	______	_______
RX13 - Steam Generator Feed Flow Xmtr Fail	______	_______
RX14 - Steam Generator Stm Flow Xmtr Fail	______	_______
RX15 - Main Stm Hdr Press Xmtr Failure	______	_______
RX16 - Turbine 1st Stage Press Xmtr Failure	______	_______
RX17 - Loss of Condenser Available Permissive	______	_______
RX18 - Spurious Noise Pickup by RPS Xmtr	______	_______
RX19 - Failure of 3FWS-PT508	______	_______
• SG System Malfunctions		
SG02 - SG Blowdown Isol VV Fails As Is	______	_______
SG03 - Steam Generator Tube Leak	______	_______
• SI System Malfunctions		
SI01 - Safety Injection Accumulator Level Inc	______	_______
SI02 - Safety Injection Accumulator Level Dec	______	_______
SI03 - SI Accumulator N2 Press Dec	______	_______
SI04 - Safety Injection PP Trip	______	_______
SI05 - Safety Injection Accumulator Press Inc	______	_______

YEAR FOUR

TEST	DATE	INITIALS
SI06 - RCS to SI Inner System LOCA	______	______
• SW System Malfunctions		
SW01 - Service Water PP Trip	______	______
SW02 - Service Water PP Failure to Auto Start	______	______
SW03 - Loss of Cooling To Emergency Diesel	______	______
SW06 - Service Water System Break	______	______
SW07 - Service Water Heat Exchanger Fouling	______	______
• TC System Malfunctions		
TC01 - Turbine Trip	______	______
TC02 - Turbine Runback	______	______
TC03 - Turbine Fails to Trip	______	______
TC04 - Turbine Fails to Runback	______	______
TC05 - EHC PP Trip	______	______
TC06 - Turbine Stop VV Fails in Position	______	______
TC07 - Turbine Control VV Failure	______	______
TC08 - Load Shed	______	______
TC09 - Turbine Rate Failure	______	______
TC10 - EHC Input Transmitter Failure	______	______

YEAR FOUR

TEST	DATE	INITIALS
• TP System Malfunctions		
TP01 - TPCCW PP Trip	______	______
TP02 - TPCCW PP Failure to Auto Start	______	______
TP03 - Turbine Lube Oil TCV Failure	______	______
TP04 - Mn Gen Hydrogen Cooling Failure	______	______
TP05 - Mn Gen Stator Coolant PP Trip	______	______
• TU System Malfunctions		
TU01 - Loss of Turbine Lube Oil Supply	______	______
TU02 - Turbine Bearing High Vibration	______	______
TU03 - Turbine Oil PP Trips	______	______
TU04 - Shaft Driven Oil PP Failure	______	______
Normal Plant Evolutions NSEM-4.10		
• Plant Shutdown Normal Ops Test	______	______
• Plant Cooldown to Cold Shutdown Normal Ops Test	______	______
Instructor Sta n Verification NSEM-4.11	______	______