BROWNS FERRY NUCLEAR PLANT

Simulator Four Year Certification Update Report

Test Period 1996 - 1999

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I. INTRODUCTION

This test report is required by 10 CFR 55.45(b)(5)(ii), to be submitted to NRC every four years on the anniversary of the initial certification report. The four year NRC Form-474 initial certification report date was December 13, 1991.

Simulator test schedules were given in the four year report submitted in December 1995 to NRC. Tests were completed as required by American National Standards Institute (ANSI) 3.5-1985 and were performed each year as outlined in the four year proposed schedule. This report outlines the methods and the unresolved discrepancies for each test. The anniversary date for this four year report is December 13, 1999.

II. GENERAL DISCUSSION

The Browns Ferry Nuclear Plant (BFN) simulator has been used for operator training since 1976 (originally built by Singer-Link). It is used to license operators on both Units 2 and 3 with Unit 2 as the simulator reference unit. Since the last four year report submitted in 1995, the Browns Ferry simulator has been used continually for various training at BFN. The simulator has been maintained in accordance with ANSI-3.5 and additional self-imposed requirements. Tuning adjustments are routinely made as plant data is made available and plant design changes have been implemented to ensure simulation models are maintained as close to the referenced unit as practical.

The BFN simulator computer system has been upgraded since the last four year report which was issued on December 13, 1995. The simulator computer systems (Encore 9780s and Concurrent 6650s), originally installed in 1991, were replaced with single-board VME based SPARC8VT computers. Also the ICS computer (VAX 6000) and DECNET intercommunications protocol were replaced with an ALPHA workstation and TCP/IP protocol. The new computer system provides tremendous processing power for simulation, improves software development and maintenance tools, and is Y2K compliant.

Major plant design changes have also been made to the BFN simulator since the previous report. The reactor feedwater level control system and reactor recirculation control system, consisting of GEMAC controllers and software, were replaced with FOXBORO stimulated digital control systems. The GE Power Range Neutron Monitoring upgrade was also installed. This included the instability detection system. Additionally, the simulator was modified to support 105 percent power uprate and 24 month fuel cycles. All simulator computer systems and microprocessor driven instruments were tested and certified as Y2K ready.

III. DESCRIPTION OF COMPLETED TESTS

This section summarizes the tests completed on the simulator over the past four years. Detailed test documentation is maintained by the Simulator Services group at the BFN

Training Center for review, in accordance with the requirements of 10 CFR 55.45(b)(5)(iii). The unresolved discrepancies are described in Section V, Unresolved Test Performance Discrepancies and Resolution Schedule. Any test discrepancies identified during certification testing are resolved though the simulator discrepancy report (DR) or simulator design change request (DCR) process.

A. Steady State Tests

Steady State Tests were performed annually. Plant critical and non-critical test parameters (refer to Table 1) were compared to the equivalent simulator values at each of three power levels. The error was calculated based on plus or minus 2 percent of span for critical and plus or minus 10 percent of span for non-critical parameters. A total of twelve discrepancies were captured in DRs in the last four years: two DRs remain to be resolved.

TABLE 1

CRITICAL TEST PARAMETERS	NON-CRITICAL TEST PARAMETERS
Reactor Thermal Power MWT	Reactor Feedpump Individual Flows
Reactor Electrical Power MWE	Reactor Feedpump Individual Pressures
APRM Power	Reactor Feedpump Turbine Speeds
Power Range Channels	Reactor Feedpump Suction Header Pressure
Recirculation Pump Flows	Condenser Pump Discharge Header Pressure
Total Core Flow	Condenser Pump Discharge Header Flow
Reactor Feedwater Temperature	Condenser Booster Pump Suction Header Press
Reactor Water Level	Condenser Booster Pump Discharge Header Press
Reactor Pressure Wide Range	Condenser Hotwell Level
Reactor Pressure Narrow Range	Condenser Hotwell Temperature
Reactor Feedwater Flow to Reactor	Reactor Feedwater Pressure to Reactor
Main Steam Flow Leaving Reactor	Feedwater Heater Shell Steam Pressures
Condenser Hotwell Pressure	Recirculation Jet Pump Loops Flows
Control Rod Drive Flow	Recirculation Jet Pump Calibrated Flows
First Stage Pressure Governor End	RWCU Demineralizer Flows
	RWCU Loop Inlet Temperature
	RWCU Loop Outlet Temperature

B. Drift Tests

Drift Tests were performed annually. The simulator was reset to 100 percent power and data was collected for an hour for each critical parameter at a rate of one sample per second. Plots were made with this data to check for stability. A parameter would fail the test if it drifted beyond plus or minus 2 percent of the initial value. No test discrepancies occurred.

C. Transient Tests

The ten Transient Tests were performed annually (refer to Table 2). Data was collected for required parameters at a rate of four samples per second. Each year the test results were plotted and compared with responses from the prior year and with initial certification data by a Browns Ferry Simulator certification team. Additionally, data collected from plant transients, when available, was compared to simulator responses. A total of four discrepancies were captured in DRs in the last four years: these discrepancies were resolved.

TABLE 2

TRANSIENT TEST LIST
1. Manual Reactor Trip
2. Simultaneous Trip of All Feedwater Pumps
3. Simultaneous Closure of All MSIVs
4. Simultaneous Trip of All Recirculation Pumps
5. Single Recirculation Pump Trip
6. Main Turbine Trip at Max Power that Does Not Result in Reactor Trip
7. Maximum Power Ramp (100% To 75% Then Back Up To 100%)
8. Maximum Size Reactor Coolant System Rupture Combined with Loss of All Offsite Power
9. Maximum Size Un-Isolable Main Steam Line Rupture
10. Simultaneous Closure of all Main Steam Isolation Valves Combined with Single Stuck Open Safety/Relief Valve. (Inhibit activation of high pressure Emergency Core Cooling Systems.)

D. Procedure Tests

To distribute the work load between each testing year, approximately 25 percent of the procedure tests were performed each year. At the completion of the four year test cycle, each of the procedure tests had been completed. Table 3 provides a summary of the tests performed. Each test used the latest revision of Unit 2 controlled procedures. A total of nine discrepancies were captured in DRs in the last four years: two DRs remain to be resolved.

TABLE 3

PROCEDURE TEST LIST	
Annual Test Period Ending	Procedure Description
1996	General Operating Procedures (GOIs)
1997	Surveillance Instructions (SIs)
1998	Emergency Operating Procedures (EOIs)
1999	Abnormal Operating Procedures (AOIs)

NOTE: The schedule above shows which set of procedures were performed during a particular test year. Detailed procedure numbers are not used because they may change. The test period ends on December 13 of each test year.

E. Malfunction Tests

Similar to the process for procedures testing, approximately 25 percent of required malfunctions were tested annually (refer to Table 4). At the completion of the four year test cycle, each of the required malfunctions had been tested. After inserting each malfunction, simulator response was compared to the Malfunction Cause and Effects document, plant procedures, and available actual plant data. Additionally, a check was made to ensure that an appropriate Initial Condition existed, the simulator could be operated to a steady state condition, operators would take the same actions in the reference plant, the variable rate features (if any) could be manipulated, and whether or not the malfunction could be removed. A total of five discrepancies were captured in DRs in the last four years: one DR remains to be resolved.

TABLE 4

MALFUNCTION TEST LIST				
Annual Test Period Ending	Item Number	Malfunction Number	Malfunction Description	ANSI-3.5 Section
1996	1	TH33	Main Steam Line Break Inside Containment	3.1.2(1b,20)
	2	CU04	RWCU System Suction Line Break	3.1.2(1b)
	3	TH21	Recirculation Pump Suction Line Break	3.1.2(1c)
	4	TH22	Coolant Leak Inside Drywell	3.1.2(1c)
	5	AD01	Relief Valve Failures	3.1.2(1d)
	6	IA01	Loss of Control Air	3.1.2(2)
	7	DG02	DG Trip	3.1.2(3)
	8	ED01	Loss of Offsite Power	3.1.2(3)
	9	ED09	Loss of 4KV Shutdown Board	3.1.2(3)
	10	ED17	Loss of 250V Battery Board 2	3.1.2(3)
	11	ED19	Loss of Unit Preferred	3.1.2(3)

MALFUNCTION TEST LIST				
Annual Test Period Ending	Item Number	Malfunction Number	Malfunction Description	ANSI-3.5 Section
1997	1	TH03	Recirculation Pump Trip	3.1.2(4)
	2	OG02	Loss of Condenser Vacuum	3.1.2(5)
	3	FW20	Condenser Hotwell Level Automatic Makeup Failure	3.1.2(5)
	4	SW04	RCW Pump Trip	3.1.2(6)
	5	SW06	Partial Loss of Plant Preferred System	3.1.2(6)
	6	TH31	Fail the Following Pressure Instruments	3.1.2(7)
	7	SW01	Loss of RBCCW Flow to the Drywell	3.1.2(8)
	8	FW01	Condensate Pump Trip	3.1.2(9)
	9	FW22	Spurious RFPT Low Suction Pressure Trip	3.1.2(10)
	10	RC03	RCIC Low Suction Pressure Turbine Trip	3.1.2(10)
1998	1	RP01	RPS Channel MG Set Failure	3.1.2(11)
	2	RD04	Drift Any Control Rod Out	3.1.2(12)
	3	RD05	Uncouple Any Control Rod	3.1.2(12)
	4	RD06	Stick Any Control Rod	3.1.2(2,13)
	5	RD07	Drift Any Control Rod In	3.1.2(12)
	6	RD13	RMCS Timer Failure	3.1.2(13)
	7	TH23	Fuel Cladding Damage	3.1.2(14)
	8	TC01	Turbine Trip	3.1.2(15)
	9	EG01	Generator Lockout Due to Transformer Faults	3.1.2(16)
	10	TH15	Recirculation System Speed Demand Failure	3.1.2(17)
1999	1	NM16	PRNM NUMAC Critical Failure	3.1.2(19,21)
	2	FW19	Feedwater Line Break in Main Steam Tunnel	3.1.2(20)
	3	NM05	IRM Failure	3.1.2(21)
	4	FW30	Woodward Governor Speed Control Handswitch Failure	3.1.2(22)
	5	TC06	Pressure Regulator Fails Open	3.1.2(22,25)
	6	CS04	Core Spray Logic Power Failure	3.1.2(23)
	7	ED27	250V RMOV Board Breaker Failure	3.1.2(23)
	8	RP06	Auto Scram Channel Failure	3.1.2(24)
	9	TC02	Turbine Bypass Valves Control Unit Failure	3.1.2(24)

Note: The test period ends on December 13 of each test year.

F. Real Time Tests

Computer real time test are run to test the computer complex for verification of real time test. Two types of Real Time Tests were performed:

1. The simulator was set to 100% power initial condition and was placed in Run for 10 minutes. A stop watch was used to independently verify 10 minutes of computer simulation. Problem time and stop watch time matched after the 10 minutes.

2. The simulator uses a real time executive test, which runs continually and monitors the execution of all simulation models. It also logs in a variable the longest frame time over a period of time. One steady state and three transient tests were collected over one minute and the longest frame times were collected and plotted. In all tests, there was more than fifty percent spare time.

No Real Time Test discrepancies were found.

G. Simulator Fidelity

As modifications are being initiated in the plant, design change packages are reviewed by the simulator staff for applicability. Additionally, photographs are made of the plant Main Control Room panels for comparison with the simulator. Items that were identified as having training impact were incorporated into the simulator under the DCR process. Plant changes are required to be compiled at least annually, and appropriate simulator modifications are required to be made within the following year. The required modifications were implemented within these time limits.

H. Simulator Limitations

The Browns Ferry simulator imposes six Limitations (refer to Table 5). The limitations prevent simulator events from exceeding plant design limits. To avoid negative training, which could result from simulator operation during such events, the occurrence of an event on the simulator that progresses beyond the plant design limits causes the simulator to automatically stop (simulator is forced to freeze and a message is displayed on the instructor station indicating the limitation that was exceeded).

TABLE 5

LIMITATIONS LIST
1. Drywell pressure exceeds the design limit (< -2 psig or > 63 psig).
2. Fuel clad temperature exceeds the clad melt point (2200 degrees Fahrenheit).
3. Reactor vessel pressure exceeds design limit (1375 psig).
4. Water entering steam turbines.
5. Suppression pool temperature exceeds boiling point.
6. Core average void fraction > 90% and water level < -400 inches.

I. Simulator Exceptions

Significant differences in simulator fidelity, other than those addressed by open DRs or DCRs, are tracked as Exception Reports (refer to Table 6 for the current list). Each have been evaluated to have no negative impact on training.

TABLE 6

OPEN EXCEPTION REPORT LIST		
Exception Number*	Open Date	Exception Description
1	11/22/91	Additional camera equipment mounted in ceiling of simulator that is not present in the plant control room.
2	11/22/91	Simulator room lighting does not match the plant control room lighting.
4	11/22/91	Panel 2-9-47 is only partially simulated.
5	11/22/91	Panel 0-9-56 is not simulated.
6	11/22/91	Panel 2-9-9 is not simulated.
7	11/22/91	Panel 2-9-46 is not simulated.
8	11/22/91	Panel 2-9-24 is not simulated.
9	11/22/91	Panel 2-9-44 is not simulated.
10	11/22/91	Panel 2-9-59 is not simulated.
11	11/22/91	Panel 2-9-22 is not simulated.
12	11/22/91	Electrical operator typer is not simulated.
13	11/22/91	Drywell TV monitor is not simulated.
14	11/22/91	Panel 2-9-54 has additional instruments.

*Note: For brevity, closed Exceptions are not listed.

IV. Status of Unresolved Test Performance Discrepancies Reported in 1995

Five open test discrepancies were documented in the four year report submitted in 1995. All five items were resolved.

V. Unresolved Test Performance Discrepancies and Resolution Schedule

Five open test discrepancies exist at the start of the next four year testing period. They are planned for resolution as shown in Table 7.

TABLE 7

SCHEDULE FOR THE RESOLUTION OF TEST DISCREPANCIES			
Test	Discrepancy	Description of Discrepancy	Scheduled Date
Steady State	DR-3539	Main Steam Flow leaving the reactor did not fall within criteria for critical parameters.	12/13/2000
	DR-3540	Reactor feedwater temperature did not fall within the criteria for critical parameters.	12/13/2000
Procedure	DR-3531	Discrepancies were noted between the BFNP simulator and the Abnormal Operating Instructions.	12/13/2000
	DR-3532	Malfunction description for malfunction ED25 is incorrect.	12/13/2000
Malfunction	DR-3538	Simulator response did not match the malfunction cause and effects document for malfunction FW19.	12/13/2000

VI. DESCRIPTION OF TEST DIFFERENCES FOR THE NEXT FOUR YEAR TEST PERIOD

During the next four year test period, each simulator test is planned to be performed in a manner similar to that of the previous period; no changes are anticipated in critical and non-critical test parameters.

VII. SCHEDULE FOR TESTING DURING THE NEXT FOUR YEAR TEST PERIOD

Table 8 lists planned test starting dates for the next simulator reporting cycle. The next anniversary of the Four Year Simulator Test Report is December 13, 2003. The only impact to this process may be due to regulatory changes to 10CFR55.45 and supporting documents that are in the planning stages at the time of this report.

TABLE 8

SCHEDULE FOR TESTING DURING THE NEXT FOUR YEAR TEST PERIOD					
Test Type		Planned Start Year 1 (Test Period Ending 12/13/2000)	Planned Start Year 2 (Test Period Ending 12/13/2001)	Planned Start Year 3 (Test Period Ending 12/13/2002)	Planned Start Year 4 (Test Period Ending 12/13/2003)
Procedure *	(25% annually)	7/1/2000	7/1/2001	7/1/2002	7/1/2003
Transient/Real Time	(100%annually)	8/1/2000	8/1/2001	8/1/2002	8/1/2003
Malfunction **	(25% annually)	9/1/2000	9/1/2001	9/1/2002	9/1/2003
Steady State	(100%annually)	10/1/2000	10/1/2001	10/1/2002	10/1/2003

Note: * Procedure tests will be conducted each test year in the pattern shown in Table 3.
** Malfunction tests will be conducted each test year in the pattern shown in Table 4.