SEQUOYAH NUCLEAR PLANT

SIMULATOR

FOUR YEAR TEST REPORT

MARCH 12, 1995

Sequoyah Nuclear Plant Simulator
Four Year Test Report

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I. Introduction

This test report is required by 10CFR55.45(b)(5)(ii), to submit to the NRC every four years on the anniversary of the initial certification report any uncorrected performance test failures and to submit a schedule for the correction of such performance failures, if any. The four year date for certification is March 12, 1995.

Initial Simulator test schedules were given in the certification submitted in March 1991 to the NRC. All test were completed as required by the ANSI 3.5-1985 and were performed each year as outlined in the initial proposed schedule. This report outlines the test methods and the unresolved test deficiencies for each.

II. General Discussion

Since the initial certification submittal, the SQN Simulator has been used nearly continuously for various training needs at Sequoyah. The simulator has been maintained based on ANSI-3.5 as well as additional self imposed requirements. Modifications and tuning adjustments are routinely made as more plant data is available to maintain simulation models as close to the referenced plant as practical. The capacity to add plant modifications and enhance models was recently increased by changing computers.

In the winter of 1994/1995, the original Gould 32/97 computer which ran the computer modeling for the simulator was replaced with a smaller, more efficient, and cost effective computer called a Mercury VA-2. The new computer utilizes the same models as the original computer, with only minor changes needed to make them run on the new platform. A full set of performance certification runs were performed on the new computer and were included as part of the four year certification test. The instructor station was also improved by making this interface much faster.

III. Description of Test Completed

The following is a summary of the test completed on the SQN simulator over the past four years. Test results are maintained in the Sequoyah Simulator Services Section near the plant simulator. They will be maintained there per the requirements of 10CFR55.45(b)(5)(iii).

A. Steady State Test

The steady state tests were performed on the simulator at three power levels each year. Plant critical and non-critical parameters(Appendix A) were compared to the simulator values at each. The simulator value was obtained, compared with plant reference data, and error calculated automatically for both critical and non-critical parameters. The error was calculated based on $\pm$ 2% of span for critical and $\pm$ 10% of span for non-critical parameters for each individual instrument. Any parameter failing this test had a Problem Report written to correct the simulation calculation of the failed parameter. Plant data was collected for each of the mentioned power levels during plant startups for test purposes. Any uncorrected test deficiencies are listed in the Uncorrected Test Performance Deficiencies and Correction Schedule, section IV of this report.

B. Drift Test

The drift test was performed each year for the past four years. The simulator was reset to 100% power and data was collected for an hour for each of the critical parameters at a rate of two

samples per second. Plots were made with this data and checked for stability. A parameter would fail the test if it drifted beyond ±2% of the initial value any time during the hour test. There were no test deficiencies found for simulator drift testing during this report period.

C. Transient Test

The required ANSI 3.5 transient tests, listed in Appendix B, were performed in each of the past four years. Test results were compared to the initial certification transients for comparison. Data was collected for each of the required parameters at a rate of two samples per second. These results were then plotted and compared with the previous year responses and the initial certification transients. Problems identified were documented by the initiation of a Simulator Problem Report. Simulation model changes as a result of repaired simulator problems and plant modifications implemented on the simulator were taken into account for each transient run to ensure proper plant behavior. Problems were then resolved via the Problem Report process. There were no uncorrected test deficiencies from transient testing in this report period.

D. Procedures Test

In each of the previous four years, 25% of the procedure tests were performed. The 25% represents the approximate amount of actual work time to perform the test. The following is a summary of the test performed:

Year 1 Plant start up procedures (General Operating Instructions)
Year 2 Plan shutdown procedures (General Operating Instructions)
Year 3 Emergency Operating Instructions (E's, FR's, ECA's)
Year 4 Abnormal Operating Instructions and Emergency Abnormal Procedures

The tests used the latest revision of the actual SQN Unit 1 plant controlled procedures. Supporting plant instructions were also used during plant startup and shutdown such as System Operating Instructions. Problems encountered during the procedures test were documented on a Problem Report. See the Uncorrected Test Performance Deficiencies and Correction Schedule of this report in section IV.

E. Malfunction Test

Approximately 25% of the certified malfunctions were tested each year. The number ranged from 10 to 16 each year. The malfunction was inserted and checked against the Malfunction Cause and Effects. Certified malfunctions are malfunctions required by ANSI-3.5-1985. See Appendix D for SQN simulator's certified malfunctions. Each malfunction tested was checked by verifying that an appropriate IC existed, simulator could be operated to a steady state condition, operators could take the same actions in the plant, the variable rate effects, and whether or not the malfunction could be removed from the simulation. Problems found in either the Malfunction Cause and Effects or the simulation of the malfunction were documented on a Problem Report. There were no uncorrected test deficiencies from malfunction testing during this test period.

F. Real Time Test

Real time tests were performed manually and is continually being performed automatically. Each transient test was checked by using a stop watch and comparing it with the computer clock for a manual check. However, the simulator uses a real time executive which continually monitors the execution of all simulation models. If a portion of a calculation does not finish in real time, the

simulator will automatically halt. The real time test feature of the simulator runs continuously. During the transient test, no real time failures occurred.

G. Simulator Fidelity

As modifications are being initiated in the plant, the design changes are reviewed by the simulator staff for simulator impact and those that do are incorporated into the simulator. The ANSI requirement that changes be detected within one year of the plant change and another year to modify the simulator has been fully met for changes that impact training. As an additional safety net, plant control room photographs are made of all simulated panels at the end of each refueling outage and compared with the simulator. Differences are then reconciled based on training impact. The photographs help to capture any additional changes made to the plant that were not detected through the design change review process.

Major differences in hardware and software fidelity that will remain and are not planned to be corrected are tracked as Exception Reports. The initial certification identified eleven Exceptions. During the past four years, three exceptions were closed and three additional ones initiated. See Appendix F for the current list of Simulator Exceptions.

The Sequoyah Simulator imposes four limits of simulation. Since the exact response of the plant would be unknown beyond these limits, the simulation is stopped automatically and the simulator is "frozen". This protects the students from negative training. The limits are listed in Appendix G.

IV. Uncorrected Test Performance Deficiencies and Correction Schedule

The following is a summary of the uncorrected performance test deficiencies encountered during simulator certification testing over the last four years.

A. Steady State Test Deficiencies:

PR-1675 SQN U-1 S/G steam flow, feedwater flow, and steam pressures were outside the acceptance criteria between 0.1 to 3% on different steam generators at various power levels on the simulator. This is scheduled to be resolved by 3/1/96.

PR-2101 Simulator S/G WR levels were outside the acceptance criteria by less than 1% at one power level. This planned to be corrected by 10/1/95

B. Transient Testing Deficiencies:

There are no uncorrected performance deficiencies for transient tests.

C. Procedures Test Deficiencies:

PR-1370 Indications of superheated conditions in the reactor core following a LOCA. were incorrect. This is scheduled for correction by 10/1/95.

PR-1786 Heat up of the RCS following a ATWS event does not appear to be severe enough. This is scheduled to be corrected by 4/1/96.

SDCR-S604 Install fire alarm on the simulator. This will be done by 4/1/96.

D. Malfunction Test Deficiencies

There were no uncorrected malfunction test deficiencies.

V. Description of Test Differences

For the next four years all test will be performed in the same manner as the previous four. There will be minor changes made to the parameters collected. They are summarized below.

The critical and non-critical parameter list will be modified as shown in Appendix A. The only difference as compared to the initial certification is that Loop Delta Temperatures were moved from Non-critical to Critical parameter list. Containment pressure, calculated core power (from process computer), and Intermediate Range indications were added to the critical parameter list. These changes were made after reevaluating the various parameters and determining that they more accurately fit the definition of a critical parameter. All of the other original parameters will be maintained.

VI. Simulator Test Schedule

The next four year test schedule is shown in Appendix E. Annual Test Periods 1 through 4 are for years 1996 through 1999 which comprise the next four year simulator certification cycle. Appendix C lists the procedures to be tested for each year. Appendix D lists the malfunctions to be tested for each year. All Steady State, Drift, Transient, and Real Time Test will be performed each year.

CRITICAL PARAMETERS
TABLE 1

Instrument Number	Parameter Description
EI-57-16A	Unit Generator Gross MW
TR-68-2BP01	RC Tref
LR-68-339	Pressurizer 1 Level
PI-68-340A	Pressurizer 1 Pressure
FI-68-6A	RCL1 1 Flow
FI-68-29A	RCL2 1 Flow
FI-68-48A	RCL3 1 Flow
FI-68-71A	RCL4 1 Flow
LI-3-42	Stm Gen 1 Nar Rng Level
LI-3-55	Stm Gen 2 Nar Rng Level
LI-3-97	Stm Gen 3 Nar Rng Level
LI-3-110	Stm Gen 4 Nar Rng Level
SC-CBDG-1&2	Control Bank D Rod Position
FI-3-35A	Stm Gen 1 Feed Wtr In Flow
FI-3-48A	Stm Gen 2 Feed Wtr In Flow
FI-3-90A	Stm Gen 3 Feed Wtr In Flow
FI-3-103A	Stm Gen 4 Feed Wtr In Flow
FI-1-3	Stm Gen 1 Stm Out Flow
FI-1-10	Stm Gen 2 Stm Out Flow
FI-1-21	Stm Gen 3 Stm Out Flow
FI-1-28	Stm Gen 4 Stm Out Flow
NI-41B	Pwr Rng Channel 1 (Quad 4)
NI-42B	Pwr Rng Channel 2 (Quad 2)
NI-43B	Pwr Rng Channel 3 (Quad 1)
NI-44B	Pwr Rng Channel 4 (Quad 3)
TI-68-1	RCS HL Loop 1 Wide Range Temperature
TI-68-24	RCS HL Loop 2 Wide Range Temperature
TI-68-43	RCS HL Loop 3 Wide Range Temperature
TI-68-65	RCS HL Loop 4 Wide Range Temperature
TI-68-18	RCS CL Loop 1 Wide Range Temperature
TI-68-41	RCS CL Loop 2 Wide Range Temperature
TI-68-60	RCS CL Loop 3 Wide Range Temperature
TI-68-83	RCS CL Loop 4 Wide Range Temperature
PI-62-92A	Charging Pump Discharge Header Pressure
PI-1-2A	Stm Gen 1 Stm Out 1 P
PI-1-9A	Stm Gen 2 Stm Out 1 P
PI-1-20A	Stm Gen 3 Stm Out 1 P
PI-1-27A	Stm Gen 4 Stm Out 1 P
PI-1-33	Stm Line Hdr P
PI-3-34	Feedwater Htrs 1 Outlet HdrP
TI-68-2BP02	RCL Highest T-Avg. (Auctioneered)
PDI-30-42	Containment Pressure Channel IV
TI-68-2D	RCS Loop 1 Delta T
TI-68-25D	RCS Loop 2 Delta T
TI-68-44D	RCS Loop 3 Delta T
TI-68-67D	RCS Loop 4 Delta T
U1118	Reactor Thermal Power Calculated
NI-35	Intermediate Range

NON-CRITICAL PARAMETERS
TABLE 2

Instrument Number	Parameter Description
PI-70-24	CCS HX A In Press
FI-62-93	Chrg Hdr Flow
FI-62-82	Let Down Flow Indicator
EI-57-96/1	125VDC Vital Battery Board I Voltage
EI-57-96/2	125VDC Vital Battery Board II Voltage
EI-57-96/3	125VDC Vital Battery Board III Voltage
EI-57-96/4	125VDC Vital Battery Board IV Voltage
EI-57-99	250VDC Battery Board Voltage
EI-57-29	480V S/D BD 1A1-A Voltage
EI-57-30	480V S/D BD 1A2-A Voltage
EI-57-83	480V S/D BD 1B1-B Voltage
EI-57-84	480V S/D BD 1B2-B Voltage
EI-57-39	6.9 kV SD-BD 1A-A Voltage
EI-57-66	6.9 kV SD-BD 1B-B Voltage
EI-57-18	500 kV Bus Voltage
LI-68-367	Reac Lvl Wide Range
LI-68-368	Reac Lvl Narrow Range
LI-68-369	Reac Lvl Plenum
FI-67-61	ERCW Supply Header A Flow
FI-67-62	ERCW Supply Header B Flow
TI-68-2E	RCS Loop 1 T-Avg
TI-68-25E	RCS Loop 2 T-Avg
TI-68-44E	RCS Loop 3 T-Avg
TI-68-67E	RCS Loop 4 T-Avg
TI-68-2A	RCS Loop 1 Overpwr Delta-T
TI-68-25A	RCS Loop 2 Overpwr Delta-T
TI-68-44A	RCS Loop 3 Overpwr Delta-T
TI-68-67A	RCS Loop 4 Overpwr Delta-T
TI-68-2B	RCS Loop 1 Overtemp Delta-T
TI-68-25B	RCS Loop 2 Overtemp Delta-T
TI-68-44B	RCS Loop 3 Overtemp Delta-T
TI-68-67B	RCS Loop 4 Overtemp Delta-T
LI-63-129	SIS Accum Tk 1 Level
LI-63-109	SIS Accum Tk 2 Level
LI-63-89	SIS Accum Tk 3 Level
LI-63-82	SIS Accum Tk 4 Level
LI-63-50	SIS RWST Level Ind
PI-63-108	SIS Accum Tk 2 Press
PI-63-128	SIS Accum Tk 1 Press
PI-63-88	SIS Accum Tk 3 Press
PI-63-62	SIS Accum Tk 4 Press

NON-CRITICAL PARAMETERS
TABLE 2

Instrument Number	Parameter Description
LI-68-300	RCS PRT Level
LI-3-43	cm Gen #1 Wide Rng Lvl Ind
LI-3-56	Stm Gen #2 Wide Rng Lvl Ind
LI-3-98	Stm Gen #3 Wide Rng Lvl Ind
LI-3-111	Stm Gen #4 Wide Rng Lvl Ind
PI-68-301	RCS PRT Press
TI-68-309	RCS PRT Temp
EI-57-15	Generator Volts
EI-57-8	Generator Megavar
PI-3-1	FW Header Pressure

APPENDIX B

TRANSIENT TEST LIST

Transient No.	Description
1.	Manual Reactor Trip
2.	Simultaneous Trip of all FW pumps
3.	Simultaneous Closure of all MSIVs
4.	Simultaneous trip of all RCPs
5.	Trip of any single RCP.
6.	Main turbine trip at Max Power that does not result in reactor trip. (<P-9)
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.	Slow primary system depressurization to saturated condition using pressurizer relief or safety valve stuck open with no high head injection.

APPENDIX C

PROCEDURE LIST AND TEST SCHEDULE

Annual Test Period	Procedure Name, Type, or Process
1.	Plant start up from cold iron to 100% power using General Operating Instructions(GOIs).
2.	Plant shutdown from 100% power using General Operating Instructions (GOIs).
3.	Emergency instructions, including the Functional Restoration Guidelines, and the Emergency Contingency Actions.(E's, FRs, and ECA's)
4.	Abnormal Operating Instructions and Emergency Abnormal Procedures) (AOIs and EAPs).

Please note that a detailed list is not given since procedure numbers do change. The Schedule above shows which set of procedures will be performed during a particular test year.

APPENDIX D
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MALFUNCTION LIST AND TEST SCHEDULE

Baseline Data Source Malfunction Cause and Effects

Annual Test Period	Item No.	Malfunction Definition	Malf Name	ANS 3.5 Section 3.1.2 Reference
1	1	VCT Level Transmitter Fails Hi	CV09	3.1.2(18)
	2	Steam Generator Tube Leak	TH05	3.1.2(1a)
	3	Letdown Line Break Inside Auxiliary Building	CV04	3.1.2(1b)
	4	LOCA Small Leak	TH03	3.1.2(1c)
	5	Pressurizer Safety Failure	TH04	3.1.2(1d)
	6	Stuck Rod	RD13	3.1.2(12)
	7	Loss of non-essential control air	IA02	3.1.2(2)
	8	Total Loss of Offsite Power	ED01	3.1.2(3)
	9	Loss of 6.9kv Shutdown Board	ED06	3.1.2(3)
	10	Loss of 480v Shutdown	ED08	3.1.2(3)
2	1	Loss of 250 vdc Batt Bd	ED15	3.1.2(3)
	2	RCP Locked Rotor	RC01	3.1.2(4)
	3	RCCA Misalignment	RD05	3.1.2(12)
	4	RCW Pump Trip	RW02	3.1.2(6)
	5	Loss of cooling to MFP oil coolers	RW07	3.1.2(6)
	6	RHR Loop Suction Line Blockage	RH04	3.1.2(7)
	7	Reactor Trip Signal Failure	RP01	3.1.2(24)
	8	Component Cooling Pipe Break Inside Containment	CC04	3.1.2(8)
	9	Condensate Booster Pump Trip	CN02	3.1.2(9)
	10	Main Steam Line Break Inside Containment	MS01	3.1.2(20)
	11	Loss of All Feedwater		3.1.2(10)
		* Trip of Turbine MFWP	FW05	
		* Trip of AFWP	FW07	

MALFUNCTION LIST AND TEST SCHEDULE

Baseline Data Source Malfunction Cause and Effects

Annual Test Period	Item No.	Malfunction Definition	Malf Name	ANS 3.5 Section 3.1.2 Reference
3	1	LOCA Hot Leg	TH01	3.1.2(1C)
	2	Main Turbine Hi Vibes	TU02	3.1.2(15)
	3	Main Generator Trip	EG01	3.1.2(16)
	4	Loss of 120 VAC Inverter	ED10	3.1.2(3,11)
	5	T-avg. Control Signal Fails	RX18	3.1.2(17)
	6	Pzr pressure Transmitter Fails Hi	RX07	3.1.2(18)
	7	RHR Pump Trip	RH01	3.1.2(7)
	8	False Auto Reactor Trip Signal	RP05	3.1.2(19)
	9	Main Steam Line Break Outside Containment	MS02	3.1.2(20)
	10	Main Feedwater Line Break Inside Containment	FW23	3.1.2(20)
	11	Dropped Rod	RD07	3.1.2(12)
4	1	Loss of 125 VDC Vital Bus	ED12	3.1.2(3)
	2	PR Channel Output Signal Failure	NI07	3.1.2(21)
	3	#1 Feedwater Heater Level Control Fails Lo	HD12	3.1.2(22)
	4	Loss of Vacuum	CN09	3.1.2(5)
	5	Charging Flow Control Problem, Pzr lvl Swing	CV15	3.1.2(22)
	6	Auto SI Initiation Signal Failure	RP02	3.1.2(23)
	7	Loss of Essential Control Air	IA03	3.1.2(2)
	8	Rods Fail to Move on Demand	RD08	3.1.2(13)
	9	Fuel Cladding Failure	THR02	3.1.2(14)
	10	Main Feedwater Line Break Outside Containment	FW20	3.1.2(20)
	11	IR Channel Failure	NI04	3.1.2(21)
	12	Charging Pumps Trip	CV01	3.1.2(18)
	13	Letdown Relief Valve Fails 62-662	CV16	3.1.2(22)
	14	Failure of Pressurizer PORV	RC05	3.1.2(1D)
	15	Loss of Emergency Generators	EG02	3.1.2(3)
	16	Loss of Condenser Level Control	CN23 CN29	3.1.2(5)

APPENDIX E

SIMULATOR FOUR YEAR TEST SCHEDULE

Annual Test Period	Test Name	Planned Start
1	Simulator Steady State Test	12/1/95
	Normal/Abnormal Operating Instructions(Plant Startup)	9/1/95
	Simulator Transient/Real Time Test	10/1/95
	Simulator Malfunction Test	11/1/95
2	Simulator Steady State Test	12/1/96
	Normal/Abnormal Operating Instructions(Plant Shutdown)	9/1/96
	Simulator Transient Test/Real Time Test	10/1/96
	Simulator Malfunction Test	11/1/96
3	Simulator Steady State Test	12/1/97
	Normal/Abnormal Operating Instructions(Emergency)	9/1/97
	Simulator Transient Test/Real Time Test	10/1/97
	Simulator Malfunction Test	11/1/97
4	Simulator Steady State Test	12/1/98
	Normal/Abnormal Operating Instructions(Abnormal)	9/1/98
	Simulator Transient Test/Real Time Test	10/1/98
	Simulator Malfunction Test	11/1/98

APPENDIX F

SIMULATOR EXCEPTIONS

Exception Number	Open Date	Close Date	Exception Description
1	3/1/91		No camera equipment is installed on the top of the main control room panels at the plant.
2	3/4/91		The simulator has a high ceiling, mercury vapor lights, and cannot simulate the loss of AC powered lights nor is DC standby lighting available.
3	3/4/91		Electrical power distribution cabinet M-7 is not simulated. Remote functions are available for the functions of this cabinet.
4	3/4/91		Panel M-8 is not fully simulated. The rod coil lift disconnect switches are simulated, but the turbine supervisory power drawers are not.
5	3/4/91	7/9/92	Closed
6	3/4/91		Annunciator input panels in the plant, M-21 and 22 are not simulated on the simulator.
7	3/4/91		Control Room panel M-25 is not simulated.
8	3/4/91		Panel M-28A is closer to the horseshoe on the simulator.
9	3/4/91		Electrical Control Board for switchyards is partially simulated.
10	3/4/91	7/9/92	Closed
11	3/4/91	2/23/95	Closed
12	7/21/92		Control Room panel M-31 is not fully simulated.
13	7/31/92		Plant process computer is not fully simulated.
14	11/10/94		Unit 2 procedures cannot be used on the simulator. The simulator is a Unit 1 simulator, used for training on both units.

APPENDIX G

SIMULATOR LIMITATIONS

The following simulator limitations have been imposed to prevent training from occurring when the simulator is operating beyond the planned scope of simulation.

1. Containment pressure exceeds the design limit.

2. Fuel clad temperature exceeds clad melt point.

3. Turbine extraction lines flooded.

4. Turbine shaft seized.

If any above limit is reached, the simulator will freeze and the instructor station will display a "SIMULATOR OUT OF BOUNDS" popup explaining the limit.