

Simulation Facility: Byron

Scenario No.: Operating Test No. **2016 Byron NRC**

N16-1 Rev 0

Examiners:

Applicant:

SRO

RO

BOP

Initial Conditions: IC-16

Turnover: Unit 1 is operating at 54.0% power due to a grid issue, steady state, equilibrium xenon, Boron concentration is 998 ppm. The fuel is preconditioned to 100% power. Online risk is green.

Event No.	Malf. No.	Event Type*	Event Description
1	None	N (BOP, SRO)	Swap stator cooling pumps.
2	None	R (RO, SRO)	Raise power at 0.4 Mw/Min
3	MF NI09D	I (RO, SRO) TS (SRO)	N44 failure high
4	MF CC01B	C (BOP, SRO) TS (SRO)	1A CC pump trip with 1B CC pump autostart failure
5	MF CV08 0 5	C (RO, SRO)	Letdown line pressure detector 1PT-CV131 fails low
6	MF RX02D	C (BOP, SRO)	1D FWRV oscillates in auto
7	MF FW09D	C (SRO)	1D FWRV fails closed resulting in a reactor trip
8	MF TH06C	M (all)	LOCA
9	MF SI01A RF RP84 MF RP15D	C (BOP, SRO)	1A SI pump failure to start & ESF relay failure of 1B SI pump – manual start required

*(N)ormal, (R)eactivity (I)nstrument, (C)omponent, (M)ajor Transient

SCENARIO OVERVIEW

Unit 1 is operating at 54.0% power due to a grid issue, 606 MWe, steady state, equilibrium xenon, Boron concentration is 998 ppm, CBD at 149 steps. The fuel is preconditioned to 100% power. Online risk is green. Following completion of turnover, the shift manager requests the BOP to swap GC pumps in preparation for an OOS on 1GC01PA next shift.

After completing shift turnover and relief, the BOP will swap stator cooling pumps per BOP GC-5.

After swapping stator cooling pumps, the crew will ramp the unit up at 0.4 MW/minute to 88% power, using 1BGP 100-3, Power Ascension.

After a measurable change in power is observed, N-44 fails high, causing CB D to step in. The RO will place rod control to MANUAL after verifying no turbine load shedding is in progress or upon seeing the PRNI failure. 1BOA Inst-1 will be entered, and Tech Spec 3.3.1 will be entered.

After the N-44 failure is addressed, the 1A CC pump will trip and the 1B CC pump will fail to automatically start. The BOP should start the 1B CC pump manually. 1BOA Pri-6 may be entered, and Tech Spec 3.7.7 will be entered.

After the 1B CC pump has been started and the failure has been addressed, letdown pressure transmitter 1PT-131 will fail low. The letdown PCV will close and letdown pressure will rise lifting the letdown line relief valve. The RO will take manual control of letdown pressure controller and restore letdown pressure. The crew may isolate letdown due to the lifting letdown relief valve. If letdown is isolated, it will be restored per 1BOA ESP-2 or BOP CV-17. On-line risk remains yellow.

After the 1PT-131 failure is addressed, 1FW-540, 1D FWRV will begin oscillating in AUTOMATIC. The BOP will take manual control and restore normal feedwater flow. AUTOMATIC operation of 1FW-540 will not be available for the remainder of the scenario.

After normal feedwater flow is restored and the plant stabilized, 1D FWRV will fail fully closed, causing a loss of feedwater to the 1D SG. The reactor will trip or be tripped, and the crew will enter 1BEP-0, and transition to 1BEP ES-0.1 at step 4 of 1BEP-0.

After 1BEP ES-0.1 has been entered, and performed to Step 4, a 5000 gpm leak develops in the 1C cold leg. The crew will manually initiate Safety Injection and re-enter 1BEP-0. BST's will be monitored at this time. 1A SI pump failed to start and will not start if a manual start is attempted. An ESF relay failure will prevent 1B SI pump from starting on the SI signal, but it can be manually started from the MCR. RCP trip criteria will be met, requiring the RCPs to be tripped.

Completion criteria is selection of and transition to 1BEP ES-1.2, Post-LOCA Cooldown.

Critical Tasks

1. Establish flow from at least one high-head SI pump before transition out of E-0' (ERG Critical Task number – CT-7) (K/A: 006000A4.07; importance - 4.4/4.4)
2. Trip all RCPs so that CET temperatures don not become superheated (when forced circulation in the RCS stops). (ERG Critical Task number – CT-16) (K/A: 000009EA1.09; importance - 3.6/3.6)

References

BOP GC-5	1BOA ESP-2
BOP CV-5	1BEP 0
1BGP 100-3,	1BEP ES-0.1
1BGP 100-3T5	1BEP 1
1BOA Inst-1	1BEP ES-1.2
1BOA Pri-6	BOP CX-14

Simulation Facility Byron Scenario No.: Operating Test No. **2016 Byron NRC N16-2 Rev 0**

Examiners: _____ Applicant: _____ SRO
 _____ RO
 _____ BOP

Initial Conditions: IC-18

Turnover: Unit 1 is at 75% power, steady state, equilibrium xenon, MOL. CB D @ 172, Boron concentration is 945 ppm. Online risk is green. 1A MFP ALOP is running to support the 1B TDFP LO pump swap. The 1B TDFP's 1A LO pump will be started and the 1B LO pump secured per BOP FW-10. Secure the 1A MFP ALOP per BOP FW-8 step F.18. SM has given an exception to BOP FW-10 Precaution 2, allowing running only the 1A MFP ALOP versus the entire 1A MFP.

Event No.	Malf. No.	Event Type*	Event Description
1		N (BOP, SRO)	TDFP LO pump swap
2	MF CV23B 50	C (RO, SRO) TS (SRO)	1B LD HX tube leak
3	MF MS04B 100	C (BOP, SRO) TS (SRO)	1B SG PORV spurious open
4	MF TH03C 15	R (RO, SRO) TS (SRO) C (BOP)	1C SGTL with power reduction required
5	MF CV09 50	I (RO, SRO)	1TI 130 failed Low
6	MF TH03C 400	M (ALL)	1C SGTR
7	MF ED04B	M (ALL)	LOOP requiring Natural circ CD using SG PORVs

*(N)ormal, (R)eactivity (I)nstrument, (C)omponent, (M)ajor Transient

SCENARIO OVERVIEW

Unit 1 is at 75% power, steady state, equilibrium xenon, MOL. CB D @ 172, Boron concentration is 945 ppm. Online risk is green. 1A MFP ALOP is running to support the 1B TDFP LO pump swap. The 1B TDFP's 1A LO pump will be started and the 1B LO pump secured per BOP FW-10. Secure the 1A MFP ALOP per BOP FW-8 step F.18. SM has given an exception to BOP FW-10 Precaution 2, allowing running only the 1A MFP ALOP versus the entire 1A MFP.

After completing shift turnover and relief, the crew will swap running 1B TDFP LO pumps using BOP FW-10.

After normal operation, the 1B LD HX develops a tube leak. The crew will enter 1BOA Pri-6 to address the tube leak and swap letdown heat exchangers.

After the letdown heat exchangers have been swapped, 1B SG PORV will spuriously open in AUTO, requiring manual closure.

After the 1B SG PORV failure has been addressed, a SGTL develops in the 1C SG at 15 GPM, which then step increases to 30 GPM. The crew enters 1BOA Sec-8 and determines that a power reduction to 50% within 1 hour is required.

After the ramp has begun, 1TI130 fails low, diverting letdown around the demineralizers. The crew will manually control letdown temperature.

After letdown temperature is stabilized, 1C SGTL will suddenly rupture to 400 gpm. The crew will enter 1BEP-0, trip the reactor and initiate safety injection.

While cooling down the plant in 1BEP-3, the station SAT will fault and offsite power will be lost. The crew will continue the cooldown on natural circulation using the SG PORVs.

Completion criteria is completion of SI termination step 24 in 1BEP-3.

Critical Tasks

1. Isolate feedwater flow into and steam flow from the ruptured SG before a transition to ECA-3.1 occurs (ERG Critical Task number – CT-18) (K/A number – EPE038EA1.32. importance – 4.6/4.7)
2. Establish/maintain an RCS temperature so that transition from E-3 does not occur because the RCS temperature is in either of the following conditions:
 - Too high to maintain minimum required subcooling
OR
 - Below the RCS temperature that causes an extreme (red-path) or a severe (orange-path) challenge to the subcriticality and/or the integrity CSF(ERG Critical Task number – CT-19) (K/A number – EPE038EA1.36 importance – 4.3/4.5)
3. Depressurize RCS to meet SI termination criteria (RCS pressure < ruptured SG pressure AND Pzr level >12%, OR Pzr level > 69%, OR RCS subcooling NOT acceptable) before the ruptured SG safety valve opens. (ERG Critical Task number – CT-20) (K/A number –EPE038EA1.05. importance – 4.1/4.3)

References

BOP FW-10	1BEP-0
BOP FW-8	1BEP-3
1BOA Pri-6	
1BOA Sec-8	

Simulation Facility	<u>Byron</u>	Scenario No.: Operating Test No.: 2016 Byron NRC NRC 16-3 Rev 0
Examiners:	_____	Applicant: _____ SRO
	_____	_____ RO
	_____	_____ BOP
Initial Conditions:	IC-14	
Turnover:	Unit 1 is at 12% power, BOL, ready to synchronize Main Generator. Online risk is green. CBD @ 151 steps, and boron concentration is 1295 ppm. 1BGP 100-3, step F.27 is the next step to perform. Steam dump demand must be raised to 25% to 35% as directed by step 23.o. The offgoing shift has just diluted 150 gallons.	

Event No.	Malf. No.	Event Type*	Event Description
Preload	IMF RP15A MRF RP83 OPEN trgset 2 "zlobyan14 > 0" trg 2 "IMF CV01b" IMF MS01A 100		1A CV pump auto start failure 1B CV pump trip 1A MSIV failed open
1		R (RO, SRO)	Power ascension
2		N (BOP, SRO)	Synchronize Main Generator to grid
3	IMF RX13A 0 15	I (RO, SRO) TS (SRO)	Pressurizer level channel 1LT-459 fails low (Tech Spec)
4	IMF RX30A 65 60 40	I (BOP, SRO)	1FW510A, 1A SG FWRV Bypass valve controller failure
5	MRF ED052A OPEN	C (RO, SRO) TS (SRO)	Loss of power to Pzr Heater Groups B and C (Tech Spec)
6	MRF SW38 OPEN IMF SW06B	C (BOP, SRO)	0B WS pump trip with 0A WS pump auto start failure
7	IMF MS08A 4 120	M (ALL)	Faulted 1A SG
8	Preload	C (RO, SRO)	1B CV pump trips/1A CV pump fails to auto start.
9	Preload		1A MSIV failed open

*(N)ormal, (R)eactivity (I)nstrument, (C)omponent, (M)ajor Transient

SCENARIO OVERVIEW

Unit 1 is at 12% power, BOL, ready to synchronize Main Generator. Online risk is green. CBD @ 151 steps, and boron concentration is 1295 ppm. 1BGP 100-3, step F.27 is the next step to perform. Steam dump demand must be raised to 25% to 35% as directed by step 23.o. The offgoing shift has just diluted 100 gallons.

After completing shift turnover and relief, the crew will continue 1BGP 100-3, step F.27 to synchronize the main generator to the grid. The RO will dilute or withdraw control rods to raise steam dump demand from current demand to 25% to 35% IAW 1BGP 100-3.

After power has been raised and the synchronization is complete, the controlling pressurizer level channel will fail low. Letdown will automatically isolate and the RO will take manual control of charging flow. 1BOA INST 2, OPERATION WITH A FAILED INSTRUMENT CHANNEL, Attachment C, will be implemented. The RO will restore pressurizer level control to automatic after letdown is reestablished and pressurizer level is restored to normal. Technical specification 3.3.1 conditions A and K will be entered. On line risk remains green.

After the pressurizer level channel failure has been addressed, the Feedwater Bypass valve controller on the 1A SG fails high. The BOP will take manual control of feedwater flow. The BOP will maintain feedwater flow control in manual. On line risk remains green.

After the feedwater controller failure has been addressed, the supply breaker to Groups B and C Pressurizer Heaters will trip and will not reset. The crew must enter TS 3.4.9, and energize a set of backup heaters to maintain RCS pressure in the normal band.

After the trip of the Pressurizer Heaters has been addressed, the 0B WS pump will trip, and the 0A WS pump will fail to automatically start on low WS header pressure, so the crew will manually start the 0A WS pump. Crew will enter 0/1BOA SEC-5 for the failure.

After the WS Pump trip has been addressed, the 1A SG steam line will fault outside containment, and the 1A MSIV will fail to close, automatically or manually. The crew will implement 1BEP-0, REACTOR TRIP OR SAFETY INJECTION. When safety injection is actuated, the 1B CV pump will trip. The 1A CV pump must be manually started to establish high head ECCS flow.

After determining 1A SG secondary pressure boundary is not intact the crew will transition to 1BEP-2, FAULTED STEAM GENERATOR ISOLATION.

The crew will complete isolation of 1A SG and transition to 1BEP-1, LOSS OF REACTOR OR SECONDARY COOLANT.

After the steam generator has blown dry, the crew will transition to 1BEP ES-1.1, SI TERMINATION.

The scenario is complete when the crew has stopped the RH pumps in step 10 of 1BEP ES-1.1.

Critical Tasks

1. Manually start the 1B CV pump prior to completion of Attachment B of 1BEP-0.
(ERG Critical Task number – CT-6) (K/A number - 013000A4.01 importance – 4.5/4.8)
2. Isolate 1A Steam Generator prior to exiting 1BEP-2.
(ERG Critical Task number – CT-17) (K/A number - APE040AA1.10 importance - 4.1/4.1)

References

1BGP 100-3	1BEP-0
1BOA INST-2	1BEP-2
1BOA ESP-2	1BEP-1
1BOA SEC-5	1BEP ES-1.1
0BOA SEC-5	

Simulation Facility	<u>Byron</u>	Scenario No.:	Operating Test No. 2016 Byron NRC N16-4 Rev 0
Examiners:	_____	Applicant:	SRO
	_____		RO
	_____		BOP
Initial Conditions: IC-18, 75% power, steady state, MOL			
Turnover: Unit 1 is at 76% power, steady state, MOL, CB D is @ 141 steps and boron concentration is 998 ppm. Online risk is green. Crew is to raise power to 100% for grid demand @ 0.5 MW/min. Crew is to switch Bus 156 from SAT to UAT following ACB 1561 maintenance.			

Event No.	Malf. No.	Event Type*	Event Description
Preload	RP02A RP02B TC03 ZDIHSTG010 NORM		Turbine fails to AUTO trip from Rx trip Manual Turbine trip PB fails to trip turbine
1	None	N (BOP,SRO)	Switch Bus 156 Electrical Lineup
2	None	R (RO, SRO)	Raise power to full power
3	None	TS (SRO)	Notified that 1A SI pump failed ASME surveillance
4	PA0154 ON PA0152 ON zao0iisx032 95	C (BOP,SRO) TS (SRO)	SX Fan high vibration requiring fan swap
5	RX18A 630	I (RO, SRO) TS (SRO)	1A TCOLD RTD Fail High
6	RX04D 0 30	I (BOP,SRO)	Feedwater flow channel 1FT-521 fails Low
7	CV16 0	I (RO, SRO)	VCT Level Channel 1LT-112 Fail Low
8	TH16C	M (ALL)	ATWS 1C RCP Trip with Rx Trip Breakers Fail To Open
9	Pre-load	C (ALL)	Failure of Main Turbine to Trip on auto signal or manual push button (OWS PB will trip it)

*(N)ormal, (R)eactivity (I)nstrument, (C)omponent, (M)ajor Transient

SCENARIO OVERVIEW

Unit 1 is at 76% power, steady state, MOL, CB D is @ 141 steps and boron concentration is 998 ppm. Online risk is green. Crew is to switch Bus 156 from SAT to UAT following ACB 1561 maintenance. 1D CD/CB is OOS for maintenance.

After completing shift turnover and relief, the crew is directed to switch Bus 156 from SAT to UAT following ACB 1561 maintenance using 1BGP 100-3, Step F.43 for reference.

After the Bus power supply swap, the crew will begin a ramp to full power at 0.5 MW/minute.

After the ramp has begun, the Unit Supervisor will be called by Engineering stating that after reviewing the previously run ASME surveillance the 1A SI pump has failed the acceptance criteria.

After the SRO has addressed the SI pump issue, 0B SX MDCT Fan High Vibration will alarm and amps will go high, requiring the 0B SX fan be tripped IAW BAR 0-37-E6 directions. The crew will evaluate SX temperature and decide whether to start 0C or 0D Fan. If sent to the SX Tower for a local inspection, the EO will report the fan gearbox is leaking oil. The US will refer to TS 3.7.9 and determine the LCO is satisfied.

After the SX fan vibration has been addressed, 1A Tcold RTD fails high, requiring entry to 1BOA Inst-2, Operation with a Failed Instrument Channel. This will require entry into Tech Specs by the SRO.

After 1BOA Inst-2 is exited, the controlling feedwater flow channel on the 1B SG fails low. The BOP will take manual control of feedwater flow. 1BOA INST 2, OPERATION WITH A FAILED INSTRUMENT CHANNEL, Attachment G, will be implemented. The BOP will restore feedwater flow control to automatic when SG level is restored to normal. On line risk remains green.

After the FW flow failure has been corrected, VCT Level channel 1LT-112 fails low. RMCS auto makeup will start, and the crew will have to place the Makeup Mode Select switch to Off. Any required makeup will have to be done in Manual.

After the VCT level channel failure has been addressed, the 1C RCP trips. When the crew attempts to trip the reactor, the trip breakers will fail to open. The crew will enter 1BFR S.1, ATWS. At step 16, the crew will be directed to return to 1BEP-0, Reactor Trip or Safety Injection.

After the crew enters 1BFR S.1, the auto turbine trip from a reactor trip signal will not function. The manual Turbine Trip P.B. will also malfunction. The turbine can be tripped via the electronic turbine trip feature associated with DEHC.

Completion criterion is transition to 1BEP-0, Reactor Trip or Safety Injection. The lead evaluator may end the scenario at the transition.

Critical Tasks

1. Isolate the main turbine from the SGs (so that RCS pressure does not exceed 3200 psig (UFSAR 15.8). (ERG Critical Task Number – CT-50) (K/A number – EPE029EA1.13 importance – 4.1/3.9)
2. Insert negative reactivity into the core by at least one of the following methods (prior to procedural step to dispatch operators to locally trip the reactor.):
 - Insert the control rods
 - Establish emergency boration flow to the RCS(ERG Critical Task Number – CT-52) (K/A number – EPE029EA1.14 importance – 4.2/3.9) or (K/A number – EPE029EK3.11 importance – 4.2/4.3)

References:

1BGP 100-3, step F.43
BAR 0-37-E6
1BOA INST-2

1BFR-S.1
1BEP-0

Simulation Facility ByronScenario No.: Operating Test No.: **2016 Byron NRC
NRC 16-5****Rev 0**

Examiners:

Applicant:

SRO

RO

BOP

Initial Conditions: IC-22

Turnover: Unit 1 is at 100% power, steady state, equilibrium xenon, MOL. Online risk is green. 1A AF Flow Test is scheduled to be performed. The unit will be ramped to 97% power at 3MW/min for the flow test.

Event No.	Malf. No.	Event Type*	Event Description
1	None	R (RO, SRO)	Ramp down for AF Flow Test
2	None	N (BOP, SRO)	AF Flow Test
3	MRF ED042H OPEN MRF ED042E OPEN MRF ED042D OPEN IOR ZLO1HSDG0201 OFF	TS (SRO)	Loss of DC to 1B DG (Tech Spec) Online Risk to Yellow
4	IMF RX10A 100 30	I (RO, SRO) TS (SRO)	Turbine impulse pressure channel 1PT-505 fails high (Tech Spec)
5	IMF EG03 90 10	C (BOP, SRO)	Generator voltage regulator failure
6	IMF CV10	I (RO, SRO)	1CV121 fails open
7	IMF RX05 1000 30	I (BOP, SRO)	Steam line pressure detector 1PT-507 fails low
8	IMF ED15C IMF ED15G IMF EG08A	M (ALL)	Dual unit loss of all AC power

*(N)ormal, (R)eactivity (I)nstrument, (C)omponent, (M)ajor Transient

SCENARIO OVERVIEW

Unit 1 is at 100% power, steady state, equilibrium xenon, MOL. Online risk is green. CBD @ 221 steps, and boron concentration is 883 ppm. 1BOSR 5.5.8.AF-1c, Comprehensive IST Requirements for the Motor Driven Auxiliary Feedwater Pump 1AF01PA, Step F.2 is to be performed following online maintenance of the 1A AF flow controllers. 1BOL 7.5 has been entered for 48 hours and will be exited following the successful completion of the surveillance.

After completing shift turnover and relief, the crew will ramp the unit to 97% power at 3MW/min (Rema supplied by QNE) and perform 1BOSR 5.5.8.AF-1c, Comprehensive IST Requirements for the Motor Driven Auxiliary Feedwater Pump 1AF01PA. This procedure has been signed off to step F.1.k.

After a measurable change in power, control power is lost to the 1B DG (both inputs). Tech Spec 3.8.1, condition B applies. The 1B DG will remain unavailable for the remainder of the scenario. On-line risk is yellow.

After the 1B DG failure is addressed and flow test is completed, turbine impulse pressure channel 1PT-505 will fail high over a 30 second period. Control rods will begin automatically withdrawing. After recognizing the instrument failure and checking turbine power stable, the RO will place rod control in manual to stop the outward rod motion. 1BOA INST-2, OPERATION WITH A FAILED INSTRUMENT CHANNEL, Attachment A, will be implemented. The crew will defeat the failed instrument and the RO will restore Tave – Tref deviation. Technical specification 3.3.1, conditions A and P apply.

After the 1PT-505 failure is addressed, the generator voltage regulator output will fail high, causing the main generator to be overexcited. The BOP will turn the voltage regulator off and manually lower main generator excitation using the base adjuster.

After the voltage regulator failure is addressed, 1CV 121 will slowly fail open in AUTOMATIC. The RO will take manual control and restore normal charging flow. AUTOMATIC operation of 1CV121 will not be available for the remainder of the scenario.

After normal charging flow is restored and the plant stabilized, steam line pressure detector 1PT-507 will fail low over a 30 second period. Both main feedwater pumps speed will lower, reducing feedwater flow and causing all steam generator levels to begin lowering. The crew will take actions to stabilize the plant by taking manual control of the main feedwater pumps. 1PT-507 will remain unavailable for the remainder of the scenario. On-line risk remains yellow.

After the 1PT-507 failure is addressed, a loss of all offsite power will occur for both Units. When the 1A DG engine attempts to start, the engine will seize, resulting in a loss of all AC power to Unit 1. Transition will be made to 1BCA-0.0, LOSS OF ALL AC POWER. A limited crosstie to Unit 2 will be required due to the failure of 2B DG to energize bus 142. The crew must restore power to Unit 1. After power is restored to Bus 141, SX will be cross-tied between units per 1BCA-0.0, Attachment C.

The scenario is complete when the crew has crosstied power from Unit 2 to Unit 1, and isolated RCP seal injection by closing seal injection filter inlet valve(s).

Critical Tasks

1. Restore power to Bus 141 (before exiting 1BCA-0.0).
(UFSAR 8.3.1.1.2.2) (K/A number – 000055EA2.03; importance 3.9/4.7)
2. Isolate RCP seal injection before a CV pump is started in 1BCA-0.0.
(ERG Critical Task number – CT-27) (K/A number - 003000A4.01; importance - 3.3/3.2)

References

1BOSR 5.5.8.AF-1c
1BOA INST-2
1BCA 0.0