Sequoyah Nuclear Plant

EMERGENCY OPERATING INSTRUCTION

EOI-2

LOSS OF SECONDARY COOLANT

Units 1 & 2

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PURPOSE

The objectives of these instructions are as follows:

1. To establish stabilized reactor coolant system and steam generator conditions prior to plant cooldown.

2. To minimize the energy release due to the break by isolation of the break where possible.

3. To prevent the PZR safety valves from lifting by dumping steam from all steam generators to the main condenser when possible or to the atmosphere from the unaffected steam generators.

4. To isolate the auxiliary feedwater flow to the affected steam generator, to maximize auxiliary feedwater flow to the intact steam generators, and minimize the energy release.

5. To borate the reactor coolant to establish and maintain reactor shutdown margin.

I. IMMEDIATE OPERATOR ACTIONS

Refer to section on Immediate Operator Actions of EOI-0, Immediate Actions and Diagnostics, if not already performed.

II. MANUAL ACTIONS:

Verify the actuation of steamline isolation. If not actuated, manually initiate steamline isolation.

III. SUBSEQUENT OPERATOR ACTIONS

CAUTION: The diesels should not be operated at idle or minimum load for extended periods of time. If the diesels are shut down, they should be prepared for restart.

NOTE: The process variables referred to in this Instruction are typically monitored by more than one instrumentation channel. The redundant channels should be checked for consistency while performing the steps of this Instruction.

NOTE: The pressurizer water level indication should always be used in conjunction with other reactor coolant system indications to evaluate system conditions and to initiate manual operator actions.

A. If reactor coolant pressure is above the low head safety injection pump shut-off head, manually reset safety injection so that safeguards equipment can be controlled by manual action. Ensure that containment isolation is maintained. Stop the low head safety injection pumps and place in the standby mode and request performance of SI-268 to verify P-4 contact position (failure of P-4 contacts will prevent reset of SI signal).

CAUTION: Whenever the wide range reactor coolant pressure decreases below the low head safety injection shutoff head, the low head safety injection pumps should be manually restarted to deliver fluid to the reactor coolant system.

CAUTION: Automatic reinitiation of safety injection will not occur since the reactor trip breakers are not reset.

CAUTION: Subsequent to this Step, should loss of offsite power occur, manual action (e.g., manual safety injection initiation) will be required to load the safeguards equipment onto the diesel powered emergency busses.

III. SUBSEQUENT OPERATOR ACTIONS (cont.)

B. Stop all reactor coolant pumps after high head safety injection pump operation has been verified and when the wide range reactor coolant pressure decreases to 1550 PSIG.

CAUTION: If component cooling water to the reactor coolant pumps is isolated on a PHASE "B" containment isolation signal, all reactor coolant pumps should be stopped within 5 minutes because of loss of motor bearing cooling.

CAUTION: If the reactor coolant pumps are stopped, the seal injection flow should be maintained.

NOTE: The conditions given above for stopping reactor coolant pumps should be continuously monitored throughout this instruction.

NOTE: See Appendix "A" for guidelines on natural circulation if RCP's are tripped.

C. Determine which steam generator is affected by observing the individual steamline pressures (PAMS). A low steamline pressure compared to the others denotes the faulted loop; terminate auxiliary feedwater to that steam generator and verify main feedwater isolated.

CAUTION: Secondary system breaks inside containment may cause PZR-PORV(s). To fail open, should this occur, isolate associated block valve. Secondary system breaks in area of S/G PORVs may cause their failure in open position, should this occur, isolate if possible. Should the PZR-PORV fail open and not be isolable, go to EOI-1.

NOTE: If no loop has a low steamline pressure compared to the others and all steamlines have been isolated, determine if a break has occurred in the steamline, in the main feedline or in any piping system that connects with the secondary pressure boundary. If no indication of a break in the pressure boundary is found, go to Section III of EOI-0 and re-evaluate the accident with particular emphasis on the Loss of Reactor Coolant. If a leak from the secondary systems is found, continue to follow these instructions.

III. SUBSEQUENT OPERATOR ACTIONS (cont.)

D. Regulate the auxiliary feedwater flow to the steam generators to restore and/or maintain an indicated narrow range steam generator water level (PAMS) or indicated wide range level (PAMS) sufficient to assure that the steam generator tubes are covered. If loss of secondary coolant is inside containment, maintain S/G level between 40% and 71% on narrow range for possible instrument error. If water level increases in an unexplained manner in one steam generator, go to EOI-3, Steam Generator Tube Rupture.

NOTE: Monitor the primary water supply (Condensate Storage Tank) for the auxiliary feedwater pumps and upon reaching a low level, verify auto, switch over to ERCW at ≅ 6" level in condensate storage tank. If auto. switch over does not occur, manually switch over.

E. Monitor Refueling Water Storage Tank level (PAMS).

1. If containment spray has been actuated, and if the containment pressure is reduced to nominal operating pressure (-0.1 to +0.3 PSID) reset containment spray. Spray pumps should be shut off and placed in the standby mode with operable flow paths.

2. The high head and low head safety injection pumps should remain aligned to the Refueling Water Storage Tank. If the Refueling Water Storage Tank low level alarm (≅ 29%) is reached, reset safety injection. Realign all safety injection pumps to the cold leg recirculation mode using the procedure presented in Table E-2.2. Note, if the reactor coolant system pressure is above the shutoff head of the low head safety injection (SI) pumps, stop these pumps and place in a standby mode prior to transfer to cold leg recirculation.

3. If a low Refueling Water Storage Tank level alarm (≅29%) is reached while the containment spray pumps are still running, reset containment spray. Spray pumps should be realigned to the recirculation mode using the procedure presented in table E-2.1 (can not be achieved until RHR pumps are changed over to recircultion mode).

F. Safety injection should be terminated IF:

NOTE: The conditions given below for termination of safety injection should be continuously monitored throughout this procedure.

1. a. One wide range reactor coolant temperature T_H (PAMS) is less than 350°F.

AND

b. Wide range reactor coolant pressure (PAMS) is greater than 700 psig and is stable or increasing.

III. SUBSEQUENT OPERATOR ACTIONS (cont.)

AND

c. PZR water level (PAMS) is greater than 20% of span and rising.

AND

d. The reactor coolant indicated subcooling is greater than $40^{\circ}F$.

NOTE: If all wide range reactor coolant temperature indicators go above $350^{\circ}F$ when attempting to satisfy the conditions of F1, initiate SI manually and continue operation until conditions of F2 or F3 are satisfied.

OR

2. a. Containment pressure or containment radiation or containment recirculation sump levels do not exhibit either abnormally high or increasing readings.

AND

b. All wide range reactor coolant temperature T_H (PAMS) are greater than $350^{\circ}F$,

AND

c. Wide range reactor coolant pressure (PAMS) is greater than 2,000 psig, and is stable or increasing,

AND

d. Wide-range indicated water level in at least one S/G is at or above 76%

AND

e. PZR water level (PAMS) is greater than 20% of span,

AND

f. The reactor coolant indicated subcooling is greater than $40^{\circ}F$.

NOTE: If containment pressure, or containment radiation, or containment recirculation sump level exhibit either abnormally high or increasing readings when attempting to satisfy the conditions of F2, initiate safety injection and continue operation until the following conditions are satisfied.

OR

III. SUBSEQUENT OPERATOR ACTIONS (cont.)

3. a. Containment pressure or containment radiation, or containment recirculation sump level exhibit either abnormally high or increasing readings.

AND

b. All wide range reactor coolant temperature T_H (PAMS) are greater then 350°F,

AND

c. Wide range reactor coolant pressure (PAMS) is greater than 2,00 psig, and is stable or increasing.

AND

d. Narrow range water level in at least one S/G is at or above 40%.

AND

e. PZR water level (PAMS) is greater than 50% of span,

AND

f. The reactor coolant indicated subcooling is greater than 40°F.

THEN

4. Reset safety injection and stop the safety injection pumps not needed for normal charging and reactor coolant pump seal injection flow.

CAUTION: If wide range reactor coolant pressure decreases by 200psi or PZR water level decreases by 10% of span from the point of safety injection termination or reactor coolant subcooling drops below 40°F, Manually Reinitate safety injection to maintain reactor coolant pressure and PZR level. Control reactor coolant pressure to the nominal value which existed when safety injection was initially terminated (T_H equal to or less than 350°) or to a nominal value of 2000 psig (T_H greater than 350°F). Go to EOI-0 to rediagnose the event.

CAUTION: Stopping and starting of the charging/safety injection pumps can cause pump motor overheating or reduced motor life. Hence, if pumps are restarted once after termination, an additional 15°F of subcooling should be added to the required subcooling prior to the second termination of the high head pumps.

III. SUBSEQUENT OPERATOR ACTIONS (cont.)

5. Place all non-operating safety injection pumps in the stand-by mode, and maintain operable safety injection flowpaths.

6. Isolate flow to the reactor coolant system cold legs via the boron injection tank and establish normal charging.

7. Reset containment isolation (Phase A). Re-establish normal makeup to maintain system pressure at values reached when safety injection was terminated ($T_H \leq 350^{\circ}F$) or to a nominal value of 2000 psig ($T_H > 350^{\circ}F$). Ensure that water addition during this process does not result in dilution of the reactor coolant system boron concentration.

8. Re-establish operation of the pressurizer heaters of sufficient pressurizer level to assure coverage of the pressurizer heaters, e.g. through comparisons of pressurizer surge line, water space, and vapor space temperatures and maintain PZR water level between 50% and 70% for instrument error if loss of secondary coolant is inside containment. When system pressure can be controlled by pressurizer heaters, and containment temperatures are low enough to assure proper operation of control systems, restore normal pressurizer level control.

   CAUTION: Should RCS temperature decrease below NDTT for the RX vessel, do not allow pressure to increase above required pressure - temperature limits in TI-28.

G. Monitor either the average temperature indication of core exit thermocouples (if available) or all wide range reactor coolant temperature T_H (PAMS) to verify that RCS temperature is at least $50^{\circ}F$ less than saturation temperature at RCS indicated pressure. If $50^{\circ}F$ indicated subcooling is not present, then attempt to establish $50^{\circ}F$ indicated subcooling by steam dump from the steam generators to the condenser or the atmosphere.

   CAUTION: If steam dump is necessary, reduce the steam generator pressure to 864 psig (200 psi below the lowest steam safety valve setpoint) and maintain a reactor coolant cooldown rate of no more than $50^{\circ}F$/HR, consistent with plant make-up capability.

Steam dump should be initiated in the following manner.

III. SUBSEQUENT OPERATOR ACTIONS (cont.)

1. Establish a flow path in at least one steamline in an intact loop (if possible) IF the main condenser is available and IF an uncontrolled steam release will not be reinitiated upon opening the MSIV.

   a. Transfer the steam dump system to steam header pressure control.

   b. Set the steam header pressure control setpoint to the pressure in the intact steam generator(s) at the time safety injection is terminated.

   c. Close steam seal supply valve 1-560.

   d. On the intact S/G(s), open the bypass warning valves for the MSIV(s).

   e. With MSIV differential pressure less than 100 psig, open MSIV(s) on intact S/G(s).

   f. With conditions stabilized, establish main turbine seals and vacuum per GOI-2.

OR

2. IF all steamline stop valves are CLOSED and cannot be reopened, the main condenser is not available, or the rupture is downstream of the main steamline isolation valves, dump steam to the atmosphere from the intact loops using the steam generator power operated relief valves. Set each steam generator power operated relief valve pressure control setpoint to the pressure in the intact steam generator(s) at the time safety injection is terminated. If 50°F indicated subcooling cannot be established or maintained, then manually reinitiate safety injection. Go to Section III of EOI-0 to re-evaluate the event, unless this re-evaluation has already been performed.

H. Implement emergency plan as required

I. Verify control room vent isolation (See SOI-30.1B).

J. Verify U-2 containment equipment hatch temporary door closed (734el.)

K. Verify Fuel handling floor equipment transfer hatch cover in place (734 el to lower elevations).

L. Place additional CRDM cooling fans and lower containment cooling fans in service if break is inside containment and Phase B isolation has not yet occurred.

M. Transfer NR-45 to 1 SR and 1 IR detector.

III. SUBSEQUENT OPERATOR ACTIONS (cont.)

N. When the reactor coolant temperature and pressure (PAMS) are stable, borate the reactor coolant system to cold shutdown conditions, as necessary.

O. After offsite power is available, establish the auxiliary systems necessary for a controlled cooldown to cold shut-down. If offsite power is available and all reactor coolant pumps are stopped, restart at least one reactor coolant pump in an intact loop (with the pressurizer spray line if possible) for cooldown purposes in accordance with procedures. Maintain subcooled conditions in the reactor coolant system consistent with the normal cooldown curve. If these subcooled conditions cannot be maintained, restart safety injection pumps.

NOTE: If there is significant radioactivity in one or more steam generator's secondary side due to tube leaks and steam is being dumped to the atmosphere, immediately isolate the steam generator associated with the break. If all steam generators with significant radioactivity cannot be isolated, begin cooldown and depressurization of the reactor coolant system to limit the release of radioactivity to the environs.

NOTE: Safety injection pump operation should be reinitiated if an uncontrolled reactor coolant system depressurization or an uncontrolled drop in pressurizer water level occurs during the cooldown process. These criteria apply in lieu of those given in Step F.

P. Stop D/Gs after ≅ 15 minutes (sooner if popossible) if not needed.

Q. After establishing operation of auxiliary systems, initiate a controlled cooldown and depressurization to cold shutdown conditions using Normal Cooldown Procedures.

NOTE: Safety Injection should be reinitiated if an uncontrolled reactor coolant system depressurization or an uncontrolled drop in pressurizer water level occurs during the cooldown process. These criteria apply in lieu of those given in Step F.

NOTE: During the controlled cooldown, the reactor coolant system pressure will decrease below 1550 psig. Tripping the operating reactor coolant pump(s) due to the pressure criterion of Step B is not required. Other criteria of Step B are still applicable at this time.

R. Recovery procedures for the particular event must be developed and implemented to effect plant return to service.

APPENDIX A

NATURAL CIRCULATION

OPERATIONAL GUIDELINES

A. The following are guidelines to determine if natural circulating is taking place in primary system.

1. Core ΔT as read on wide range RTD's (hot and cold) or an indicated ΔT between WR cold leg and incore T/C's, should be stable and temperature dropping a relatively stable ΔT with valves less than 55°F with a gradual decrease indicates natural circulation.

2. Incore T/C's temperature indicating below saturation temperature for the existing primary system pressure.

3. Heat is being removed form primary system by secondary system i.e., SG's steaming and water being added to SG's, and secondary system pressure near saturation pressure for the primary system temperature.

B. Instructions to enhance natural circulation.

1. Keep SG levels in narrow range (tubes covered), between 40% and 71% for post accident instrument error.

2. Keep primary system pressure above saturation pressure for the existing hot leg (WR) or incore T/C temperature if possible.

3. Use steam dump or atmospheric reliefs to steam off and cool primary system.

TABLE E-2.1

CONTAINMENT SPRAY SWITCHOVER TO RECIRCULATION MODE

A. With a low RWST level alarm (≤29%) and containment spray pumps still running, reset containment spray with HS-72-42 & 72-43 and:

1. Stop both containment spray pumps (CSP) ("pull to lock in stop" to preclude the possibility of pump restart while realigning suction valves).

2. Close the following valves:

   a. _____ Close FCV-72-22 containment spray pump A-A suction from RWST (1 minute)

   b. _____ Close FCV-72-21 containment spray pump B-B suction from RWST (1 minute)

3. Open the following ERCW valves (Panel M-27A):

   a. _____ Open FCV-67-125 containment spray HX A ERCW inlet (1 min)

   b. _____ Open FCV-67-126 containment spray HX A ERCW outlet (1 min)

   c. _____ Open FCV-67-123 containment spray HX B ERCW inlet (1 min)

   d. _____ Open FCV-67-124 containment spray HX B ERCW outlet (1 min)

4. Open the following CSP suction valves:

   a. _____ Open FCV-72-23 containment spray pump A-A suction from containment sump (1 min)

   b. _____ Open FCV-72-20 containment spray pump B-B suction from containment sump (1 min)

   _____ [illegible] the pump suction valve from pump or the RWST containment sump valve will not open or not restart the corresponding containment spray pump.

CONTAINMENT SPRAY SWITCHOVER TO RECIRCULATION MODE(cont)

TABLE E-2.1

A. 5. _____ Observe CSP suction valves from containment sump full open. Step 4 above. (1 min)

6. _____ Start containment spray pump A-A (HS-72-27A)

7. _____ Start containment spray pump B-B (HS-72-10A)

8. _____ Verify at least 4500 gpm flow on CSP A-A (FI-72-34)

9. _____ Verify at least 4500 gpm flow on CSP B-B (FI-72-13)

TABLE E-2.2

COLD LEG RECIRCULATION SWITCHOVER INSTRUCTIONS

I. OPERATIONAL STEPS

A. The following automatic phase of switch-over from the injection to the recirculation mode is initiated when the RWST is at low level 29% (120,000 gal) coincident with a containment sump level of 10%.

NOTE: This times provided at the end of subsequent steps are normal times for the valves to travel full stroke.

NOTE: All operator actions must be performed expeditiously, in a precise, orderly sequence. Do not interrupt the changeover operation until all actions are completed. If a valve fails to respond or to completed its demanded operation, postpone any corrective action until the subsequent steps are performed except as noted. Loss of one complete train of power will allow the other train to be swapped, and parallel valves required to be closed will require one valve to be closed locally.

1. _____ Verify RHR pumps operating or start if not.

2. _____ Verify that valves FCV-63-72 (A-A) and FCV-63-73 (B-B) RHR pumps suction from containment sump, start to open while RHR pumps continue to run. (2 min)

CAUTION: If a containment sump valve cannot be opened, stop the corresponding RHR pump.

3. _____ Verify the valves FCV-74-3 and FCV-74-21, RHR pumps suction from RWST start to close. (2 min)

B. The following manual operations are done upon verification that the automatic switchover phase has begun.

CAUTION: Immediately stop any pumps taking suction from the RWST on indication of the RWST being empty. Complete the switchover steps listed below, then restart required pumps.

1. Close the following RHR HX outlet crosstie valves.

a. _____ Close FCV-74-33 (40 sec)

b. _____ Close FCV-74-35 (40sec)

TABLE E-2.2

I. OPERATIONAL STEPS (cont)

2. Open the following component cooling valves: (Panel M-27B)

   a. _____ Open FCV-70-156 RHR HX. A outlet (60sec)

   b. _____ Open FCV-70-153 RHR HX. B outlet (60 sec)

3. Verify flow to the RCS from the safety injection pumps and close the following SI pump miniflow valves:

   a. _____ Close FCV-63-4 SI pump A-A miniflow (10 sec)

   b. _____ Close FCV-63-3 SI pumps A and B miniflow to RWST (10 sec)

4. _____ Verify that the automatic valve realignments in step A above have been completed.

5. Open the following:

   a. _____ Open FCV-63-8 RHR HX A outlet to centrifugal charging pumps suction and SI pump A suction (10 sec)

   b. _____ Open FCV-63-11 RHR HX B outlet to SI pump B suction (10 sec)

6. _____ Close FCV-63-1 RHR pump suction header from RWST (2 min)

   NOTE: 480V breaker must be closed before operating valve from control room (Rx MOV bd A1-A)

7. Open the following parallel valves:

   a. _____ Open FCV-63-6 RHR HX A to SI pump A suction (10sec)

   b. _____ Open FCV-63-7 RHR HX A to SI pump A suction (10 sec)

8. _____ After completion of the above steps verify that the two Si pumps and centrifugal charging pumps are receiving suction supply flow from the RHR pump, and proper flow is established to RCS cold legs on all injection pumps.

   CAUTION: Do not perform steps 9 and 10 until the above verification is made.

TABLE E-2.2

I. OPERATIONAL STEPS (cont)

9. _____ Close FCV-63-5 safety injection pump suction from RWST (2 min)

10. Close the following:

a. _____ Close FCV-62-135 RWST to centrifugal charging pump suction (10 sec)

b. _____ Close FCV-62-136 RWST to centrifugal charging pump suction (10 sec)

11. Periodically check auxiliary building area radiation monitors for detection of leakage from ECCS during recirculation. If significant leakage has been identified in the ECCS, attempt to isolate the leakage. The recirculation Flow to the RCS must be maintained at all times.

12. While the plant is in cold leg recirculation mode, make provisions for an evaluation of equipment in the plant.

II. VERIFICATION:

A. After completing the preceding steps, verify that the safety injection system is aligned for cold leg recirculation as follows:

1. One low head safety injection pump is delivering from the containment recirculation sump directly to two reactor coolant system cold legs and to the suction of two charging/safety injection pumps.

2. The other low head safety injection pump is delivering from the containment recirculation sump directly to two reactor coolant system cold legs and to the suction of two high head safety injection pumps.

3. The two high head safety injection and two charging/safety injection pumps are taking suction from the low head safety injection pumps and are delivering to four reactor coolant system cold legs.

4. The suction paths from the RWST to all safety injection pumps have been isolated.

5. If containment spray is required, verify that flow is being delivered.

B. If any failures have occurred, proceed to contingency actions.

TABLE E-2.2

III. CONTINGENCY ACTIONS

A. CONTAINMENT RECIRCULATION SUMP VALVE FAILS TO OPEN

If a containment recirculation sump valve cannot be opened, stop the corresponding low head safety injection pump and verify that:

1. One low head safety injection pump is delivering flow to two reactor coolant system cold legs and to the suction of the two high head safety injection and two charging/safety injection pumps.

2. The two high head safety injection and the two charging/safety injection pumps are delivering to four reactor coolant system cold legs.

B. LOSS OF ONE TRAIN OF ELECTRICAL POWER

If the single active failure is the failure of one of the emergency diesel generators to start in conjunction with a LOCA and a loss of offsite power, electrical power would not be available to one of the vital safeguard busses. As a consequence, all engineered safeguards equipment assigned to that corresponding electrical power train would not be available for operation until power could be restored to that bus. The instruction for switchover to cold leg recirculation, assuming a train failure, is essentially the same as the instruction, which assumed no single failures. The operator could follow the instruction which assumed no single failure, with the understanding that those valves, without power, do not have to be repositioned.

It should be noted that if a train failed subsequent to the initiation of the safety injection signal additional steps may be required. For example, if no failure is assumed, the parallel suction valves in the line from the RWST to the charging/safety injection pump suction header would open on a safety injection signal. Should a subsequent failure of one of the electrical trains occur, one of the parallel suction valves could not be closed from the main control board. Therefore, position isolation of the RWST to charging/safety injection pump suction path would have to accomplished locally.