SOUTH CAROLINA ELECTRIC AND GAS COMPANY

VIRGIL C. SUMMER NUCLEAR STATION

NUCLEAR OPERATIONS

NUCLEAR OPERATIONS
FOR INFORMATION ONLY

# EMERGENCY OPERATING PROCEDURE

# EOP-13

# NATURAL CIRCULATION

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SAFETY RELATED

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## 1.0 PURPOSE

1.1 This procedure provides guidance to the operator on how to place the reactor coolant system in a stable condition utilizing natural circulation in the event of a loss of forced reactor coolant flow. Its intent is to insure adequate core cooling and prevent possible core damage due to overheating.

## 2.0 REFERENCES AND GLOSSARY

2.1 References

2.1.1 V. C. Summer Technical Specifications

2.1.2 V. C. Summer GOP-4, Power Operation

2.1.3 V. C. Summer GOP-5, Plant Shutdown from minimum load to Hot Standby

2.1.4 V. C. Summer EOP-1, Safety Injection

2.1.5 V. C. Summer EOP-4, Station Blackout

2.1.6 V. C. Summer EOP-5, Reactor Trip

2.1.7 Westinghouse generic procedure A-4

2.1.8 Westinghouse generic procedure A-6

2.1.9 Westinghouse Precaution, Limitation Setpoints study for V. C. Summer Nuclear Station.

2.2 GLOSSARY

2.2.1 NATURAL CIRCULATION - The flow of coolant through the reactor coolant system utilizing a thermal driving head.

2.2.2 ADEQUATE CORE COOLING - Adequate core cooling exists when:

A. Pressurizer pressure is maintained above (2000) psia. The desired control band is between (2200) psia and (2300) psia.

B. Pressurizer level is maintained at or above programmed no-load level.

C. Average core coolant exit temperature is being maintained at (600°F) or below by steam dump to the condenser and is slowly decreasing.

D. Charging flow, letdown flow and seal injection flow are normal.

E. Emergency feedwater pumps are in operation delivering to the active steam generators.

F. Steam generator water level is being maintained above the top of the tube bundle by operator positioning of the Emergency feedwater flow control valves. The desired control point is the no-load programmed level in each steam generator. To cool down steps 7 & 8 are additionally required.

G. Reactor coolant boron concentration in the active portions of the system is as necessary to provide the shutdown reactivity margin required by the Plant Technical Specifications when calculated on the basis of homogeneous distribution or boron within the total coolant mass.

H. Reactor makeup control is in automatic and set to deliver at the required boron concentration.

2.2.3 ABBREVIATIONS

BOP - Balance of Plant

CST - Condensate Storage Tank

EOP - Emergency Operating Procedure

GOP - General Operating Procedure

KV - Kilovolt

MCB - Main Control Board

MSIV - Main Steam Isolation Valve

NR - Nuclear Recorder

PORV - Power Operated Relief Valve

RCS - Reactor Coolant System

RHR - Residual Heat Removal

Rx - Reactor

S/G - Steam Generator

SI - Safety Injection

SOP - System Operating Procedure

$T_C$ - Cold Leg Temperature

$T_H$ - Hot Leg Temperature

## 3.0 SYMPTOMS

3.1 Rx Coolant low flow alarms actuated for all three loops.

3.2 Rx Coolant pump motors indicate 0 Amps and a green light.

3.3 Rx Coolant loop flow indicators indicate little or no flow.

3.4 Loss of BOP 7.2 KV electrical buses.

## 4.0 AUTOMATIC ACTIONS

4.1 Rx Trip

4.2 Turbine Trip

4.3 Generator Trip (after 30 second time delay)

## 5.0 IMMEDIATE OPERATOR ACTIONS

5.1 Verify Reactor Trip/Turbine Trip. Manually trip the reactor if power level is below P-7 (10% Rx Power).

5.1.1 Verify all control and shutdown rods are fully inserted by digital rod position indication and rod bottom lights.

A. If the reactor has not tripped:

1. Manually trip the Rx and turbine from the MCB.

2. If the Rx does not trip place XSW1B1 and 1C1 BUS TIE BKR in MANUAL and OPEN XSW1B1 and 1C1 FDR BKR.

| NOTE: | Bus 1B1 and 1C1 may be re-energized when rods are inserted. |
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5.1.2 EMERGENCY BORATE approximately 17 minutes (100 ppm) for each control or shutdown rod not fully inserted.

5.1.3 Verify Rx Power decreasing and transfer NR-45 recorder to one source range and one intermediate channel.

5.1.4 Verify Turbine Trip:

A. If turbine has not tripped:

1) Trip turbine from MCB or turbine front standard OR

2) Stop EHC Pumps A and B OR

3) Close all main steam isolation valves.

5.2 Verify pressurizer pressure and level are beginning to recover from the transient.

5.2.1 If not recovering evaluate conditions for safety injection systems. If necessary safety inject and go to EOP-1, Safety Injection.

5.3 Verify main generator trip approximately 30 seconds after turbine trip.

5.3.1 Generator output breaker open.

5.3.2 Generator field breaker open.

5.3.3 Turbine speed decreasing.

5.4 Announce condition over paging system.

## 6.0 FOLLOW UP ACTIONS

NOTE: Check or initial steps indicated as they are completed.

6.1 Verify all automatic and immediate actions have been completed.

CAUTION: If at any time it is determined that adequate core cooling does not exist, Safety Inject and go to EOP-1, Safety Injection.

NOTE: At anytime conditions permit and the requirements for starting a reactor coolant pump are satisfied as per SOP-101, restart at least one reactor coolant pump and use normal plant recovery procedures.

NOTE: This procedure may be used concurrently with EOP-1, Safety Injection; EOP-4 Station Blackout; and EOP-5 Reactor Trip.

6.2 If the condenser is available, transfer STEAM DUMP SELECT switch to STM PRESS MODE position.

6.2.1 Verify STEAM DUMP pressure controller is set for 1092 psig.

6.3 If the condenser is not available switch the MS LINE SD/PWR RLF valves (IPV-2000, 2010, 2020) to the POWER RELIEF position.

6.3.1 Verify the controller for each valve is set for 1090 psig.

6.3.2 If the S/G PORV's are not operable from the MCB they can be operated with local manual hand wheels.

A. Establish communication between the control room and the operator at the valve(s).

B. Slowly open the valve until the desired steam flow to maintain 1092 psig is established.

6.3.3 If a S/G PORV sticks open it must be closed locally by operation of the manual hand wheel or by manually closing the isolation valve upstream of the S/G PORV.

6.4 Start or verify auto starting of the Emergency Feedwater Pumps.

NOTE: Based on conditions both motor driven emergency feedwater pumps and the turbine driven emergency feedwater pump may have started. It is preferable to use the two motor driven emergency feedwater pumps for cooldown operations.

6.4.1 Verify emergency feedwater flow to all S/G's.

6.5 If feedwater flow is unavailable, implement EOP-14, Inadequate Core Cooling, concurrently with this procedure.

6.6 Monitor condensate storage tank level throughout this procedure and:

6.6.1 If CST level reaches the low-low level alarm switch to service water backup:

A. For motor driven emergency feedwater pumps open

1. MVG-1001A-EF
2. MVG-1037A-EF
3. MVG-1001B-EF
4. MVG-1037B-EF

B. For turbine driven emergency feedwater pump open

1. MVG-1002-EF and XVG-1037B OR
2. MVG-1008-EF and XVG-1037A

6.6.2 If Emergency Feedwater Pump Suction Low alarm is received verify automatic switch over to service water supply.

6.7 Adjust Emergency Feedwater flow to establish and maintain stable S/G levels of between 25 and 30% of narrow range span. _____

6.7.1 Place †FV-3531, 3541, 3551 in RESET than MANUAL.

6.7.2 Adjust HCV-3531, 3541, 3551 for desired flow.

6.7.3 Stop the Turbine Driven Emergency Feedwater Pump when S/G low level alarms clear.

6.7 Trip all operating Main Feedwater Pumps. _____

6.8 Monitor system parameters to verify that natural circulation is being established and that plant conditions are stabilizing. _____

6.8.1 Verify steam generator pressures are stabilized at setpoint pressure ( 1092 psig).

6.8.2 Verify $T_H$ is $\leq$ 600°F and stable or decreasing.

6.8.3 Verify $T_H$ minus $T_C$ is between 15°F and 50°F.

6.8.4 Verify pressurizer pressure is recovering to normal operating pressure ( 2235 psig).

6.8.5 Verify pressurizer level is recovering to normal no-load level (25% of span).

6.8.6 Verify that RCS subcooling exists .($\geq$ 50°F).

6.9 If natural circulation flow is insufficient to remove total decay heat from the core ($T_H$ above 600°F or increasing) reset the MS LINE POWER RELIEF controller to a lower setpoint.

6.10 If $T_H - T_C$ T is greater than 50°F reduce emergency feedwater flow to raise $T_C$. OR

6.10.1 Decrease steam dump flow.

6.11 If pressurizer pressure is increasing de-energize pressurizer heater groups to stabilize.

| CAUTION: Normal pressurizer spray is inoperable. |
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6.12 If pressurizer level is increasing adjust charging and letdown as necessary.

6.13 If pressurizer pressure and level continue to decrease slowly evaluate for an RCS leak and implement EOP-12, Loss of Reactor Coolant without Safety Injection, concurrently with this procedure.

6.14 $T_H$ $T_C$ reading will indicate trends and may be irratic. They can be verified by:

6.14.1 Using the steam tables convert S/G pressure to saturation temperature and use as $T_C$.

6.14.2 Use the incore thermocouple to determine $T_H$. This can be done on the plant computer.

A. Push In-Core T/C map
B. Push Numerical 0 and Valve 1
C. Push Valve 2 and Start

6.15 Maintain the reactor coolant system in a stable natural circulation mode while completing any concurrent emergency procedures.

6.15.1 Initiate a log of Pressurizer Pressure, $T_H$, $T_C$, S/G pressure at 15 minute intervals.

| NOTE: The following sections will cool down the reactor coolant system utilizing natural circulation. Do this section only if forced reactor coolant flow cannot be reestablished without cooling down. |
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6.16 Slowly decrease either the STEAM DUMP PRESSURE or S/G PORV controller(s) in 100 psig increments maintaining the minimum P between steam generators.

6.17 Adjust emergency feedwater flow as necessary to maintain stable S/G levels.

6.18 Plot RCS temperature versus pressure on a Reactor Coolant System - Pressure/Temperature Limits curve using $T_H$ instead of $T_{avg}$.

6.19 Decrease pressurizer pressure to maintain < 1600 psid across the steam generator tubes.

6.19.1 De-energize pressurizer heaters.

6.19.2 Cycle pressurizer PORV's.

CAUTION: Verify pressurizer PORVS reset or close the associated isolation valve.

6.20 Wait between pressures decreases until natural circulation heat removal at the new pressure is confirmed and stabilized.

6.20.1 $T_H$ has decreased and stable.

6.20.2 $T_H - T_C$ is between 15° and 50°F.

6.20.3 Reactor Coolant has a minimum of 50°F subcooling.

6.21 Borate the reactor coolant system as necessary to maintain the required shutdown reactivity margin as per SOP-106, Section 4.4.

6.21.1 Monitor nuclear instrumentation to confirm the continued subcritical condition of core.

6.21.2 Sample for boron concentration to insure mixing.

A. All three hot legs
B. Pressurizer liquid volume
C. Letdown

6.22 Bypass steam dump interlock at 553°F by turning both INTERLOCK switches to Bypass Interlock.

NOTE: Due to no flow in the RTD manifold it will be necessary to defeat the $T_{avg}$ Interlock whenever $T_{avg}$ indicates 553°F.

6.23 Continue cooldown as per steps 6.16 through 6.20 until reactor coolant system is at 350°F and 400 psig.

6.24 Reference GOP-6, Section 5.0 for additional actions.

## 7.0 FINAL CONDITIONS

7.1 The reactor coolant system is stable at 600°F in a free convection heat transfer mode or

7.2 The reactor coolant system has been cooled down to 350°F and depressurized to 400 psig and ready for RHR operation.