GE Nuclear Energy

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REVISION STATUS SHEET

DOCUMENT TITLE IOP-7, COOLDOWN TO COLD SHUTDOWN, MAIN CONDENSER NOT AVAILABLE

LEGEND OR DESCRIPTION OF GROUPS

TYPE: OPERATING PROCEDURE

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1.0 SCOPE/APPLICABILITY

This procedure provides the detailed instructions for performing and sequencing the various steps required to achieve and maintain cold shutdown conditions when the main condenser is not available, utilizing the Reactor Safety Relief Valves and the RHR Shutdown Cooling Mode for depressurization and cooldown.

2.0 DISCUSSION

This procedure provides the means for organizing the diverse activities associated with conducting a unit cooldown to a cold shutdown condition with the main condenser not available. The cooldown process consists of depressurization using primarily the Reactor Safety Relief Valves, controlling suppression pool temperature using the RHR Suppression Pool Cooling Mode, and cooldown of the reactor using the RHR Shutdown Cooling Mode.

Cold Shutdown condition is defined as follows: Reactor Mode Switch in the SHUTDOWN position, and reactor coolant temperature ≤ 93 °C.

The depressurization and cooldown actions may be conducted subsequent to the completion of IOP-5, "Unit Shutdown to Unit Off-Line, Main Condenser Available".

3.0 PRECAUTIONS AND LIMITATIONS

3.1 Do not exceed a cooldown rate of 55 °C per hour as averaged over any one-hour period.

3.2 Limit the cooldown rate such that the rate of positive reactivity insertion added by cooldown does not exceed the capability of the control rods to insert negative reactivity to maintain the reactor subcritical.

3.3 Maintain reactor water level in the normal operating range of 425.5 cm to 448.5 cm on the Narrow Range water level instruments through out the cooldown.

3.0 PRECAUTIONS AND LIMITATIONS(continued)

3.4 When reactor coolant temperature is maintained at less than 100 °C, maintain reactor water chemistry within the following limits:

Chlorides	< 10 ppb
Conductivity at 25 °C	< 1.0 µS/cm
pH at 25 °C	5.9 – 8.3
Silica (SiO_2)	< 100 ppb
Sulfate	< 10 ppb
Total Iron (Fe)	< 10.0 ppb
total Copper (Cu)	< 0.5 ppb
All other metals	< 4.5 ppb

3.5 Maintain Control Rod Drive Hydraulic System cooling water chemistry within the following limits:

Chlorides	< 10.0 ppb
Conductivity* at 25 °C	< 0.25 µS/cm
Silica (SiO_2)	< 20.0 ppb
Sulfate	< 10.0 ppb
pH	6.2 – 8.0
Total Iron	< 10.0 ppb
Total Copper (Cu)	< 1.0 ppb
All other metals	< 4.0 ppb
Organic Impurities [Equivalent ΔK (µS/cm)]	< 0.2

* Does not include an incremental conductivity value of 0.8 µS/cm at 25 °C due to carbon dioxide from air in the water stored in tanks open to the atmosphere.

4.0 PREREQUISITES

4.1 The reactor is shutdown, or subcritical and proceeding to full shutdown and mode switch is in STARTUP/HOT STANDBY position.

4.2 At least the following systems are available for reducing reactor pressure and to achieve the cooldown:

a. RHR System for operation in the Suppression Pool Cooling and Shutdown Cooling Modes.

b. Reactor Safety/Relief valves for depressurization.

c. Reactor Building Cooling Water System to provide cooling water to the RHR heat exchangers.

d. Suppression Pool water level at the normal range [later] and average temperature less than [later] to provide a heat sink for depressurization.

5.0 PROCEDURE

*** *NOTE* ***

This procedure begins with the assumption that the plant is at normal operating temperature and pressure, reactor shutdown or currently in progress. As specific to the initial conditions of pressure and temperature, this procedure may be entered wherever appropriate. This procedure may be terminated whenever the desired conditions are achieved.

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5.1 Preparation for Cooldown

5.1.1 Initiate the recording of cooldown trend of at least the following parameters:

- Cooldown Rate
- Bottom Head Drain Temperature [later]
- Coolant Temperatures [later]

5.1.2 Verify the appropriate CRT displays have been selected per SOP-[later], "Performance Monitoring System".

5.2 Main Steam System Isolation and Reactor depressurization

5.2.1 Start the RCIC System to provide high pressure makeup to the reactor vessel and to assist RPV depressurization.

5.2.2 Initiate two loops of the RHR system in the Suppression Pool Cooling mode per SOP-E11, "Residual Heat Removal System".

5.2.3 Use the following sequence of Safety Relief valve opening to control reactor pressure: [sequence later]

5.2.4 Shutdown the motor-driven feedpump, per SOP-[later], "Condensate and Feedwater System". Maintain MDRFP in "Standby" until reactor pressure has decreased below 40 kg/cm^2.

5.2.5 If main condenser vacuum is to be maintained, startup the Startup SJAEs and shutdown the main SJAEs per SOP-[later], "Condenser Evacuation System", and shift the turbine gland sealing steam to the Auxiliary Boiler.

5.2.6 Align the Feedwater and Condensate System in the Long Cycle or Short Cycle Cleanup mode per SOP-[later], "Condensate and Feedwater System".

5.2.7 Close the inboard MSIVs (B21-F071s) one at a time by placing its control switch to TEST CLOSE position.

5.2.8 Close the main steam line drain line containment isolation valves (B21-F141 and F142).

5.2 Main Steam System Isolation and Reactor depressurization (continued)

5.2.9 When steam pressure downstream of the MSIVs has decreased to [later], similarly close the outboard MSIVs (B21-F072s).

5.2.10 Continue to use the designated Safety Relief valves to depressurize the reactor and maintain the specified cooldown rate **UNTIL** reactor pressure has decreased to a pressure where the shutdown cooling interlock has cleared. Place remaining loop of RHR System in the Suppression Cooling mode if necessary to control suppression pool temperature.

5.3 Shutdown Cooling

5.3.1 Warm one loop of RHR for shutdown cooling operation per SOP-E11, "Residual Heat Removal System". During warming of the RHR, control and maintain RPV pressure with RCIC to below the shutdown cooling interlock pressure.

5.3.2 When warming is complete, initiate one loop of the RHR System in the Shutdown Cooling mode per SOP-E11, "Residual Heat Removal System".

CAUTION

- Do not permit shutdown cooling flow to decrease below the setpoint for the RHR pump minimum flow valve setpoint of [later].
- Do not allow reactor water level to decrease below L3 as this will isolate the Shutdown Cooling mode of the RHR System.

5.3.3 Maintain at least [number, later] recirculation pumps in operation running at [speed, later]. If no recirculation pumps, or less than [number,later] recirculation pumps are running at [speed, later], raise the RPV water level to [later] to promote core flow (natural circulation).

5.3 Shutdown Cooling(continued)

5.3.4 Throttle RHR heat exchanger service water as necessary to maintain the specified cooldown rate, averaged over any one-hour period.

5.3.5 Secure the RHR loop(s) that are operating in the Suppression Pool Cooling mode when pool temperatures are normal.

5.3.6 Initiate reactor head spray, if desired, in accordance with SOP-G31, "Reactor Water Cleanup System", Section 4.3.

5.3.7 Warm and place additional loop(s) of RHR System into the Shutdown Cooling mode as necessary for cooldown.

5.4 Reactor Pressure Decreases to Atmospheric

5.4.1 Shutdown the RCIC System prior to reaching [3.5 kg/cm^2] or when no longer needed for reactor water level control, per SOP-E51, "Reactor Core Isolation Cooling System".

CAUTION

Do not reduce reactor pressure vessel temperature below 21 °C [TE later] unless the head bolts are detensioned.

5.4.2 At 0 kg/cm2 and a reactor temperature of [87 °C, TE later], open reactor head vent valves B21-F012 and F013, and close the head vent to main steamline valve F014.

5.4.3 Set the setpoint of the Pressure Regulator to [10 kg/cm^2].

5.4.4 Place the reactor mode switch in the SHUTDOWN position.

5.4.5 Reset the RPS scram logic.

5.5 Maintaining Cold Shutdown

5.5.1 Maintain reactor vessel water level on the Shutdown Range instrumentation within the range of [later]. When it is necessary to reject water to Radwaste with CUW, maintain CUW filter demineralizer inlet temperature less than [54°C].

*** NOTE ***

During periods of low flow through the core the water temperature in the upper part of the core could be at or above saturation while the the reactor bottom head drain temperature is well below saturation.

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5.5.2 Maintain one loop of the RHR System operating in the Shutdown Cooling Mode per SOP-E11. Adjust the RHR heat exchanger cooling water flow rate or bypass valve as necessary to maintain the reactor vessel flange and head flange temperature [TE's later] greater than or equal to 21 °C and the reactor coolant temperature [TE later] less than or equal to 87 °C.

5.5.3 Check for thermal stratification by monitoring reactor water temperature [TE-later] and [later] . Verify that they are within [later °C] of each other.

5.5.4 Initiate reactor head spray, as required, per SOP-G31, to maintain the temperature difference between the bottom head drain and [later] to within [later °C] of each other.

6.0 REFERENCES

6.1 General Electric Service Information Letter SIL-357, "Control of Reactor Vessel Temperature/Pressure During Shutdown".

6.2 General Electric Service Information Letter SIL-388, "RHR Valve Misalignment During Shutdown Cooling Operation".

6.3 U.S. NRC IE Circular No. 81-11, "Inadequate Decay Heat Removal During Reactor Shutdown".

6.4 INPO SOER-82-2, "Inadvertent Reactor Pressure Vessel Pressurization".