GF Nuclear Energy

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DOCUMENT TITLE IOP-6, COOLDOWN TO COLD SHUTDOWN, MAIN CONDENSER AVAILABLE

LEGEND OR DESCRIPTION OF GROUPS

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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 utilizing the main condenser as the heat sink 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 available. The cooldown process consists of depressurization using the turbine bypass valves, followed by cooling using the Shutdown Cooling mode of the RHR System.

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 Drive the reactor subcritical by inserting control rods per IOP-8, prior to establishing cooldown.

3.3 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.

3.4 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)

3.5 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

3.6 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 reactor 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 Shutdown Cooling Mode.

b. RHR Heat Exchanger Service Water System to provide cooling water for the RHR heat exchangers.

c. The main condenser is available as a heat sink, with condenser pressure being maintained below [later] mm Hg Absolute.

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 [TE later]
- Coolant Temperatures [later]

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

5.1.3 Initiate flushing of the RHR in preparation for shutdown cooling operation, per SOP-E11.

CAUTION

IF WHILE executing the following steps 5.2, 5.3, or 5.4, the MSIVs close, initiate RCIC in the recirculation mode or injection mode if necessary to maintain the specified cooldown rate. Supplement pressure control with SRVs if necessary. Proceed to execute applicable steps in integrated operating procedure IOP-7, "Cooldown to Cold Shutdown, Main Condenser Not Available".

5.2 Initiating Depressurization and Cooldown from Normal Operating Temperature and Pressure.

Initiate depressurization and cooldown by opening a bypass valve to establish and maintain a specified cooldown rate. During the cooldown, maintain the setpoint of the pressure regulator [2 kg/cm^2] above reactor pressure.

5.3 At [40 kg/cm^2] Reactor Pressure, Decreasing

5.3.1 Transfer feedwater control to the Low Flow Control Mode and control water level with one LPCP and one HPCP and shut down the motor-driven feedpump, per SOP-[later], "Condensate and Feedwater System", and SOP-C31, "Feedwater Control System".

5.3.2 Place main condenser LOW VACUUM BYPASS switches to BYPASS in panels [later].

5.4 At [20 kg/cm^2] Reactor Pressure, Decreasing

5.4.1 At [19 kg/cm^2] reactor pressure, place the startup SJAEs into operation and shut down the main SJAEs per SOP-[later], "Condenser Evacuation System."

5.5 Shutdown Cooling

5.5.1 When the shutdown cooling interlocks clear, warm RHR for shutdown cooling operation per SOP-E11, "Residual Heat Removal System".

5.5.2 Continue to cooldown with the turbine bypass valves during warming of the RHR.

5.5.3 When warming is complete, initiate one loop of RHR in the Shutdown Cooling Mode per SOP-E11.

CAUTION

- Do not permit shutdown cooling flow to decrease below the setpoint for the RHR pump minimum flow valve setpoint of [later]. This would result in reactor coolant water being pumped to the suppression pool.
- Do not allow reactor water level to decrease below L3 as this will isolate the Shutdown Cooling mode of the RHR System.

5.5.4 When RHR is operating in the Shutdown Cooling mode, continue to use the turbine bypass valves and maintain a specified cooldown rate. If desired, close the steam bypass valves, if open, by raising the pressure regulator setpoint above the RPV pressure.

5.5.5 Maintain at least [number, later] recirculation pumps in operation running at [speed, later]. If no recirculation pumps, or less than [number, later] pumps running are running at [speed, later], raise the RPV water level to [later, level corresponding to the bottom of pre-dryer in the steam separator assembly] to promote core flow (natural circulation).

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

5.5 Shutdown Cooling(continued)

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

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

5.5.9 If it is desired to maintain condenser pressure, shift gland sealing steam supply to the Auxiliary Boiler prior to decreasing reactor pressure below [5.0 kg/cm^2].

5.6 Reactor Pressure Decreases to Atmospheric

5.6.1 Verify that the RCIC System isolates automatically at [3.5 kg/cm^2]. Complete system shutdown per SOP-E51, "Reactor Core Isolation Cooling System".

> CAUTION
>
> Do not reduce reactor pressure vessel temperature below 21 °C unless the head bolts are detensioned.

5.6.2 If condenser vacuum is not required, shutdown the startup SJAEs per SOP–[later]. When condenser vacuum decays to [value, later], open vacuum breakers [valve identities, later].

5.6.3 At a reactor temperature of [87 °C], open reactor head vent valves B21-F012 and F013.

5.6.4 Perform shutdown operations of the Nuclear Boiler System per Section 8.0 of SOP–B21, "Nuclear Boiler System".

5.7 Maintaining Cold Shutdown

5.7.1 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].

5.7.2 When the Condensate System is no longer needed to maintain reactor water level, align the Condensate System in the Long Cycle or Short Cycle[as designated] Cleanup per SOP-[later], "Feedwater and Condensate System".

*** 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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5.7.3 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 22 °C and the reactor coolant temperature [TE later] less than or equal to 87 °C.

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

5.7.5 Initiate reactor head spray, as required, per SOP-G31, to maintain the temperature difference between the bottom head drain [TE-later] 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".

6.5 Water Quality Specification, 22A8479, Revision 2, PAE No. 1.A.9.