REFERENCE INSTRUCTIONS

FOR

POST-LOCA COOLDOWN AND DEPRESSURIZATION

REVISION 0

APRIL 1980

This document contains guidelines for cooldown and depressurization of the reactor coolant system for a reference PWR Plant. These guidelines must be modified to be applicable to specific plant designs.

8007220357

DOCUMENT AND PAGE REVISION STATUS

Document Identification: Reference Instructions for Post LOCA Cooldown and Depressurization

Doc. Rev.	0
Date	4/80

DOCUMENT REVISIONS

Page No.	0
	Page Revisions
Cover	0
i	0
1	0
2	0
3	0
4	0
5	0
6	0
7	0
8	0
9	0
10	0
11	0

DOCUMENT REVISIONS

Page No.	Page Revisions

REFERENCE INSTRUCTIONS

FOR

POST-LOCA COOLDOWN AND DEPRESSURIZATION

A. PURPOSE

To cooldown and depressurize the reactor coolant system to or below 350°F and 400 psi respectively.

B. INITIAL CONDITIONS

1. The plant systems may be aligned in the injection mode, as accomplished by the automatic safeguards actuation signal, or may be in the cold leg (or hot leg) recirculation mode.
2. The instructions in E-1 Loss of Reactor Coolant have been completed at least through Step 10 with the possible exception of Step 7 (initiate recirculation). One or both trains of the safety injection and auxiliary feedwater systems may be in service.
3. The reactor coolant pumps may be in operation or may have been stopped in accordance with Step 5 of instruction E-1 or for other reasons such as loss of electric power.

C. SUBSEQUENT ACTIONS

NOTE: While in the injection mode, if the refueling water storage tank level approaches the low level alarm during the cooldown and depressurization actions, immediately terminate those actions and do not resume them until the transfer to cold leg recirculation has been completed and verified.

NOTE: During the following operator actions, if all reactor coolant pumps are running, trip all but one pump so as to maintain one reactor coolant pump operating in the loop connected to the pressurizer, or in another loop to which a spray line is connected.

If all reactor coolant pumps have been stopped, and offsite power is available, attempt to reestablish the required conditions for operation of a reactor coolant pump as the following actions are conducted. If the required conditions are established, start one pump. (Preferably in the loop connected to the pressurizer, or to another loop to which a spray line is connected).

If a reactor coolant pump is operating during the controlled reactor coolant system depressurization actions in the following instructions, the reactor coolant pressure criterion for tripping the reactor coolant pumps, established in Step 5 of instruction E-1, does not apply.

NOTE: The safety injection actuation signal must be reset, if not already reset, before performing the first manual operator action to realign the systems required by the following instructions.

NOTE: The containment isolation signal must be reset, if not already reset, before performing the first manual operator action required to realign a system penetrating the containment.

1. If the steam generator steam pressures are greater than the reactor coolant pressure, immediately dump steam from all steam generators to decrease the steam generator pressures to approximately equal the reactor coolant pressure.

   NOTE: Dump steam to the main condenser if offsite power and the condenser are available. If offsite power or the condenser are not available, utilize the steam generator power operated relief valves to discharge the steam.

   NOTE: Monitor the steam generator water levels while discharging steam. Increase the feedwater flow rate or reduce the steam dump rate if the indicated water levels begin to decrease.

2. Sample the reactor coolant and obtain a boron concentration analysis of the sample. (Observe the applicable health physics precautions when obtaining the reactor coolant sample) From the analysis and the known time in core life, determine if additional boron must be added to reach the required shutdown margin at cold conditions. If required, conduct a boration operation.

   NOTE: While the boration operation is being conducted, proceed immediately to the following actions.

3. If the reactor coolant temperature is below 350°F, proceed to Step 4. Begin a controlled cooldown of the reactor coolant to a temperature of 350°F or below by use of the steam dump to the condenser, if available, or through the steam generator power operated relief valves, if the condenser is not available.

NOTE: Do not begin the cooldown operation until the steam generator actual water levels have been restored to a level sufficient to assure that the U-tubes are covered.

While discharging steam, control the auxiliary feedwater flow to maintain the steam generator actual water levels sufficient to assure the U-tubes are covered.

Monitor the reactor coolant outlet temperature (core exit T/C) to verify that the reactor coolant is being cooled at a rate less than 100°F/hr, by the discharge of steam from the steam generators and that the subcooling of the reactor coolant (as determined by wide range pressure and core exit T/C) is increasing.

NOTE: After natural circulation has been established, the reactor outlet temperature should trend down with the decreasing steam generator pressure. If the reactor outlet temperature stops trending down, decrease or stop the steam dump operation and allow the natural circulation to reestablish itself before continuing the cooldown operation.

NOTE: While the reactor coolant system cooldown operation is in progress, proceed to Step 4 to aid in restoring the water level into the pressurizer.

4. When the reactor coolant subcooling has been increased to at least 50°F by the continuing cooldown of the reactor coolant by the steam

dump, reduce the steam volume in the system to attempt to restore a pressurizer water level. If the water level has already been established, proceed to Step 5.

NOTE: During the following cooldown and depressurization operations the criteria for termination of safety injection do not apply.

NOTE: During this operation, do not allow the pressure to decrease below a value which provides a minimum reactor coolant subcooling of °F (insert plant specific value as determined in instruction E-1 before termination of safety injection, Step 3(C)). If the subcooling should decrease to the minimum value, stop the steam volume reduction operation until the continuing cooldown of the reactor coolant, by action of the steam dump, exceeds the minimum value of subcooling.

NOTE: If the steam volume reduction operation is terminated due to a reduction in the subcooling, before the water level has been returned into the pressurizer, continue the cooldown and then resume the steam volume reduction operation when the subcooling has been increased to at least 50°F.

Reduce the steam volume by use of the normal pressurizer spray (if one RCP is in operation) or by opening one pressurizer PORV if spray is not available.

NOTE: The auxiliary spray must not be used unless it is required to depressurize and neither the normal spray or the PORV are available. Since at this time the auxiliary spray flow will not be heated by the regenerative heat exchanger (letdown flow has been isolated) the number of these auxiliary spray cycles must be minimized.

NOTE: If the steam volume reduction operation is by use of the pressurizer PORV, continuously monitor the PRT pressure, temperature and water level. Verify closure of the PORV using both the stem mounted position indicators and the PRT conditions. If the PORV cannot be reclosed, close the isolation valve upstream from the PORV.

Continue to reduce the steam volume and to monitor the reactor coolant subcooling while observing the pressurizer water level instruments for a return of the water level. When the pressurizer actual water level has been returned above the heaters, stop the steam volume reduction operation.

NOTE: If possible, the pressurizer should not be allowed to fill solid during the steam volume reduction operation.

5. When the water level has been returned to the pressurizer, reestablish the operation of all available pressurizer heaters to establish saturation conditions in the pressurizer. Do not proceed to Step 6 until the temperature of the pressurizer water is at least 50° higher than the reactor outlet temperature.

6. If the reactor coolant pressure is above 400 psi, proceed to the following controlled depressurization operations after isolating the SI accumulators by means of the outlet isolation valves, or venting the compressed gas from the accumulators into the containment until the gas pressure is reduced to 400 psi or less.

7. Throttle the safety injection flow paths to slowly reduce the injection flow into the reactor coolant system (plant specific means). Simultaneously decrease the pressurizer steam pressure by pump spray, if available, or by use of a PORV to maintain a relatively constant pressurizer water level.

NOTE

(The following example operations to throttle the safety injection flow are specific to the Model 412 plant)

1. Establish communications between the main control room and the charging pump room. Reopen the charging pump miniflow path to the pump suction. Enter the pump room, observing the applicable health physics precautions, and proceed to slowly throttle the flow from one operating charging pump by use of the manual discharge isolation valve.

   NOTE: If only one charging pump is in operation, verify that component cooling water is being supplied to the reactor coolant pumps thermal barriers to protect the shaft seals when the seal injection flow is decreased or stopped.

   Monitor the decreasing pressurizer water level as the injection flow is decreased. Quench the steam bubble by spray, or vent the bubble by briefly opening the PORV, to allow the pressurizer actual water level to rise and to be maintained above the pressurizer heaters.

   NOTE: Do not allow the pressure to decrease below a value which provides a minimum reactor coolant subcooling of ____°F (insert plant specific value as determined in instruction E-1 before termination of safety injection, Step 3(C)). Stop the pump throttling and depressurization actions until the reactor coolant temperature has been decreased by the continual action of the steam dump and the subcooling has been increased above the specified minimum value.

NOTE: Do not allow the pressurizer actual water level to decrease below the pressurizer heaters.

When the throttling of the flow from the pump has reached a point where the pump discharge pressure (local indicator) indicates the pump is approaching its shutoff head, stop that pump which has been throttled.

Before proceeding to throttle the second charging pump (if two had been in service), and hence decrease or stop the reactor coolant pump seal injection flow, verify that component cooling water is being supplied to the reactor coolant pumps thermal barriers to protect the seals. Then repeat the throttling operation for the second charging pump until the second pump has been stopped or has been throttled to a flow rate which maintains a reactor coolant pressure 400 psi or less.

2. If both charging pumps have been stopped, isolate the flow path through the BIT, reopen the charging pump isolation valves which had been throttled, restore the normal charging and seal injection flow paths and restart one charging pump to provide RCP seal injection flow.

If the reactor coolant pressure remains above 400 psi, establish communications between the main control room and the safety injection pump room.

CAUTION: If the safety injection system is in the recirculation mode, do not reopen the miniflow isolation valves.

Proceed to slowly throttle the flow from one operating safety injection pump by use of the manual discharge isolation valve. Monitor the decreasing pressurizer water level and reduce the steam bubble pressure as required to maintain the pressurizer actual water level above the pressurizer heaters.

NOTE: Do not allow the pressure to decrease below a value which provides a minimum reactor coolant subcooling of ____°F (insert plant specific value as determined in instruction E-1 before termination of safety injection, Step 3(C)). Stop the pump throttling and depressurization actions until the reactor coolant temperature has been decreased by the continual action of the steam dump and the subcooling has been increased above the specified minimum value.

NOTE: Do not allow the pressurizer actual water level to decrease below the pressurizer heaters.

Continue to throttle the pump until the reactor coolant pressure is decreased to 400 psi or less. However, if the pump discharge pressure indicates the pump is approaching the minimum allowable flow, stop the pump which is being throttled. Repeat the throttling operation for the second safety injection pump (if two had been in service) as required to decrease the reactor coolant pressure to 400 psi.

3. When the reactor coolant pressure has been decreased to 400 psi or less, verify operation of the pressurizer heaters to maintain the pressurizer in a saturated condition with the actual water level above the pressurizer heaters.

(End of Model 412 Example Instructions)

D. FINAL PLANT CONDITIONS

1. The reactor coolant temperature is at a value determined by the effectiveness of the steam dump (probably below 300°F) and residual heat is being dissipated through the steam dump and/or through the leak.
2. Except for the case of very large breaks, the reactor coolant system is refilled and a water level is being maintained in the pressurizer. (Pressurizer heaters in operation to maintain saturated conditions). The reactor coolant pressure is at or below 400 psi and is being controlled by a steam bubble in the pressurizer such that the safety injection flow equals the leak flow.
3. Except for the case of very large breaks, the reactor coolant subcooling is being maintained at 50°F or more.
4. The safety injection (makeup) flow into the system is throttled to the minimum capacity which will just match the leak flow at the prevailing system pressure.
5. The safety injection system is either in the injection mode or has been transferred to the cold leg (or hot leg) recirculation mode.

E. FINAL NOTES

1. At this point in the cooldown/depressurization operation for a specific accident, a decision must be made as to whether it will be possible to realign the residual heat removal system and to establish the required actions such that one train can be maintained in a cold leg (or hot leg) recirculation mode for reactor coolant makeup from the containment sump, and the second train made to serve as a closed loop cooling system taking suction from the reactor coolant hot leg.

2. An alternate alignment would be to remain in the cold leg (or hot leg) recirculation mode and to allow the continual recirculation flow to slowly cooldown the system using the leak flow at some elevated system pressure (dependent on size of break).

3. An alternate alignment for small breaks would be to restore normal controlled charging and seal injection flow and to realign the cold leg (or hot leg) recirculation equipment to supply coolant makeup to the charging pump suction. With this alignment the charging pumps would deliver the injection flow to maintain the reactor coolant system inventory and the safety injection flow paths would not be in service.