REFERENCE EMERGENCY OPERATING INSTRUCTIONS (HP)

Revision 2
April, 1980

Plant Applicability

This document contains Emergency Operating Instructions for plants with *high pressure* (HP) safety injection pumps and is intended to provide guidance in the preparation of Emergency Operating Procedures for individual plants in this category.

It is not likely that these instructions will apply in their entirety to any specific plant design and adaptation will be required.

DOCUMENT AND PAGE REVISION STATUS

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EMERGENCY INSTRUCTION E-0

IMMEDIATE ACTIONS AND DIAGNOSTICS

For Plants With High Pressure Safety Injection Pumps

A. PURPOSE

This instruction presents the automatic actions, the immediate operator actions and the diagnostic sequence which is to be followed in the identification of the following:

1. Spurious Actuation of Safety Injection
2. Loss of Reactor Coolant
3. Loss of Secondary Coolant
4. Steam Generator Tube Rupture

The reactor automatic protection equipment is designed to safely shut down the reactor in the event of any of the above emergencies. The safety injection system is designed to provide emergency core cooling and boration to maintain the safe reactor shutdown condition. These plant safeguards systems operate with offsite electrical power or from onsite emergency diesel-electric power should offsite power not be available.

In the subsequent documents in this series (E-1, E-2 and E-3), instructions for recovery from the event are presented for each particular accident.

B. SYMPTOMS

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.

The following symptoms are typical of those which may arise in a plant which is undergoing a loss of reactor coolant, loss of secondary coolant or steam generator tube rupture (one or more symptoms may appear in any order):

Low Pressurizer Pressure

Low Pressurizer Water Level

High Pressurizer Water Level

High Containment Pressure

High Containment Radiation

High Air Ejector Radiation

High Steam Generator Blowdown Radiation

Steam Flow/Feedwater Flow Mismatch

Letdown Isolation/Pressurizer Heater Cutout

Low Low Reactor Coolant System Average Coolant Temperature

High Containment Recirculation Sump Water Level

Low Steamline Pressure (one or all Steamlines)

Low Steam Generator Water Level

Increasing Steam Generator Water Level

Rapidly Changing Reactor Coolant System Average Coolant Temperature

Increased Charging Flow

High Steam Flow (one or all Steam lines)

High Containment Humidity

High Containment Temperature

Low Feedwater Pump Discharge Pressure

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

C. IMMEDIATE ACTIONS

1. Conditions warranting reactor trip or safety injection may be characterized by a number of anomalous situations or unusual instrument indications.

   a. If the plant is in a condition for which a reactor trip is warranted and an automatic reactor trip has not yet occurred, manually trip the reactor. Continue monitoring plant conditions as shown in Figure 1.

   b. If the plant is in a condition for which safety injection is warranted and an automatic safety injection has not yet occurred, manually initiate safety injection.

2. Verify the following actions and system status:

   a) Reactor trip and turbine trip have occurred.

   b) Bus voltages indicate that the busses are energized and all intended loads are being powered.

   c) Feedwater Isolation has occurred.

   d) Containment Isolation Phase A has occurred.

   e) Auxiliary Feedwater Pumps have started and the Auxiliary Feedwater System valves are in their proper Emergency Alignment and are fully open or fully closed as appropriate.

   f) Safety Injection Pumps have started and the monitor lights indicate that the Safety Injection System valves are in the proper safeguards position.

   g) Service and Component Cooling Water Pumps have started.

   h) Containment Ventilation isolation has occurred.

   i) Other essential equipment as required by the specific plant design has been put into service.

3. If any of the above automatic actions have not occurred and are required, they should be manually initiated.

Verify the following:

a) Safety Injection flow from at least one train is being delivered to the reactor coolant system when the Reactor Coolant System pressure is below the high head safety injection pump shutoff head. If not, attempt to operate equipment manually or locally.

b) Auxiliary Feedwater flow from at least one train is being delivered to the steam generators. If not, attempt to operate equipment manually or locally.

NOTE: Only after steam generator water level is established above the top of the U-Tubes, should the Auxiliary Feedwater System Flow be regulated to maintain required level.

c) Verify that heat is being removed from the reactor plant via the steam generators by noting the following:

1) Automatic steam dump to the condenser is occurring;

2) Reactor coolant average temperature is decreasing towards programmed no-load temperature.

NOTE: Atmospheric steam dump may be blocked by an existing "Turbine Tripped" condition. If condenser steam dump

has been blocked due to a control malfunction or loss of the "Condenser Available" condition, decay heat removal will be effected by automatic actuation of the steam generator power-operated relief valves, or, if these prove ineffective, the steam generator code safety valves. In this event, steam pressure will be maintained at the set pressure of the controlling valve(s) and reactor coolant average temperature will stabilize at approximately the saturation temperature for the steam pressure being maintained.

4. Whenever the Containment Hi-2 pressure setpoint is reached, verify that the Main Steam Isolation Valves have closed. If not, manually close the Main Steam Isolation Valves from the Control Board.

5. Whenever the Containment Hi-3 pressure setpoint is reached, verify that the following have occurred:

   a) Containment Spray is initiated
   b) Containment Isolation Phase B is initiated

   If not, manually initiate Containment Spray and Containment Isolation Phase B.

D. ACCIDENT DIAGNOSTICS (Refer to Figure 2)

1. Evaluate reactor coolant pressure to determine if it is low or decreasing in an uncontrolled manner. If it is low or decreasing, verify that:

   a. all pressurizer spray line valves are closed and

   b. all pressurizer relief valves are closed.

   If not, manually close the valves from the Control Board.

   If the RCS pressure is above the low pressure reactor trip setpoint and is stable or increasing, go to STEP 7.

2. Stop ALL Reactor Coolant Pumps after the high head safety injection pump operation has been verified and when the wide range reactor coolant pressure is at (plant specific pressure derived from method in Appendix A of E-0).

   CAUTION: If component cooling water to the reactor coolant pumps is isolated on a containment pressure 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.

*3. IF the condenser air ejector radiation or steam generator blowdown radiation monitor exhibit abnormally high readings, AND containment pressure, containment radiation and containment recirculation sump level exhibit normal readings, THEN go to E-3, "Steam Generator Tube Rupture."

*4. IF the steamline pressure is abnormally lower in one steam generator than in the other steam generators, THEN go to E-2, "Loss of Secondary Coolant."

5. IF containment pressure, OR containment radiation OR containment recirculation sump levels exhibit either abnormally high readings or increasing readings, THEN go to E-1, "Loss of Reactor Coolant".

NOTE: For very small breaks inside the containment building, the containment pressure increase will be very small and possibly not recognizable by the operator. For very small breaks the containment recirculation sump water level will increase very slowly and early in the transient may not indicate a level increase.

*These steps may be interchanged.

6. IF the containment pressure, containment radiation AND containment recirculation sump water level continue to exhibit stable readings in the normal pre-event range, THEN go to E-2, "Loss of Secondary Coolant".

7. In the event of a spurious safety injection signal, the sequence of reactor trip, turbine trip and safeguards actuation will occur.

   The operator must assume that the safety injection signal is non-spurious unless the following are exhibited:

   a. Normal readings for containment temperature, pressure, radiation and recirculation sump level AND

   b. Normal readings for auxiliary building radiation and ventilation monitoring AND

   c. Normal readings for steam generator blowdown and condenser air ejector radiation.

   If all of the symptoms a through c above are not met, return to Step 2.

   IF all of the symptoms a through c above are met and when the following d through g are exhibited:

d. Reactor coolant pressure is greater than 2000 psig and increasing AND

e. Pressurizer water level is greater than programmed no load water level AND

NOTE: Pressurizer water level should trend with reactor coolant system temperature. If the pressurizer water level is low enough to prohibit pressurizer heater operation, re-establish water level by operating the charging system.

f. The reactor coolant indicated subcooling is greater than (insert plant specific value which is the sum of the errors for the temperature measurement system used, and the pressure measurement system translated into temperature using the saturation tables) AND

g. Auxiliary feedwater flow of at least (insert plant specific value derived from method in Appendix B to E-0) gpm is injected into the steam generators OR indicated wide range water level in at least one steam generator is above the top of the steam generator U-tubes.

THEN:

h. Reset safety injection and stop safety injection pumps not needed for normal charging and RCP seal injection flow.

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.

i. Place all safety injection pumps not needed to provide normal charging flow in standby mode and maintain operable safety injection flowpaths.

j. Establish normal charging flow and then isolate safety injection flow to RCS Cold Legs via Boron Injection Tank.

CAUTION: IF reactor coolant pressure drops below the low pressurizer pressure setpoint for safety injection actuation OR if pressurizer water level drops below 10% of span, OR the reactor coolant sub-cooling drops below the value for SI termination, MANUALLY REINITIATE SAFETY INJECTION. The operator must rediagnose plant conditions and proceed to the appropriate emergency instruction.

CAUTION: If the pumps are restarted once after termination, an additional 15°F of sub-cooling should be added to the

required sub-cooling prior to the second termination of the high head pumps. This can be achieved by terminating SI at 200 psi higher pressure.

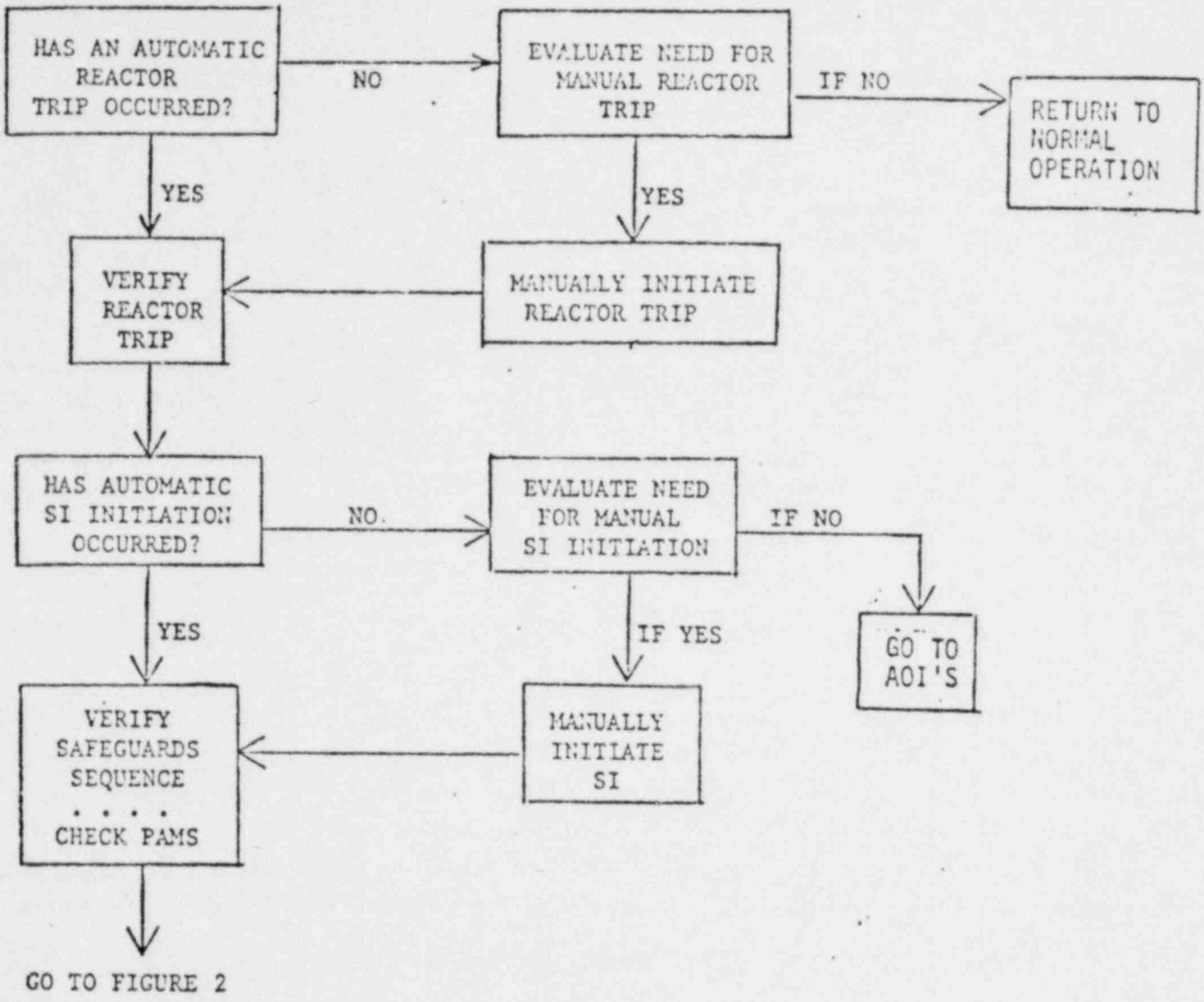
k. Control auxiliary feedwater flow as necessary to recover to no load conditions.

l. Reestablish normal makeup and letdown (if letdown is unaffected) to maintain pressurizer water level in the normal operating range and to maintain reactor coolant pressure at values reached when safety injection is terminated. Ensure that water addition during this process does not result in dilution of the reactor coolant system boron concentration.

m. Reestablish operation of the pressurizer heaters. When reactor coolant pressure can be controlled by pressurizer heaters alone, return makeup and letdown to pressurizer water level control only.

8. IF after securing safety injection and transferring the plant to normal pressurizer pressure and level control, the reactor coolant pressure does not drop below the low pressurizer pressure setpoint for safety injection actuation AND the pressurizer water level remains above 10% of span, AND the reactor coolant

indicated subcooling is greater than (insert plant specific value which is the sum of the errors for the temperature measurement system used, and the pressure measurement system translated into temperature using the saturation tables), THEN go to the abnormal operating instructions. If not, MANUALLY REINITIATE SAFETY INJECTION and rediagnose plant conditions.



IMMEDIATE ACTIONS

FIGURE 1

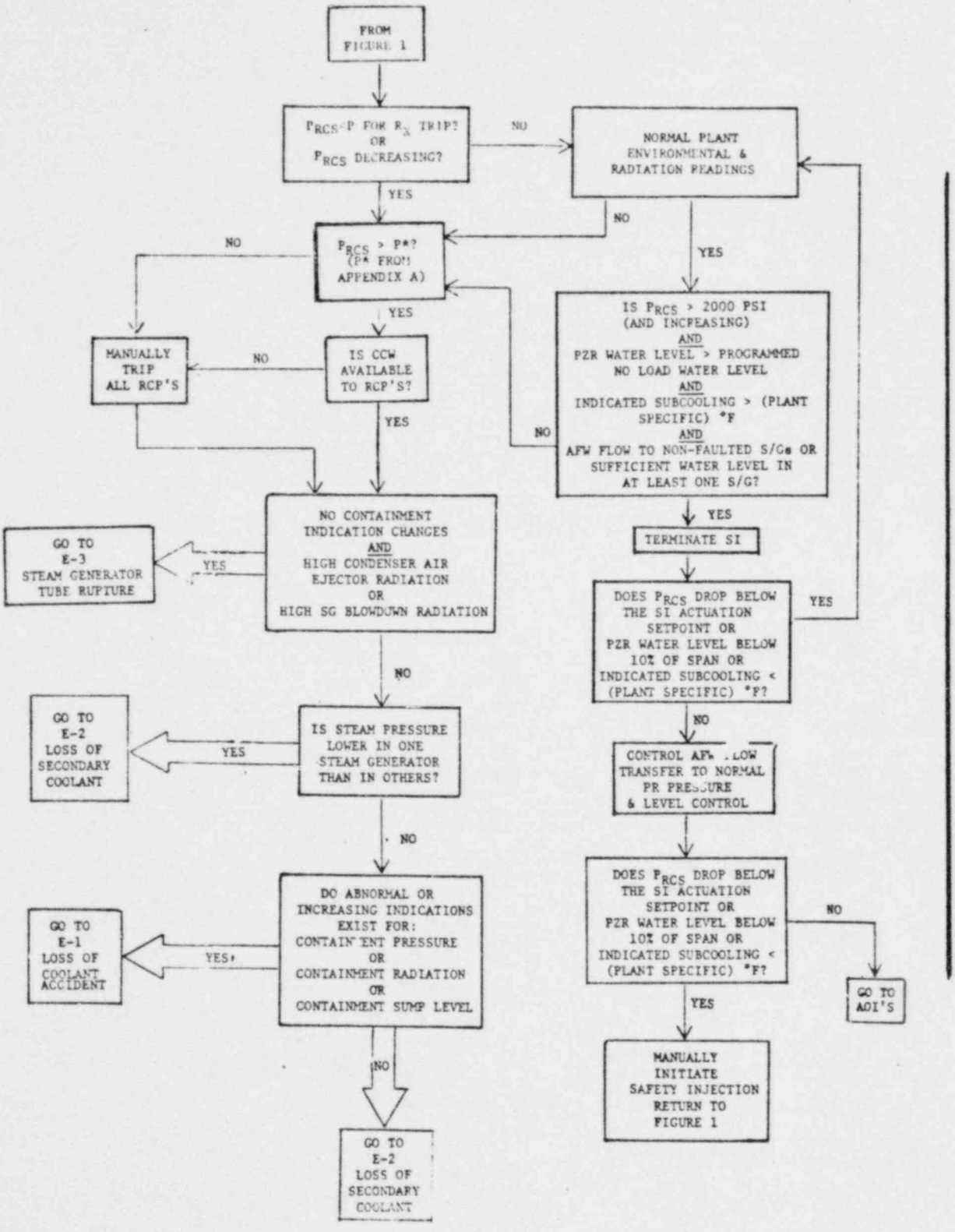

FROM FIGURE 1
P_{RCS} < P FOR R_X TRIP? OR P_{RCS} DECREASING?
NO
NORMAL PLANT ENVIRONMENTAL & RADIATION READINGS
YES
NO
P_{RCS} > P*? (P* FROM APPENDIX A)
NO
YES
MANUALLY TRIP ALL RCP'S
NO
IS CCW AVAILABLE TO RCP'S?
YES
IS P_{RCS} > 2000 PSI (AND INCREASING) AND PZR WATER LEVEL > PROGRAMMED NO LOAD WATER LEVEL AND INDICATED SUBCOOLING > (PLANT SPECIFIC) °F AND AFW FLOW TO NON-FAULTED S/Gs OR SUFFICIENT WATER LEVEL IN AT LEAST ONE S/G?
NO
YES
TERMINATE SI
DOES P_{RCS} DROP BELOW THE SI ACTUATION SETPOINT OR PZR WATER LEVEL BELOW 10% OF SPAN OR INDICATED SUBCOOLING < (PLANT SPECIFIC) °F?
YES
NO
CONTROL AFW FLOW TRANSFER TO NORMAL PR PRESSURE & LEVEL CONTROL
DOES P_{RCS} DROP BELOW THE SI ACTUATION SETPOINT OR PZR WATER LEVEL BELOW 10% OF SPAN OR INDICATED SUBCOOLING < (PLANT SPECIFIC) °F?
NO
GO TO AOI'S
YES
MANUALLY INITIATE SAFETY INJECTION RETURN TO FIGURE 1
NO CONTAINMENT INDICATION CHANGES AND HIGH CONDENSER AIR EJECTOR RADIATION OR HIGH SG BLOWDOWN RADIATION
YES
GO TO E-3 STEAM GENERATOR TUBE RUPTURE
NO
IS STEAM PRESSURE LOWER IN ONE STEAM GENERATOR THAN IN OTHERS?
YES
GO TO E-2 LOSS OF SECONDARY COOLANT
NO
DO ABNORMAL OR INCREASING INDICATIONS EXIST FOR: CONTAINMENT PRESSURE OR CONTAINMENT RADIATION OR CONTAINMENT SUMP LEVEL
YES
GO TO E-1 LOSS OF COOLANT ACCIDENT
NO
GO TO E-2 LOSS OF SECONDARY COOLANT

FIGURE 2

APPENDIX A TO INSTRUCTION E-0

RCP TERMINATION PRESSURE CALCULATION

1. Secondary System Pressure - Based on the number and size of the secondary system safety valves, the secondary pressure will be established by determining the pressure setpoint for that valve in which the calculated steam relief is less than 60% of the valve's relief rating. If the calculated relief is greater than 60% of the rated capacity, then t' next highest pressure setpoint should be used.

2. Primary to Secondary Pressure Difference - To account for the pressure gradient needed for heat removal, pressure drop between the steam generator and safety valves, pressure drop from steam generator to measurement location, etc., the primary pressure for RCP trip should be the secondary pressure as established by (1) above plus 100 psi if the adjustments calculated are 100 psi or less. If the adjustments are determined to be greater than 100 psi, the larger value should be used.

3. Instrument inaccuracies appropriate for that time in the loss of coolant accident should be added to the primary system pressure value established in (2) above. The resulting pressure is the indicated primary system pressure at which the operator should trip the reactor coolant pumps.

APPENDIX B TO INSTRUCTION E-0

SI TERMINATION AUXILIARY FEEDWATER FLOW CALCULATION

Required Flowrate (gpm) = $0.218\ P_o + 6.12\ P_{pump} + F_{env}$

where: P_o = Licensed core power rating, MwT

P_{pump} = Reactor Coolant Pump power (Difference between NSSS and core power rating), MwT

F_{env} = Auxiliary feedwater flow normal channel accuracy plus channel inaccuracy due to post accident environment (if applicable), gpm

EMERGENCY INSTRUCTION E-1

LOSS OF REACTOR COOLANT

For Plants With High Pressure Safety Injection Pumps

A. PURPOSE

The objectives of these instructions are to specify required operator actions and precautions necessary to:

1. Verify and establish short term core cooling to prevent or minimize damage to the fuel cladding and release of excessive radioactivity.

2. Maintain long term shutdown and cooling of the reactor by recirculation of spilled reactor coolant, injected water and containment spray system drainage.

B. IMMEDIATE ACTIONS

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

C. SUBSEQUENT ACTIONS

CAUTION: Monitor RWST level closely. If RWST level decreases rapidly such that the RWST low level alarm appears imminent, go directly to step 5.

CAUTION: The diesels should not be operated at idle or minimum load for more than (insert plant specific time period of allowed diesel operation at minimum load). If the diesels are shut down, they should be prepared for restart.

NOTE: The operator should verify that the Post Accident Monitoring (PAM) instruments are operating and recording. These instruments include wide range RCS temperature and pressure, steam pressure, steam generator water level, containment pressure, RWST water level, condensate storage tank water level, pressurizer water level, and boric acid storage tank water level.

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: Reactor coolant system isolation valves (LSIV) are optional equipment on the Westinghouse Standard Plants. If a plant is so equipped, the use of LSIV's is not currently recommended during the course of this Instruction. Any use of LSIV's must be justified on a plant specific basis.

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

1. As the water level in the refueling water storage tank decreases under the action of the safeguards pumps, check that the recirculation sump water level instrumentation indicates an increase in water level in the sump. If a sump water level increase is not evident then a re-evaluation of the symptoms in E-0 must be conducted.

   Regulate the auxiliary feedwater flow to the steam generators to restore and/or maintain an indicated narrow range water level. If narrow range water level increases in an unexplained manner in one steam generator, go to E-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, switch over to an alternate water supply source.

2. Verify that all pressurizer PORV's are closed. Also verify the open status and availability of power to all pressurizer PORV backup isolation valves.

   CAUTION: If the pressurizer Power Operated Relief Valves (PORV's) open at any time during this transient, verify that the valves reclose when RCS pressure drops below the PORV setpoint pressure. If any

PORV does not reclose, attempt to isolate it using the appropriate backup isolation valve.

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

Ensure that containment isolation is maintained, i.e., not reset until such time as manual action is required on necessary process streams.

Safety Injection can be terminated IF:

(A) Reactor coolant pressure is greater than 2000 psig and increasing, AND

(B) Pressurizer water level is greater than 50% of span, AND

(C) The reactor coolant indicated subcooling is greater than (insert plant specific value which is the sum of the errors for the temperature measurement system used, and the pressure measurement system translated into temperature using the saturation tables), AND

(D) Auxiliary feedwater flow is isolated to all depressurized steam generators and at least (insert plant specific value derived from method in Appendix B to E-0) gpm is injected into the non-faulted steam generator(s) or indicated narrow range water level in at least one non faulted steam generator is greater than (insert plant specific value which includes an allowance for normal channel accuracy, post-accident transmitter errors and reference leg process errors) percent of span.

THEN:

(E) Reset safety injection and stop safety injection pumps not needed for normal charging and RCP seal injection flow.

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.

(F) Place all safety injection pumps not needed to provide normal charging flow in standby mode and maintain operable safety injection flowpaths.

(G) Establish normal charging flow and then isolate safety injection flow to RCS Cold Legs via Boron Injection Tank

CAUTION: IF reactor coolant pressure drops below the low pressurizer pressure setpoint for safety injection OR pressurizer water level drops below 20% of span following termination of safety injection flow OR the reactor coolant sub-cooling drops below the value for SI termination, MANUALLY REINITIATE safety injection to establish reactor coolant pressure and pressurizer water level. Go to Section D of E-0 to reevaluate the event, unless this reevaluation has already been performed.

CAUTION: If the pumps are restarted once after termination, an additional 150F of sub-cooling should be added to the required sub-cooling prior to the second termination of the high head pumps. This can be achieved by terminating SI at 200 psi higher pressure.

(H) Reestablish normal makeup and letdown (if letdown is unaffected) to maintain pressurizer water level in the normal operating range and to maintain reactor coolant pressure at values reached when safety injection is terminated. Ensure that water addition during this process does not result in dilution of the reactor coolant system boron concentration.

(I) Reestablish operation of the pressurizer heaters. When reactor coolant pressure can be controlled by pressurizer heaters alone, return makeup and letdown to pressurizer water level control only.

(J) After the water level in the non-faulted steam generator(s) has been restored to the narrow range span, regulate the auxiliary feedwater flow to those steam generator(s) to maintain an indicated narrow range water level.

NOTE: Monitor the primary water supply (Condensate Storage Tank) for the auxiliary feedwater pumps and upon reaching a low level, switch over to an alternate water supply source.

(K) Monitor either the average temperature indication of core exit thermocouples (if available) or all wide range reactor coolant temperature T_H to verify that RCS temperature is at least 50°F less than saturation temperature at RCS indicated pressure.

If 50°F indicated subcooling is not present, then attempt to establish 50°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 maintain a reactor coolant cooldown rate of no more than 50°F/HR, consistent with plant make-up capability, until 50°F subcooling is established.

If 50°F indicated subcooling cannot be established or maintained, then MANUALLY REINITIATE SAFETY INJECTION. Go to Section D of E-0 to re-evaluate the event, unless this re-evaluation has already been performed.

(L) Perform a controlled cooldown to cold shutdown conditions using Normal Cooldown Procedures if required to affect repairs. Maintain subcooled conditions (at least 50°F indicated subcooling) in the reactor coolant system. If subcooled conditions cannot be maintained, go to Step 4.

4. If the conditions for terminating safety injection in Step 3 are not met, maintain necessary safety injection pumps operating. If any safeguards equipment is not operating, attempt to operate the equipment from the control room or locally. Effect repairs if necessary. If reactor coolant pressure stabilizes above the low head safety injection pump shut-off head, manually reset safety injection so that safeguards equipment can be controlled by manual action. Stop the low head safety injection pumps and place in the standby mode.

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

5. Stop ALL Reactor Coolant Pumps after the high head safety injection pump operation has been verified and when the wide range reactor coolant pressure is at (plant specific pressure derived from method in Appendix A of E-0).

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

CAUTION: If 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.

6. In the case of a break characterized by reactor coolant pressure quickly decreasing below steam generator pressure, go to step 7. In the case of a break characterized by a slowly decreasing reactor coolant pressure or stabilized reactor coolant system pressure above the lowest steam system safety valve setpoint, (plant specific) psig, the following additional manual actions should be taken to aid the cooldown and depressurization of the reactor coolant system:

   a. If the main condenser is in service, open at least one main steamline isolation valves or bypass valves and transfer the steam dump control to steam header pressure control and dump steam to the condenser to lower the reactor coolant temperature and consequently the reactor coolant pressure.

b. If the main condenser is not in service, dump steam to the atmosphere with the steam relief valves to lower the reactor coolant temperature and consequently the reactor coolant pressure.

CAUTION: Reduce the steam generator pressure 200 psi below the lowest steam system safety valve setpoint and maintain a reactor coolant cooldown rate of no more than 50°F/HR, consistent with plant make-up capability.

7. Go to the Cold Leg Recirculation Instruction presented in Table E-1.1. If the reactor coolant system pressure is above the shut-off head of the high head safety injection pumps, stop these pumps and place them in a standby mode prior to transfer to cold leg recirculation.

CAUTION: The cold leg recirculation procedures are different for each plant ECCS design. The plant specific procedures should be incorporated in Table E-1.1.

NOTE: If RWST low level alarm is not imminent, then consideration should be given to performing a preliminary evaluation of the plant status in Steps 9 and 10.

8. If containment spray has been actuated, and if the containment pressure is reduced to nominal operation containment pressure, reset containment spray. Spray pumps should be shut-off and placed in the standby mode with operable flow paths.

9. Periodically check auxiliary building area radiation monitors for detection of high radiation. If significant leakage has been identified, attempt to isolate the leakage. If leakage is detected in the ECCS, the operator must maintain recirculation flow to the RCS at all times.

10. Plant operators should make provision for an evaluation of equipment in the plant. This evaluation should include the primary safeguards equipment e.g., RCS pumps and valves, emergency diesels, containment fan coolers, etc. and support equipment e.g., ECCS HVAC equipment, diesel fuel supply, diesel start air supply, sampling of RCS for boron concentration and fuel damage, sampling of containment atmosphere, sampling of recirculation sump, etc. Adjust recirculation sump pH, if required.

11. Prior to the time specified for the plant for the switchover to the hot leg recirculation mode, the operator in the control room should:

    a. Ensure that control room valve switches are aligned in the proper positions for cold leg recirculation mode.

b. Re-energize the breakers, as required, for valves needed to effect switchover to the hot leg recirculation mode.

12. At (plant specific) hours after the accident, realign the safety injection systems for hot leg recirculation. Go to Table E-1.2.

CAUTION: The hot leg recirculation switchover procedures are different for each plant ECCS design. The plant specific procedures should be incorporated in Table E-1.2.

13. Continue to implement the hot leg recirculation mode of cooling.

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

TABLE E-1.1

COLD LEG RECIRCULATION SWITCHOVER INSTRUCTIONS

PREREQUISITES AND PRECAUTIONS:

A. Prior to receipt of the Refueling Water Storage Tank (RWST) Low Level Alarm restart any safety injection pump not operating and reset/defeat the safety injection signal. Also open component cooling water (CCW) valves to Residual Heat Removal (RHR) heat exchangers if these valves are not interlocked to open automatically.

B. The Refueling Water Storage Tank (RWST) Low Level Alarm signifies automatic initiation of cold leg recirculation. The containment recirculation sump valves will immediately start to open automatically.

C. IMMEDIATELY perform all steps given below when the recirculation sump isolation valve position lights indicate that the valve is fully open.

D. Do not close a RWST/RHR pump suction valve unless the corresponding recirculation sump valve is open.

E. All operator actions must be performed expeditiously, in a precise, orderly sequence. Do not interrupt this operation until all actions

are completed. When both trains are initially available and a valve fails to respond or to complete its demanded operation, postpone any corrective action until the subsequent operational steps are performed.

F. IMMEDIATELY stop any pumps taking suction from the RWST on receipt of a RWST empty alarm. Complete the switchover steps listed below, then restart required pumps.

OPERATIONAL STEPS (NO SINGLE FAILURES):

STEP 1

a) Close the RWST to low head safety injection pump suction isolation valves

b) Close the high head safety injection pump miniflow valves

c) Close the low head safety injection crossover isolation valves

STEP 2

a) Open parallel valves in the high head safety injection and charging safety injection pump common suction header.

b) Open the low head safety injection to high head safety injection and charging/safety injection pump suction isolation valves

c) After completion of the above steps VERIFY that the two high head safety injection pumps and the two charging/safety injection pumps are receiving suction flow from the low head safety injection pumps.

CAUTION: Do not perform the following steps until the above verification is made.

STEP 3

a) Close the RWST to high head safety injection pump suction valves

b) Close the RWST to charging/safety injection pump suction isolation valves

STEP 4

The utility should provide spray system switchover procedures and integrate them into this instruction.

NOTE: For plant designs which utilize only the spray system heat exchanger to remove energy from the containment recirculation sump the spray system must be operated during the long term even if it was not automatically actuated.

VERIFICATION:

STEP 5

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

a) 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.

b) 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.

c) 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.

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

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

STEP 6

If the system alignment has been verified go to E-1 Step 9. If any failures have occurred, proceed to contingency actions.

CONTINGENCY ACTIONS

1. 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:

a) 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.

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

2. LOSS OF ONE TRAIN OF ELECTRICAL POWER

NOTE: 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 above, which assumed no single failures. The operator could follow the above instruction with the understanding that those valves, without power, do not have to be repositioned.

The following instruction is provided to illustrate the similarity between the instruction which assumes no single failures, and an instruction which assumes one complete electrical power train failure. For this instruction, it is assumed that Train B failed simultaneously with the loss of reactor coolant. It should be noted that if a train failed subsequent to the initiation of the "S" 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 an "S" 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, positive isolation of the RWST to charging/safety injection pump suction path would have to be accomplished locally.

OPERATIONAL STEPS: (Assume only Train A available)

STEP 1

a) Close the RWST to low head safety injection pump suction isolation valve

b) Close the high head safety injection pump miniflow valves

c) Close the low head safety injection crossover isolation valve

STEP 2

a) Open one of the parallel valves in the high head safety injection and charging/safety injection pump common suction header

b) Open the low head safety injection to charging/safety injection pump suction isolation valve

After completing the above steps, verify that the one high head safety injection pump and one charging/safety injection pump are receiving suction flow from the one operating low head safety injection pump.

Caution: Do not perform the following steps unless the above verification is absolute.

STEP 3

a) Close the RWST to high head safety injection pump suction valve

b) Close the RWST to charging/safety injection pump suction valve

VERIFICATION:

STEP 4

After completing the above step, verify that the safety injection system is aligned for cold leg recirculation as follows:

a) One low head safety injection pump is delivering from the containment recirculation sump to two reactor coolant system cold legs and to the suction of one high head safety injection and one charging/safety injection pump.

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

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

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

STEP 5

If the system alignment in Step 4 has been verified, go to E-1 Step 9. If any failures have occurred, attempt to operate the equipment manually and locally.

TABLE E-1.2

HOT LEG RECIRCULATION SWITCHOVER INSTRUCTIONS

NOTE: Hot Leg Recirculation Phase - At approximately 24 hours after the accident, hot leg recirculation shall be initiated. The following manual operator actions are required to complete the switchover operation from the cold leg recirculation mode to the hot leg recirculation mode. In this instruction it is assumed that both electrical power trains A and B are available and that all safety injection pumps are operating. (No single failure has occurred). If failures have occurred continue through the instruction to contingency actions.

OPERATIONAL STEPS BASED ON NO SINGLE FAILURE

Step 1: Terminate low head safety injection pump flow to reactor coolant system cold legs and establish low head safety injection flow to reactor coolant system hot leg by performing the following actions:

a) Close the low head safety injection cold leg header isolation valves

b) Open the low head safety injection crossover isolation valves

c) Open the low head safety injection leg header isolation valve

Step 2: Terminate high head safety injection pump flow to reactor coolant system cold legs and establish high head safety injection flow to reactor coolant system hot legs by performing the following steps:

a) Stop high head safety injection pump no. 1

b) Close the corresponding high head safety injection cross-over header isolation valve

c) Open the corresponding hot leg header isolation valve

d) Restart the high head safety injection pump no. 1

e) Stop high head safety injection pump no. 2

f) Close the corresponding high head safety injection cross-over isolation valve

g) Close the corresponding high head safety injection cold leg header isolation valve

h) Open the corresponding high head safety injection hot leg header isolation valve

i) Restart the high head safety injection pump no. 2

VERIFICATION:

STEP 3

After completing the above steps, verify that the safety injection system is aligned to hot leg recirculation as follows:

a) Both low head safety injection pumps are aligned to deliver flow directly to the two reactor coolant system hot legs via the single low head safety injection hot leg header while each high head safety injection pump is aligned to deliver flow to the two reactor coolant system hot legs via two separate and redundant high head safety injection hot leg headers.

b) The low head safety injection pumps continue to provide suction flow to the high head safety injection and charging pumps.

c) The charging pumps continue to provide flow directly to the four reactor coolant system cold legs.

d) If containment spray is required, verify flow is being delivered.

STEP 4

If the system alignment has been verified go to E-1 Step 13. If any failures have occurred, proceed to contingency actions.

CONTINGENCY ACTIONS

1. LOSS OF ONE TRAIN OF ELECTRICAL POWER:

In the event that a single failure had resulted in a complete loss of power to one of the electrical power trains in conjunction with a LOCA and a loss of offsite power, the hot leg switchover procedures would require some operations to be performed outside the main control room, unless power could be restored to the failed train during the 24 hour cold leg recirculation phase. These operations, outside the main control room, would be necessary to open a hot leg isolation valve and to close a cold leg isolation valve. In both cases this can be accomplished either by manually operating the valve or by disconnecting the power to the valve from the failed train and temporarily connecting it to the available power.

In the following steps, it is assumed that train B failed simultaneously with the accident.

OPERATIONAL STEPS (Assume only Train A Available)

STEP 1

Terminate low head safety injection pump flow to reactor coolant system cold legs and establish low head safety injection flow to reactor coolant system hot legs.

a) Close the low head safety injection cold leg header isolation valves

NOTE: Since it is assumed in this case that train B has failed, power to close one isolation valve may not be available. This valve could be closed manually or it could be closed remotely by disconnecting it from train B and temporarily connecting it to train A.

b) Open the low head safety injection crossover isolation valve

c) Open the low head safety injection hot leg header isolation valve

NOTE: Since it is assumed in this case that train B has failed, power to open this valve may not be available. This valve could be opened manually or it could be opened remotely be disconnecting it from train B and temporarily connecting it to train A.

STEP 2

Terminate high head safety injection pump flow to reactor coolant system cold legs and establish high head safety injection flow to reactor coolant system hot legs:

a) Stop the Train A high head safety injection pump

b) Close the corresponding high head safety injection crossover header isolation valve

c) Open the corresponding high head safety injection hot leg header isolation valve

d) Restart the Train A high head safety injection pump.

STEP 3

Go to E-1 Step 13. If any failures have occurred, attempt to operate the equipment manually or locally.

EMERGENCY INSTRUCTION E-2

LOSS OF SECONDARY COOLANT

For Plants With High Pressure Safety Injection Pumps

A. 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 pressurizer 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.

B. IMMEDIATE ACTIONS

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

Manual Actions:

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

C. SUBSEQUENT ACTIONS

CAUTION: The diesels should not be operated at idle or minimum load for more than (insert plant specific time period of allowed diesel operation at minimum load). If the diesels are shut down, they should be prepared for restart.

CAUTION: If the pressurizer Power Operator Relief Valves (PORV's) open at any time during this transient, verify that the valves reclose when RCS pressure drops below the PORV setpoint pressure. If any PORV does not reclose, attempt to isolate it using the appropriate backup isolation valve. If the PORV's do not reclose and cannot be isolated, go to E-1, Loss of Reactor Coolant.

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: Reactor coolant system isolation valves (LSIV) are optional equipment on the Westinghouse Standard Plants. If a plant is so equipped, the use of LSIV's is not currently recommended during the course of this Instruction. Any use of LSIV's must be justified on a plant specific basis.

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

1. If reactor coolant pressure stabilizes 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.

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.

2. Stop all reactor coolant pumps after high head safety injection pump operation has been verified and when the wide range reactor coolant pressure is at (plant specific pressure derived from method in Appendix A of E-0).

CAUTION: If component cooling water to the reactor coolant pumps is isolated on containment pressure 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.

3. Determine which steam generator(s) is affected by observing each steamline pressure. A low steamline pressure compared to the other loops denotes a faulted loop(s); terminate auxiliary feedwater to that depressurized or depressurizing steam generator(s).

NOTE: If all steam generators are depressurized or depressurizing, the auxiliary feedwater flow must not be terminated to any steam generator until the faulted loop(s) is identified.

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 D of E-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.

4. If the water level in the non-faulted steam generator(s) is in the narrow range span, regulate the auxiliary feedwater flow to those steam generator(s) to maintain an indicated narrow range water level . If water level increases in an unexplanned manner in one steam generator, go to E-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, switch over to an alternate water supply source.

5. Monitor Refueling Water Storage Tank level.

   A. If containment spray has been actuated, and if the containment pressure is reduced to a (plant specific) value below the containment spray actuation pressure, reset containment spray. Spray pumps should be shut off and placed in the standby mode with operable flow paths.

   B. If a low Refueling Water Storage Tank level alarm is reached while the containment spray pumps are still running, reset containment spray. Spray pumps should be realigned to the recirculation mode.

C. The safety injection pumps should remain aligned to the Refueling Water Storage Tank. If the Refueling Water Storage Tank low-low level alarm is reached, reset safety injection. Realign the safety injection pumps to the cold leg recirculation mode using the procedure presented in Table E-2.1 If the reactor coolant system pressure is above the shutoff head of the high head safety injection pumps, stop these pumps and place in a standby mode prior to transfer to cold leg recirculation.

6. Safety injection should be terminated IF:

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

A. (1) One wide range reactor coolant temperature T_H as confirmed by core exit thermocouples, if available, is less than 350°F, AND

(2) Wide range reactor coolant pressure is greater than 700 psig and is stable or increasing AND

(3) Pressurizer water level is greater than 20% of span and rising (heaters covered), AND

(4) The reactor coolant indicated subcooling is greater than (insert plant specific value which is the sum of the errors for the temperature measurement system used, and the pressure measurement system translated into temperature using the saturation tables), AND

(5) Auxiliary feedwater flow is isolated to all depressu - ized steam generators and at least (insert plant specific value derived from method in Appendix B to E-0) gpm is injected into the non-faulted steam generator(s) or indicated narrow range water level in at least one non-faulted steam generator is greater than (insert plant specific value which includes an allowance for normal channel accuracy, post-accident transmitter errors and reference leg process errors) percent of span.

NOTE: If all wide range reactor coolant temperature indicators go above 350°F when attempting to satisfy the conditions of 6A, initiate safety injection pump operation and continue operation until conditions of 6B or 6C (depending on containment indications) are satisfied.

NOTE: If all steam generators are depressurized or depressurizing, the safety injection flow must not be terminated until the faulted loop(s) is identified.

OR

B. (1) All wide range reactor coolant temperature T_H are greater than 350°F, AND

(2) Containment pressure, AND containment radiation, AND containment recirculation sump levels do not exhibit either abnormally high or increasing readings, AND

(3) Wide range reactor coolant pressure is greater than 2000 psig, and is stable or increasing, AND

(4) Pressurizer water level is greater than 20 percent of span, AND

(5) The reactor coolant indicated subcooling is greater than (insert plant specific value which is the sum of the errors for the temperature measurement system used, and the pressure measurement system translated into temperature using the saturation tables), AND

(6) Auxiliary feedwater flow is isolated to all depressurized steam generators and at least (insert plant specific value derived from method in Appendix B to E-0) gpm is injected into the non-faulted steam generator(s) or indicated wide range water level in at least one non-faulted steam generator is above the top of the steam generator U-tubes.

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 6B, initiate safety injection pump operation and continue operation until the conditions of 6C are satisfied.

NOTE: If all steam generators are depressurized or depressurizing, the safety injection flow must not be terminated until the faulted loops is identified.

OR

C. (1) All wide range reactor coolant temperature T_H are greater than 350°F, AND

(2) Containment pressure, OR containment radiation, OR containment recirculation sump level exhibit either abnormally high or increasing readings, AND

(3) Wide range reactor coolant pressure is greater than 2000 psig, and is stable or increasing, AND

(4) Pressurizer water level is greater than 50% of span, AND

(5) The reactor coolant indicated subcooling is greater than (insert plant specific value which is the sum of the errors for the temperature measurement system used, and the pressure measurement system translated into temperature using the saturation tables), AND

(6) Auxiliary feedwater flow is isolated to all depressurized steam generators and at least (insert plant specific value derived from method in Appendix B to E-0) gpm is injected into the non-faulted steam generator(s) or indicated narrow range water level in at least one non-faulted steam generator is greater than (insert plant

specific value which includes an allowance for normal channel accuracy, post-accident transmitter errors and reference leg process errors) percent of span.

NOTE: If all steam generators are depressurized or depressurizing, the safety injection flow must not be terminated until the faulted loop(s) is identified.

THEN:

D. 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 200 psi or pressurizer water level decreases by 10 percent of span from the point of safety injection termination or the reactor coolant sub-cooling drops below (insert plant specific value which is the sum of the errors for the temperature measurement system used, and for the pressure measurement system translated into temperature using the saturation tables), MANUALLY REINITIATE safety injection pump operation to maintain reactor coolant pressure and pressurizer level. Go to Section D of E-0 to rediagnose the event.

Safety injection may be terminated after the restart when reactor coolant pressure is being controlled to the nominal value which existed when safety injection was initially terminated ($T_H \leq 350^oF$) or to a value greater than or equal to 2000 psig ($T_H > 350^oF$) and when the reactor coolant indicated subcooling is greater than (insert plant specific value which is the sum of the errors for the temperature measurement system used, and the pressure measurement system translated into temperature using the saturation tables, plus 15°F).

E. Place all non-operating safety injection pumps in the standby mode, and maintain operable safety injection flowpaths.

F. Establish normal charging and then isolate flow to the reactor coolant system cold legs via the boron injection tank.

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

H. Re-establish operation of the pressurizer heaters after verification 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. 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.

I. After the water level in the non-faulted steam generator(s) has been restored to the narrow range span, regulate the auxiliary feedwater flow to those steam generator(s) to maintain an indicated narrow range water level.

7. Monitor either the average temperature indication of core exit thermocouples (if available) or all wide range reactor coolant temperature T_H to verify that RCS temperature is at least 50°F less than saturation temperature at RCS indicated pressure.

If 50°F indicated subcooling is not present, then attempt to establish 50°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 maintain a reactor coolant cooldown rate of no more than 50°F/HR, consistent with plant make-up capability, until 50°F subcooling is established.

Steam dump should be initiated in the following manner.

A. 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 is not reinitiated upon opening the MSIV. Transfer the steam dump system to steam header pressure control. Set the steam header pressure control setpoint to the pressure in the intact steam generator(s) at the time safety injection is terminated.

OR

B. 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 $50^{o}F$ indicated subcooling cannot be established or maintained, then MANUALLY REINITIATE SAFETY INJECTION. Go to Section D of E-0 re-evaluate the event, unless this reevaluation has already been performed.

8. When the reactor coolant temperature and pressure are stable, borate the reactor coolant system to cold shutdown conditions, as necessary.

9. 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 (preferably in the loop conneted to the pressurizer, or if this is the faulted loop, in the other loop to which a spray line is connected) 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.

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

CAUTION: 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 the reinitiation criteria given in Step 6.

NOTE: During the controlled cooldown, the reactor coolant system pressure will decrease below (plant specific pressure derived from method in Appendix A of E-0). Tripping the operating reactor coolant pump(s) due to the pressure criterion of Step 2 is not required. Other criteria of Step 2 are still appliable at this time.

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

TABLE E-2.1

COLD LEG RECIRCULATION SWITCHOVER INSTRUCTIONS

PREREQUISITES AND PRECAUTIONS:

A. Prior to receipt of the Refueling Water Storage Tank (RWST) Low Level Alarm restart any safety injection pump not operating and reset/defeat the safety injection signal. Also open component cooling water (CCW) valves to Residual Heat Removal (RHR) heat exchangers if these valves are not interlocked to open automatically.

B. The Refueling Water Storage Tank (RWST) Low Level Alarm signifies automatic initiation of cold leg recirculation. The containment recirculation sump valves will immediately start to open automatically.

C. IMMEDIATELY perform all steps given below when the recirculation sump isolation valve position lights indicate that the valve is fully open.

D. Do not close a RWST/RHR pump suction valve unless the corresponding recirculation sump valve is open.

E. All operator actions must be performed expeditiously, in a precise, orderly sequence. Do not interrupt this operation until all actions are completed. When both trains are initially available and a valve

b) Open the low head safety injection to high head safety injection and charging/safety injection pump suction isolation valves

c) After completion of the above steps VERIFY that the two high head safety injection pumps and the two charging/safety injection pumps are receiving suction flow from the low head safety injection pumps.

CAUTION: Do not perform the following steps until the above verification is made.

STEP 3

a) Close the RWST to high head safety injection pump suction valves

b) Close the RWST to charging/safety injection pump suction isolation valves

STEP 4

The utility should provide spray system switchover procedures and integrate them into this instruction.

NOTE: For plant designs which utilize only the spray system heat exchanger to remove energy from the containment recirculation sump the spray system must be operated during the long term even if it was not automatically actuated.

VERIFICATION:

STEP 5

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

a) 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.

b) 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.

c) 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.

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

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

STEP 6

If the system alignment has been verified go to E-1 Step 9. If any failures have occurred, proceed to contingency actions.

CONTINGENCY ACTIONS

1. 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:

a) 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.

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

2. LOSS OF ONE TRAIN OF ELECTRICAL POWER

NOTE: 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 buses. 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 above, which assumed no single failures. The operator could follow the above instruction with the understanding that those valves, without power, do not have to be repositioned.

The following instruction is provided to illustrate the similarity between the instruction which assumes no single failures, and an instruction which assumes one complete electrical power train failure. For this instruction, it is assumed that Train B failed simultaneously with the loss of reactor coolant. It should be noted that if a train failed subsequent to the initiation of the "S" 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 an "S" 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, positive isolation of the RWST to charging/safety injection pump suction path would have to be accomplished locally.

OPERATIONAL STEPS: (Assume only Train A available)

STEP 1

a) Close the RWST to low head safety injection pump suction isolation valve

b) Close the high head safety injection pump miniflow valves

c) Close the low head safety injection crossover isolation valve

STEP 2

a) Open one of the parallel valves in the high head safety injection and charging/safety injection pump common suction header

b) Open the low head safety injection to charging/safety injection pump suction isolation valve

After completing the above steps, verify that the one high head safety injection pump and one charging/safety injection pump are receiving suction flow from the one operating low head safety injection pump.

Caution: Do not perform the following steps unless the above verification is absolute.

STEP 3

a) Close the RWST to high head safety injection pump suction valve

b) Close the RWST to charging/safety injection pump suction valve

VERIFICATION:

STEP 4

After completing the above step, verify that the safety injection system is aligned for cold leg recirculation as follows:

a) One low head safety injection pump is delivering from the containment recirculation sump to two reactor coolant system cold legs and to the suction of one high head safety injection and one charging/safety injection pump.

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

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

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

STEP 5

If the system alignment in Step 4 has been verified, go to E-1 Step 9. If any failures have occurred, attempt to operate the equipment manually and locally.

EMERGENCY INSTRUCTIONS E-3

STEAM GENERATOR TUBE RUPTURE

For Plants With High Pressure Safety Injection Pumps

A. PURPOSE

The objectives of these instructions are as follows:

1. To minimize the release of radioactive material by identifying and isolating the faulted steam generator and by reducing reactor coolant system pressure below the steam generator safety valve settings.

2. To establish capability to supply feedwater to all steam generators and to isolate feedwater to the faulted steam generator.

3. To maintain the ability to remove the necessary residual heat from the reactor through the intact steam generators via the steam dump valves or power operated relief valves.

4. To maintain the reactor coolant system in a subcooled state during the recovery.

5. To prevent overflooding of the faulty steam generator.

B. IMMEDIATE ACTIONS

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

C. SUBSEQUENT ACTIONS

CAUTION: The diesels should not be operated at idle or minimum load for more than (insert plant specific time period of allowed diesel operation at minimum load). If the diesels are shut down, they should be prepared for restart.

NOTE: Make arrangements to sample containment atmosphere and steam generators to identify presence of abnormal radioactivity.

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: Reactor coolant system isolation valves (LSIV) are optional equipment on the Westinghouse Standard Plants. If a plant is so equipped, the use of LSIV's is not currently recommended during the course of this Instruction. Any use of LSIV's must be justified on a plant specific basis.

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

1. Identify the faulted steam generator by one or more of the following methods:

   a) An unexpected rise in one steam generator water level with auxiliary feedwater flow reduced or stopped.

   b) High radiation from any one steam generator blowdown line radiation monitor.

   c) High radiation from any one steam generator, as determined by analysis or a sample.

   d) High radiation from any one steam generator main steam line.

NOTE: While identifying and isolating the faulted steam generator according to Steps 1 and 2, continue with subsequent Steps 3 through 9.

2. When the faulted steam generator has been positively identified, then:

   a) Stop all feedwater flow to the faulted steam generator.

b) Close the main steam isolation valve and bypass valves associated with the faulted steam generator.

NOTE: If the main steam isolation valve or bypass valve associated with the faulted steam generator will not close, then close the main steam isolation valves and bypass valves associated with the non-faulted steam generators and terminate all steam dumps to the condenser. Utilize the non-faulted steam generators' power operated relief valves to maintain the reactor coolant system at approximately no-load conditions.

c) Verify the closure of all power operated relief valves associated with the faulted steam generator.

d) Close the isolation valve in the steam line to the auxiliary feedwater pump associated with the faulted steam generator.

3. Verify that all pressurizer power operated relief valves are closed. Verify the open status and availability of power to all pressurizer power operated relief valve backup isolation valves.

4. Stop <u>all</u> reactor coolant pumps after the high head safety injection pump operation has been verified and when the wide range reactor coolant pressure is at (plant specific pressure derived from method in Appendix A of E-0).

CAUTION: If component cooling to the reactor coolant pumps is isolated on a containment pressure signal, all reactor coolant pumps are to be stopped within 5 minutes because of loss of motor bearing cooling.

CAUTION: If 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 through Step 10 of this instruction.

5. If offsite power and the condenser are available, open bypass valves and any closed main steam line isolation valves to provide a flowpath to the condenser dump valves.

6. Establish power sources necessary to operate at least one pressurizer power operated relief valve, at least one steam generator power operated relief valve, and charging and letdown flowpaths.

NOTE: Ensure that containment isolation is maintained, i.e., not reset until such time as manual action is required on necessary process streams.

7. Manually stabilize the reactor coolant system (if not accomplished automatically) at approximately no-load temperature by steam dump to the main condenser if offsite power and the condenser are available. If offsite power or the condenser is not available, utilize the steam generator power operated relief valves to stabilize the reactor coolant system at approximately no-load temperature.

8. Whenever the water level in the steam generators has been restored to the narrow range span, regulate the auxiliary feedwater flow to those steam generators to maintain an indicated narrow range water level.

NOTE: Monitor the primary water supply (Condensate Storage Tank) for the auxiliary feedwater pumps and upon reaching a low level, switch over to an alternate water supply source.

9. If reactor coolant system pressure stabilizes above the low head safety injection pump shut-off head, manually reset safety injection so that safeguards equipment can be controlled by manual action. Stop the low head safety injection pumps and place in the standby mode.

CAUTION: If the reactor coolant system pressure decreases uncontrollably below the low head safety injection shut-off head, the low head safety injection pumps must 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.

CAUTION: Do not proceed to Step 10 until the faulted steam generator has been identified and isolated.

10. After the faulted steam generator has been identified and isolated, begin a rapid cooldown of the reactor coolant system to 50°F below the no-load temperature by use of the steam dump.

    a) If offsite power and the condenser are available, dump steam to the main condenser from the non-faulted steam generators by manual control of the steam header presssure controller.

    b) If offsite power is not available or the main condenser is not available, dump steam from the non-faulted steam generators through the steam generator power operated relief valves.

c) If the faulted steam generator has been isolated by closure of the main steam isolation valves associated with the non-faulted steam generators, dump steam only from the non-faulted steam generators through the steam generator power operated relief valves.

11. After the reactor coolant system temperature has been reduced to 50oF below the no-load temperature, if necessary begin a depressurization of the reactor coolant system to a value equal to the faulted steam generator steam pressure.

CAUTION: Monitor containment indications to verify that a loss of reactor coolant other than the steam generator tube rupture is not in progress. If recirculation sump level or a containment sample (if available at this time) are not in the normal pre-event range, further accident recovery must be directed according to Emergency Instruction E-1, Loss of Reactor Coolant, Step 5 (Small LOCA).

NOTE: During subsequent controlled reactor coolant system depressurization, the reactor coolant system pressure criterion for tripping the reactor coolant pumps established in Step 2 DOES NOT APPLY.

If the RCP's are in service, use the pressurizer spray to reduce the pressure.

If offsite power is not available, or the RCP's are not in service open one pressurizer PORV to decrease pressure.

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: Prior to the initiation of a controlled RCS depressurization, there may be no indicated pressurizer level. As the depressurization process proceeds, an increase in indicated pressurizer level is expected as liquid replaces steam in the pressurizer.

12. As the reactor coolant system pressure decreases, due to the quenching of the steam by the pressurizer spray or due to the steam release through the pressurizer PORV, monitor the pressurizer water level indications and stop the depressurization operation:

    a) If the indicated water level in the pressurizer rises above 50 percent of span OR,

    b) As soon as the reactor coolant system pressure decreases to a value equal to the faulted steam generator steam pressure.

13. After the depressurization operation has been verified to have been terminated (using the pressurizer PORV stem-mounted position indicators or spray valve demand signal), continue to monitor the reactor coolant system pressure and the pressurizer water level.

a) If the pressurizer water level continues to rise or remains nearly constant concurrent with a reactor coolant system pressure decrease, suspect leakage from the pressurizer steam space. Monitor the pressurizer relief tank (PRT) pressure, temperature and level to identify continuously increasing conditions. Close the PORV isolation valves if a reactor coolant leak to the PRT is identified. Monitor PRT conditions to verify PRT integrity.

CAUTION: If pressurizer relief tank integrity is lost, abnormal containment conditions could exist and may not be true indications of a continued loss of reactor coolant. If conditions of Step 13a persist after closing the pressurizer PORV isolation valves, further recovery must be directed according to E-1, Loss of Reactor Coolant, Step 5. The conditions of Step 13b must be satisfied before proceeding to Step 14.

b) If the pressurizer water level subsequently continues to increase concurrent with a reactor coolant system pressure increase, the safety injection flow is greater than the leak.

THEN, stop all operating safety injection pumps not needed for normal charging and reactor coolant pump seal injection flow WHEN

1. Reactor coolant system pressure has increased by at least 200 psi (after shutting the spray valves or verified closure of the pressurizer PORVs), AND

2. An indicated water level has returned in the pressurizer, AND

3. The reactor coolant system indicated subcooling BASED ON WIDE RANGE TEMPERATURE IN THE NON-FAULTED LOOPS OR THE CORE EXIT THERMOCOUPLES is greater than (insert plant specific valve which is the sum of the errors for the temperature measurement system used, and the pressure measurement system translated into temperature using the saturation tables).

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

NOTE: Following termination of safety injection, pressurizer pressure should decrease to a value equal to the faulted steam generator steam pressure.

14. Place all safety injection pumps in a standby mode and maintain operable safety injection flow paths.

15. Re-establish charging and letdown flows to maintain the pressurizer water level in the operating range (approximately 20 percent indicated level):

CAUTION: If, during subsequent recovery actions, pressurizer water level cannot be maintained above 20 percent indicated level or the reactor coolant system indicated subcooling BASED ON WIDE RANGE TEMPERATURE IN THE NON-FAULTED LOOPS OR THE CORE EXIT THERMOCOUPLES cannot be maintained at a value greater than the value for SI termination, operate safety injection pumps as required to re-establish pressurizer water level and subcooling. If pressurizer water level and subcooling cannot be established by this method, MANUALLY REINITIATE SAFETY INJECTION, return to Step 11 and proceed with the instruction from that point.

16. Re-establish the use of the pressurizer heaters to maintain the reactor coolant system pressure.

17. If offsite power has been restored, establish the required conditions for operation of a reactor coolant pump and start the pump in a non-faulted loop (preferably in the loop connected to the pressurizer, or if this is the faulted loop, in the other loop to which a spray line is connected). If all reactor coolant pumps are running, trip all but one reactor coolant pump so as to maintain one pump operating in the loop connected to the pressurizer, or if this is in the faulted loop, in the other loop to which a spray line is connected.

CAUTION: The following steps 18, 19 and 20 must be performed simultaneously. Failure to expeditiously reduce reactor coolant system pressure to a value equal to the faulted steam generator steam pressure once system cooldown is initiated could cause loss of pressurizer level control.

CAUTION: Prior to this time, samples of the RCS, containment atmosphere and steam generators may have been obtained. The results of these samples, or corresponding estimates, should be used to calculate the potential radioactive releases in the subsequent steps. Do not proceed with the following steps if the calculation concludes that 10CFR20 limits will be exceeded.

18. If offsite power is available, begin a controlled cooldown of the reactor coolant system at a rate of about 50°F/hr by use of the steam dump to the main condensers from the non-faulted steam generators. Control the water levels in the steam generators to maintain steam generator water level in the narrow range span or in the wide range span at a level sufficient to assure that the U-tubes are covered.

    If offsite power is not available, dump steam from the non-faulted steam generators through the steam generator power operated relief valves to provide a controlled cooldown of the reactor coolant system at a rate of about 50°F/hr.

19. Simultaneous with the cooldown using the non-faulted steam generators, slowly decrease the faulted steam generator pressure by opening the bypass valve to the condenser (if available), or using the steam generator power operated relief valve.

20. As pressure is reduced in the faulted steam generator, control the reactor coolant pressure at a value approximately equal to the steam pressure in the faulted steam generator to minimize the leakage flow. Reactor coolant pressure control should be accomplished by use of the pressurizer heaters and action of <u>one</u> of the following:

    a) Normal pressurizer spray (if an RCP is in service), <u>OR</u>

b) Use of pressurizer auxiliary spray (if spray is heated by letdown through the regenerative heat exchanger), OR

c) Brief intermittent opening of one pressurizer PORV.

NOTE: Maintain reactor coolant system temperature and pressure within the limits of the normal cooldown curves in the Technical Specifications.

CAUTION: 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.

CAUTION: If reactor coolant pressure control is accomplished by use of the pressurizer PORV, continuously monitor the PRT pressure, temperature and water level and take appropriate actions to verify and maintain PRT integrity. Verify pressurizer PORV closure using the PORV stem-mounted position indicators and PRT conditions. If a reactor coolant leak to the PRT is identified, close the PORV isolation valves.

21. Periodically sample and analyze the reactor coolant boron concentration during the continuing cooldown. Borate as necessary to maintain the required shutdown margin at all times during the cooldown.

22. When the reactor coolant system pressure approaches the safety injection accumulator pressure, close the safety injection accumulator isolation valves.

23. Continue to cooldown and depressurize the reactor coolant system and faulted steam generator until the reactor coolant hot leg temperatures are below 400°F in the non-faulted loops and the reactor coolant pressure has reached about 400 psig (do not collapse the pressurizer steam bubble).

24. Place the residual heat removal system in operation using Normal Cooldown Procedures.

NOTE: Throughout this cooldown procedure, maintain a steam bubble in the pressurizer. Solid water pressure control may not be effective.

25. Continue the plant cooldown in a normal mode except that after the RCP operation has been terminated, continue to simultaneously control the faulted steam generator steam pressure and reactor coolant pressure to minimize the leakage flow.

26. When the reactor coolant system hot leg temperatures are reduced below 200°F, the pressure in the pressurizer may be reduced by using auxiliary spray until reactor coolant system pressure and the faulted steam generator pressure equilibrate.

27. Continue the operation of the residual heat removal system to remove the core residual heat and maintain the charging and letdown in service to control the pressurizer water level and provide a boration path.

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