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NOV 5 1979

Mr. Cordell Reed, Chairman
Westinghouse Owners' Group
Commonwealth Edison Company
P. O. Box 767
One First National Plaza
Chicago, Illinois 60690

Dear Mr. Reed:

SUBJECT: EVALUATION OF SMALL-BREAK LOSS-OF-COOLANT ACCIDENT OPERATOR GUIDELINES

We have completed our review of the small-break loss-of-coolant accident operator guidelines E-0 and E-1 contained in Appendix A of Westinghouse Electric Corporation Report WCAP-9600. Our evaluation of these guidelines is documented in Enclosure 1.

As stated in our evaluation, we have concluded that the guidelines E-0 and E-1, as modified in accordance with your letters dated October 16, 1979, October 31, 1979 and November 2, 1979 are acceptable for plants having high head safety injection pumps similar to the 412 standard plant. A copy of the approved guidelines is provided in Enclosure 2 for your information and use. For the case of 4-loop, 3-loop, and 2-loop plants with nominal 1400 psi range safety injection pumps, it is our understanding that revisions to the guidelines for these plants similar to those provided for the 412 standard plant in your October 31, 1979 and November 2, 1979 letters will be submitted shortly. Based on your commitment to provide these agreed-upon revisions to the guidelines in a timely manner, we find the guidelines for these plants acceptable, pending fulfillment of this commitment.

All licensees of Westinghouse Electric Corporation pressurized water reactor plants may now proceed with their development of small-break loss-of-coolant accident emergency procedures and operator training based on the modified guidelines. As indicated on Page 5 of Enclosure 6 to Darrell G. Eisenhut's September 13, 1979 letter to all operating nuclear power plants, implementation of these procedures and operator training are to be completed by December 31, 1979.

In the implementation of these procedures, each licensee shall provide:

1. The basis for the pressure setpoint at which the operator is to trip the reactor coolant pumps. The basis should include defining the steam generator safety valve setpoints and instrument uncertainties.

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2. The instrument uncertainties involved with the HPI termination criteria to indicate the criteria will insure subcooled conditions.

3. Justification that the procedures for switchover from inspection to recirculation will insure that the valve realignments can be accomplished before the RWST is emptied. This justification should include instrument uncertainties and show that the pumps will be protected against operating without adequate suction pressure.

4. Licensees with 4-loop, 3-loop, or 2-loop plants with nominal 1400 psi range safety injection pumps, should show that the pumps will not be run deadheaded when in the recirculation mode.

5. An indication of the typicality of the analyses documented in WCAP-9600 relative to its own plant.

Licensees will also be required to implement emergency procedures covering the extended loss of all feedwater (including pressure vessel integrity considerations), and to revise emergency procedures for initiating (if necessary) and monitoring natural circulation (including provisions for plant cooldown). Such procedures will be based on guidelines which you are developing under inadequate core cooling.

As part of our audit program, we expect to examine the procedures of lead plants in several of the classes of Westinghouse-designed pressurized water reactors to assure that they have been developed in accordance with the approved guidelines. We also plan to check out some of the procedures at a Westinghouse pressurized water reactor simulator, on a schedule to be developed later. It should be noted however, that our audit program need not impede progress towards implementation of approved procedures and associated training by December 31, 1979.

Sincerely,

Original signed by:

D. F. Ross, Jr., Director
Bulletins and Orders Task Force

Enclosures:
As stated

cc: See attached lists

OFFICE	B&OTF	B&OTF	B&OTF	B&OTF	B&OTF	B&OTF
SURNAME	PDO'Reilly:jk	WKane	ZRosztoczy	SIsrael	TMNovak	DFRoss
DATE	11/01/79	11/01/79	11/2/79	11/2/79	11/ /79	11/4/79

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EVALUATION OF WESTINGHOUSE OPERATOR GUIDELINES FOR SMALL BREAK LOCA

Guidelines for Emergency Procedures

A Westinghouse Interdisciplinary Task Force was formed to prepare guidelines for operators for small break loss-of-coolant accidents (LOCA's). The Task Force consisted of safety analysts, systems analysts, training personnel and other disciplines. The guidelines which were developed were reviewed and approved by the Working Group on Procedures, which is a subgroup of the Westinghouse Owners' Group.

Preliminary guidelines were submitted to the NRC staff as part of the generic report WCAP-9600, "Report on Small Break Accidents for Westinghouse NSSS System." The intent of the guidelines was for each of the utilities using a Westinghouse nuclear steam supply system to revise or develop its emergency procedures for the operators to use in diagnosing and responding to a loss of reactor coolant. The reference instructions developed by Westinghouse were expanded to include all emergency events in which the Emergency Core Cooling System (ECCS) was automatically actuated. The guidelines include Immediate Actions and Diagnostics (E-0), Loss of Reactor Coolant (E-1), Loss of Secondary Coolant (E-2), and Steam Generator Tube Rupture (E-3). Only E-0 and E-1 have been reviewed by the NRC staff at this time for both the 412 Standard Plant, which has high head safety injection pumps, and other plants with nominal 1400 psi safety injection (SI) pumps. The staff will not review E-2 and E-3 until after January 1, 1980.

The philosophy of the instructions was for the operator to respond to an event in which safety injection was initiated and, following the required immediate actions, to diagnose the event and perform the necessary subsequent actions. The immediate actions consist of verifying that the automatic actions did occur. Verification, in this context, includes performing the action manually if it did not occur automatically. These actions are intended to assure that the reactor is adequately shut down, that the safety injection system is performing its design function and that auxiliary feedwater is being delivered to the steam generators as a heat sink for the core decay heat.

In the diagnostic procedure E-0, the operator assesses the event using reactor coolant system pressure as a key parameter. If the pressure falls below a specified value, he must immediately trip all the reactor coolant pumps. The primary system pressure at which the pumps will be tripped will be determined based on the secondary system pressure in the following manner:

(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 the 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 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.

The action regarding reactor coolant pump trip was deemed necessary by a Westinghouse analysis of delayed reactor coolant pump trip for a limited range of small break LOCAs (WCAP-9584). If, in addition to low pressure, the condenser air ejector radiation or steam generator blowdown radiation monitor readings are abnormally high, the operator is directed to E-3, the steam generator tube rupture procedure. If the steamline pressure is abnormally lower in one steam generator than in the others, he must assume a loss of secondary coolant. Abnormally high readings for containment pressure, containment high radiation, or containment recirculation sump levels are symptomatic of a loss of reactor coolant.

In the diagnostic procedure, the operator is permitted to terminate a spurious high pressure injection (HPI) actuation if the primary system pressure, pressurizer level, and subcooling are within acceptable limits and there is sufficient water level in at least one steam generator and no abnormal readings for containment atmosphere monitors.

If HPI actuation is not spurious, the operator would proceed to the emergency procedures for one of the depressurization accidents. The core is assured of adequate core cooling in the LOCA procedure (E-1) in that the operator is prevented from terminating high pressure injection unless certain criteria are met. These criteria include:

1. At least normal full power subcooling,
2. Primary system pressure of 2000 psig or greater and increasing, and
3. Pressurizer level at or above programmed no-load range, and
4. Sufficient water level in at least one steam generator to assure a heat sink.

Similar HPI termination criteria are included in the other emergency procedures.

Recognizing that, in most instances of safety injection, the primary system will be repressurized, these criteria are necessary to allow the operator to terminate safety injection to reduce the probability of lifting the pressurizer power operated relief or safety valves.

The criteria for the lower head SI plants are basically the same. If the safety injection is sufficient to repressurize the plant, flow will stop when the shutoff head of the pumps is reached. The normal charging pumps and pressurizer heaters can be used to bring pressure above 2000 psig, at which time the SI pumps can be stopped.

Subsequent actions in the E-1 guidelines are based on whether the plant can be repressurized. If the plant can be repressurized, the operator is directed to increase the subcooling to 50° F and proceed with plant cooldown while monitoring subcooling. If subcooling cannot be maintained, HPI is reinitiated. Subsequent actions include switchover from injection to recirculation when the level in the refueling water storage tank (RWST) is low and hot leg injection at about 20 hours. The NRC staff has not reviewed the guidelines for switchover and hot leg injection, because these will be plant-specific.

Evaluation

The NRC staff reviewed the guidelines with respect to critical operator actions, namely:

1. reactor coolant pump trip.
2. HPI termination criteria.
3. verification of safety systems actuation.
4. verification of a heat sink.
5. monitoring of important system parameters.

During our review, the staff identified modifications to be made to the guidelines to enhance the directions to the operator. These modifications were subsequently incorporated in the guidelines as defined by Revision 1 (October 16, 1979) and revisions dated October 31, 1979, and November 2, 1979.

The criteria for tripping the reactor coolant pumps are consistent with the analyses presented in WCAP-9584, which have been reviewed by the staff and found acceptable. In order to implement the criteria in individual plant procedures, each licensee must document the basis for the low pressure set point. This documentation should include defining the steam generator safety valve set points and system and instrument uncertainties associated with the plant. Based on our review of WCAP-9584 and the requirement for each licensee to justify the low pressure trip point described in the preceding section, we conclude that the reactor coolant pump trip criteria are acceptable.

Although we find that the reactor coolant pump trip criteria are acceptable, manual tripping of the pumps should be considered only a short-term solution. For the long-term, we will require that this trip be made automatic.

The criteria for terminating HPI flow is based on a combination of system pressure, subcooling, pressurizer level, and steam generator water level. The staff concurs that these criteria are sufficient for establishing subcooled conditions in the core so that HPI can be safely terminated without concern for detrimental voids being formed in the primary system. In implementing these criteria, each licensee is required to document the instrument uncertainties (even in an adverse environment) to show that the criteria in the guidelines will indeed insure subcooled conditions. Based on the above requirement, we find the HPI termination criteria acceptable.

As part of the immediate actions, the operator is directed to verify that the ECCS, auxiliary feedwater (AFW), and containment isolation systems have been actuated. We concur that these verifications are sufficient to insure minimum safeguards availability needed to mitigate small break LOCAs.

The operator is also directed to verify that he has established heat removal from the steam generator. We concur that this is a necessary instruction for mitigating small break LOCAs.

The operator is directed to monitor primary system pressure, pressurizer level, and coolant hot leg temperatures to insure that subcooling is maintained if HPI has been terminated. We concur that monitoring these system variables is sufficient to maintain adequate subcooling in the primary system.

The staff has not reviewed the guidelines for switchover from injection to recirculation or hot leg injection because these actions are mostly plant-specific instructions. The staff requires each licensee to justify the procedures for switchover to insure that the valve realignments can be accomplished before the RWST is emptied. This justification should include instrument uncertainties and show that the pumps will be protected against operating with inadequate suction. We will require that plants with nominal 1400 psi range SI pumps demonstrate that these pumps will not be deadheaded when in the recirculation phase.

The staff noted that the guidelines are based on obtaining at least minimum safeguards operation to mitigate small break LOCAs. We require each licensee to extend the emergency procedures to cover the loss of all feedwater. Procedures for this degraded condition should also take into account pressure vessel integrity considerations. The Owners' Group has committed to prepare guidelines for operational procedures regarding the loss of all feedwater as part of its effort on the issue of inadequate core cooling.

The staff also requires that the emergency procedures include instructions for monitoring and initiating (if lost) natural circulation for small break LOCAs where heat removal by the steam generators is required.

The guidelines for such procedures should direct the operator to initiate a controlled plant cooldown is stable system conditions can be maintained. The staff requires that each licensee provide procedures for cooling down the plant under natural circulation conditions. These procedures should address boration control and monitoring, cooldown of the pressurizer, and adequate criteria for monitoring coolant system temperatures to insure that voids do not form in the primary system which could inhibit adequate heat removal. As in the case of loss of all feedwater, the Owners' Group has committed to prepare guidelines for operational procedures regarding natural circulation and cooldown under natural circulation conditions as part of its effort on inadequate core cooling.

Conclusion

Based on our review, we conclude that the guidelines E-0 and E-1 as revised by the Owners' Group letters dated October 16, 1979, October 31, 1979, and November 2, 1979 are acceptable for plants having high head safety injection pumps similar to the 412 standard plant, provided that licensees implement the requirements noted above when they develop their procedures. For the case of 4-loop, 3-loop, and 2-loop plants with nominal 1400 psi range safety injection pumps, the Owners' Group has committed to submit revisions to the guidelines for these plants which are similar to those provided for the 412 standard plant in the Owners' Group letters dated October 31, 1979 and November 2, 1979. Based on this commitment, we find the guidelines for these plants acceptable, pending submission of such revisions, subject to the requirements on individual licensees identified above.

Enclosure 2

412 STANDARD PLANT
REFERENCE EMERGENCY
OPERATING INSTRUCTIONS

Revision 1

September 26, 1979

with Revised Pages

dated October 15, 1979,

October 29, 1979,

and November 2, 1979

This document contains Emergency Instructions for the Model 412 Standard Plant and is intended to provide guidance in the preparation of Emergency Operating Procedures for individual plants. It is not likely that these instructions will apply in their entirety to any specific plant design and adaptation will be required.

ATTACHMENT A

(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 the 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.

412 STANDARD PLANT

E-0

EMERGENCY INSTRUCTIONS

IMMEDIATE ACTIONS AND DIAGNOSTICS

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:

a) Automatic steam dump to the condenser is occurring;

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

NOTE: Atmospheric steam dump will 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. <u>ACCIDENT DIAGNOSTICS</u> (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 Attachment A of letter OG-17).

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 met and when the following d through f 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

f. The reactor coolant indicated subcooling is greater than (insert plant specific value of subcooling equal to full power normal operation). 10/29

g. Water level in at least one steam generator is in the narrow range span, or in the wide range span at a level sufficient to assure that the U-tubes are covered 10/29

*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. Energize the heaters.

THEN:

h. Reset safety injection and stop safety injection pumps not needed for normal charging and RCP seal injection flow. 10/29

CAUTION: Automatic reinitiation of safety injection will not occur since the reactor trip breakers are not reset. 10/15

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. 10/15

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

j. Isolate safety injection flow to RCS Cold Legs via Boron Injection Tank and establish normal charging flow.

k. 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.

l. 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.

NOTE: IF after securing safety injection and attempting to transfer to normal pressurizer pressure and level control, 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 T_H > normal full power T_H, THEN SAFETY INJECTION MUST BE MANUALLY REINITIATED. The operator must rediagnose plant conditions and proceed to the appropriate emergency instruction.

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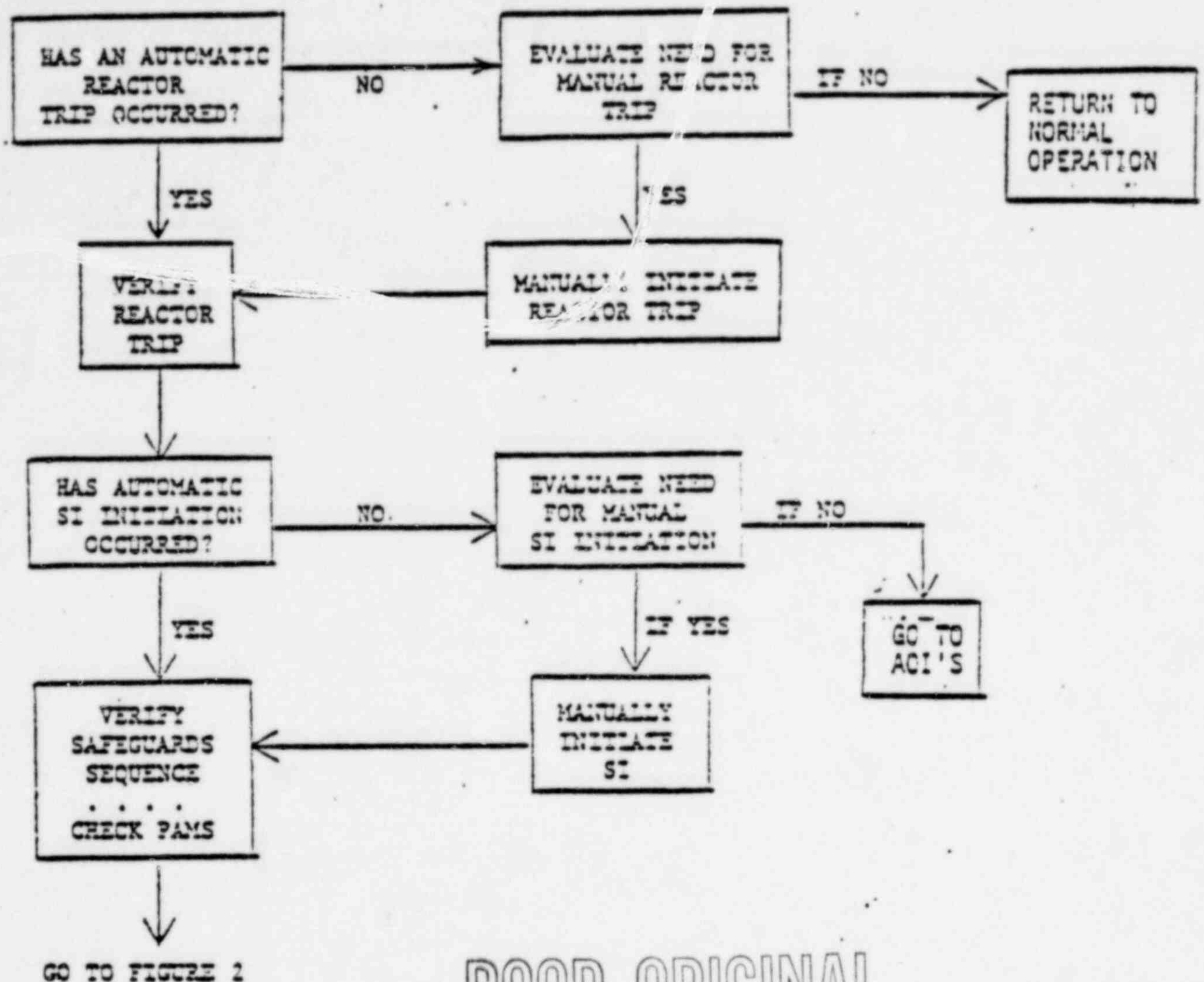
NOTE: IF after securing safety injection and transferring the plant to normal pressurizer pressure and level control, the reactor coolant pressure does not drop below the low pressurizer pressure setpoint for safety injection actuation AND the pressurizer water level remains above 10% span, AND the reactor coolant indicated subcooling is greater than (insert plant specific value of subcooling based on full power normal operation), THEN go to the abnormal operating instructions.



IMMEDIATE ACTIONS

FIGURE 1

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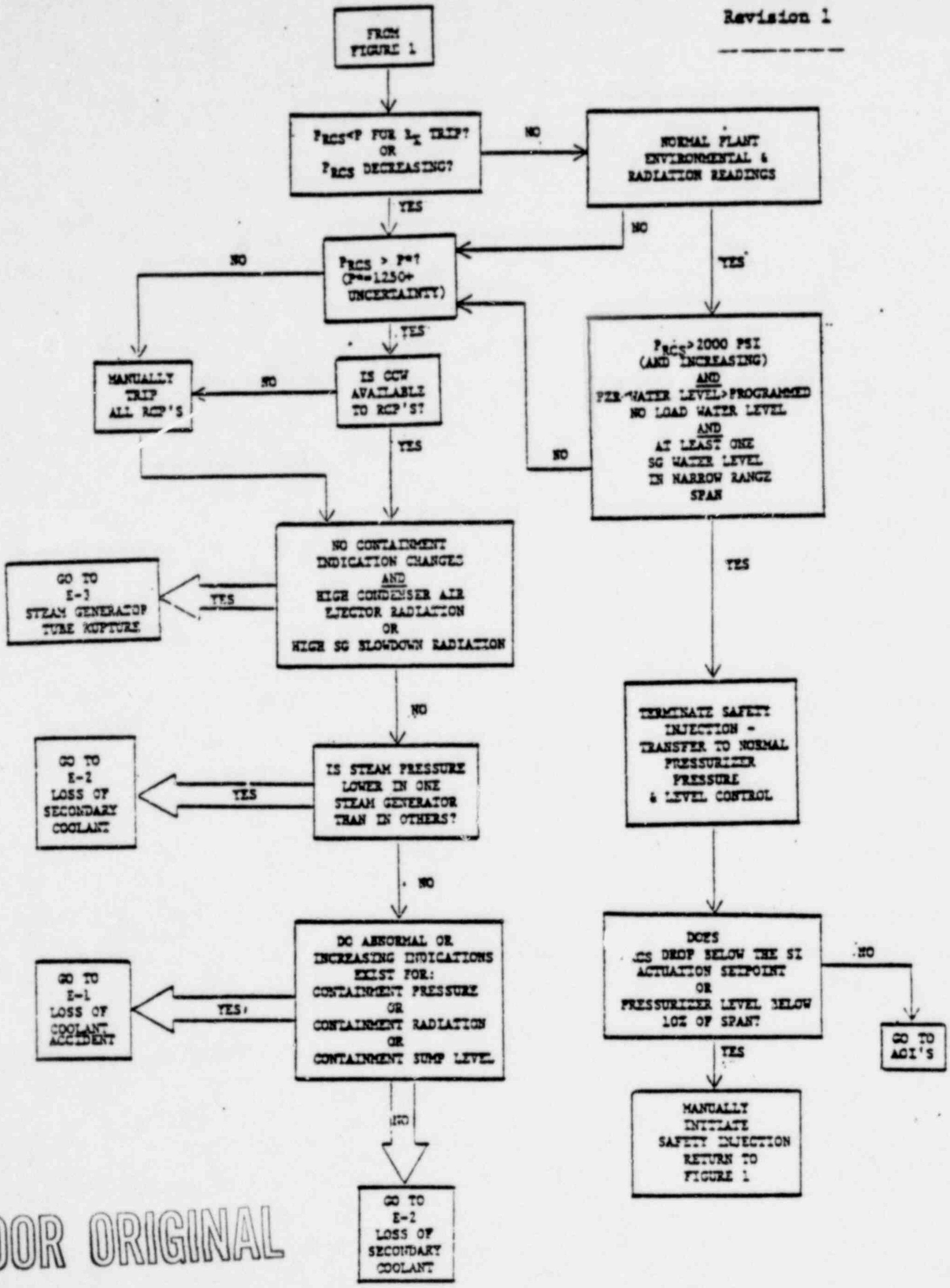

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FIGURE 2

E-0(HP)-14

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412 STANDARD PLANT

E-1

EMERGENCY INSTRUCTION

LOSS OF REACTOR COOLANT

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 extended periods of time. 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 (PAMS) 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 (PAMS). 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. Close all pressurizer power operated relief valves and backup isolation valves.

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 of subcooling based on full power normal operation), AND

(D) Water level in at least one Steam Generator is in the narrow range span, or in the wide range span at a level sufficient to assure that the U-tubes are covered.

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. 10/2

(F) Place all safety injection pumps not needed to provide normal charging flow in standby mode and maintain operable safety injection flowpaths. 10/2

(G) Isolate safety injection flow to RCS Cold Legs via Boron Injection Tank and establish normal charging flow. 10/2

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 T_H >Normal Full Power T_H 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. 10/2

(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) Monitor either the average temperature indication of core exit thermocouples (if available) or all wide range reactor coolant temperature T_H (PAMS) 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 200 psi below the lowest steam safety valve setpoint and maintain a reactor coolant cooldown rate of no more than 50°F/HR, consistent with plant make-up capability.

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.

(K) 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 is 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 Attachment A of letter OG-17).

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 (PAMS) 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. Note, 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.

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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 leakage from ECCS during recirculation. If significant leakage has been identified in the ECCS, attempt to isolate the leakage. The operator must maintain recirculation flow to the RCS at all times.

10. While the plant is in cold leg recirculation mode, 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

TABLE E-1.1 (Continued)

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.

TABLE E-1.1 (Continued)

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.

TABLE E-1.1 (Continued)

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.

TABLE E-1.1 (Continued)

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.

TABLE E-1.1 (Continued)

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

TABLE E-1.1 (Continued)

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

TABLE E-1.1 (Continued)

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:

TABLE E-1.1 (Continued)

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

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TABLE E-1.2 (Continued)

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 crossover 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 crossover 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

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TABLE E-1.2 (Continued)

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 redun- dant 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.

TABLE E-1.2 (Continued)

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.

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TABLE E-1.2 (Continued)

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:

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TABLE E.1-2 (Continued)

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.

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