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AP600 Emergency Response Guidelines

List of Affected Pages for Revision 3

Emergency Response Guidelines

Replace AE-0 Revision 2 with Revision 3

Replace AES-0.1 Revision 2 with Revision 3

Replace AE-1 Revision 2 with Revision 3

Replace AES-1.2 Revision 2 with Revision 3

Replace AE-3 Revision 2 with Revision 3

Replace AFR-C.1 Revision 2 with Revision 3

Replace AFR-C.2 Revision 2 with Revision 3

Replace AFR-H.1 Revision 2 with Revision 3

Replace AFR-H.3 Revision 2 with Revision 3

Replace AFR-I.1 Revision 2 with Revision 3

AP600

Emergency Response Guidelines

AP600 Document Number GW-GJR-100

Revision 3

May 31, 1997

A. PURPOSE

This guideline provides actions to verify proper response of the automatic protection systems following manual or automatic actuation of a reactor trip or safety injection, to assess plant conditions, and to identify the appropriate recovery guideline.

B.* SYMPTOMS OR ENTRY CONDITIONS

1) The following are symptoms that require a reactor trip, if one has not occurred:

   a. Source range high neutron flux (interlocked with P6)
   b. Intermediate range high neutron flux (interlocked with P10)
   c. Power range high neutron flux - low setpoint (interlocked with P10)
   d. Power range high neutron flux - high setpoint
   e. Power range high positive flux rate
   f. Overtemperature delta-T
   g. Overpower delta-T
   h. Low pressurizer pressure (interlocked with P10)
   i. Low reactor coolant cold leg flow (interlocked one loop out of four with P8 and two loops out of four with P10)
   j. Low reactor coolant pump speed (interlocked with P10)
   k. Reactor coolant pump bearing water high temperature (interlocked one loop out of four with P8 and two loops out of four with P10)
   l. High pressurizer pressure
   m. High pressurizer water level (interlocked with P10)
   n. Low SG level - narrow range (either SG)
   o. Hi-2 SG level (either SG)
   p. ADS actuation signal
   q. Safety injection actuation signal
   r. CMT actuation signal
   s. Low SG wide range level (DAS)
   t. Low pressurizer level (DAS)
   u. Manual (PMS or DAS)

2) The following are symptoms of a reactor trip:

   a. Any reactor trip alarm
   b. Rapid decrease in neutron level indicated by nuclear instrumentation
   c. All shutdown and control rods are fully inserted

SYMPTOMS OR ENTRY CONDITIONS (continued)

3) The following are symptoms that require a reactor trip and safety injection, if one has not occurred:

   a. Low pressurizer pressure
   b. Hi-1 containment pressure
   c. Low compensated steam line pressure
   d. Low cold leg temperature
   e. Manual

4) The following are symptoms of a reactor trip and safety injection:

   a. Any SI alarm

   b. CMT injection valves open

   c. PRHR isolation valves open

* All reactor trip parameters, safety injection parameters and alarms listed in the symptoms or entry conditions are preliminary and are subject to change to be consistent with the AP600 PMS and DAS design.

STEP	ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED
	NOTE • *Steps 1 through 3 are IMMEDIATE ACTION steps.* • *Foldout page should be open.*	
1	**Verify Reactor Trip:** • All control rods - INSERTED • Reactor trip breakers - OPEN • Neutron flux - DECREASING	Manually trip reactor. IF reactor will NOT trip, THEN go to AFR-S.1, AP600 RESPONSE TO NUCLEAR POWER GENERATION/ATWS, Step 1.
2	**Verify Turbine Trip:** • All turbine stop valves - CLOSED	Manually trip turbine.
3	**Check If SI Is Actuated:** [Include additional AP600 details in EOPs]	Check if SI is required. IF SI is required, THEN manually actuate. IF SI is NOT required, THEN go to AES-0.1, AP600 REACTOR TRIP RESPONSE, Step 1.
4	**Verify Main FW Isolation:** • Main flow control valves - CLOSED • Main FW isolation valves - CLOSED	Manually close valves as necessary.
5	**Verify SG Blowdown Isolation:** • SG blowdown isolation valves - CLOSED	Manually close valves as necessary.

STEP	ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED
6	**Verify Containment Isolation:**	
	a. Containment isolation - ACTUATED	a. Manually actuate containment isolation.
	b. Containment isolation valves - CLOSED	b. Manually close valves.
7	**Verify CMT Actuated:** • CMT injection valves - OPEN	Actuate CMT initiation. IF valves will NOT open, THEN manually open valves as necessary.
8	**Verify PRHR Actuated:**	
	a. Verify PRHR isolation valves - OPEN	a. Actuate PRHR Initiation. IF valves will NOT open, THEN manually open valves as necessary.
	b. Verify IRWST gutter drain isolation valves - CLOSED	b. Manually close valves.
9	**Verify All RCPs Tripped**	Manually trip RCPs.

STEP	ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED
10	**Check If Main Steamlines Should Be Isolated:**	
	a. Check if any of the following signals have occurred: • Low steam line pressure -OR- • Low T-cold -OR- • Hi-1 containment pressure	a. Go to Step 11.
	b. Verify main steamline isolation and bypass valves - CLOSED	b. Manually close valves.
11	**Verify Passive Containment Cooling Not Required:** • Containment pressure - HAS REMAINED LESS THAN (P01) PSIG • Containment temperature - LESS THAN (T03)	Verify PCS initiated. IF NOT, THEN manually initiate.

STEP	ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED
12	**Check RCS Temperatures:** • RCS cold leg temperatures - STABLE AT OR TRENDING TO (T04) °F	IF temperature less than (T04) °F and decreasing, THEN: a) Stop dumping steam. b) IF cooldown continues, THEN control total feed flow. Maintain total feed flow greater than (F01) gpm until narrow range level greater than (L03)% [(L04)% for adverse containment] in at least one SG. c) IF cooldown continues, THEN close main steamline isolation and bypass valves. IF temperature greater than (T04) °F and increasing, THEN: • Dump steam to condenser. -OR- • Dump steam using SG PORVs. -OR • Initiate PRHR.
13	**Verify Power to ECS AC Busses:**	
	a. ECS AC busses - AT LEAST ONE ENERGIZED	a. Try to restore power to at least one ECS ac bus.
	b. AC busses - ALL ENERGIZED	b. Try to restore power to deenergized ac busses.

STEP	ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED

NOTE

- *It may be necessary to block the Low T-cold to restart SFW pumps.*
- *SFW flow should not be reestablishd to a depressurized SG unless needed for RCS cooldown.*

14	**Verify SFW Pumps Running**	Manually start pumps.
15	**Verify Total SFW Flow - GREATER THAN (F01) GPM**	IF SG narrow range level greater than (L03)% [(L04)% for adverse containment] in any SG, THEN control feed flow to maintain narrow range level. IF narrow range level less than (L03)% [(L04)% for adverse containment] in all SGs, THEN manually start SFW pumps and align valves as necessary. IF SFW flow greater than (F01) gpm can NOT be established, THEN initiate PRHR. IF PRHR can NOT be initiated, THEN go to AFR-H.1, AP600 RESPONSE TO LOSS OF RCS HEAT SINK, Step 1.
16	**Verify SFW Valve Alignment - PROPER SHUTDOWN ALIGNMENT**	Manually align valves as necessary.

STEP	ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED
	CAUTION *If adverse containment conditions exist, RCS makeup should be operated in manual to maintain pressurizer level.*	
17	**Check RCS Makeup Status:**	
	a. PRZR level - GREATER THAN (L05)% [(L23)% FOR ADVERSE CONTAINMENT]	a. Verify one makeup pump running. IF NOT, THEN manually start one makeup pump.
	b. PRZR level - LESS THAN (L06)% [(L31)% FOR ADVERSE CONTAINMENT]	b. Verify all makeup pumps stopped. IF NOT, THEN manually stop all makeup pumps.
	c. Verify demineralized water isolation valves - CLOSED	c. Manually close valves.
18	**Verify SWS System Operation:**	
	a. SWS pumps - AT LEAST ONE RUNNING	a. Start SWS pumps as necessary.
	b. Verify proper valve alignment: [Include additional AP600 details in EOPs]	b. Manually align valves as necessary.
19	**Verify CCS System Operation:**	
	a. CCS pumps - AT LEAST ONE RUNNING	a. Start CCS pumps as necessary.
	b. Verify proper valve alignment: [Include additional AP600 details in EOPs]	b. Manually align valves as necessary.

STEP	ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED
20	**Verify VWS System Operation:**	
	a. VWS pumps - AT LEAST ONE RUNNING	a. Start VWS pumps as necessary.
	b. Verify proper valve alignment [Include additional AP600 details in EOPs]	b. Manually align valves as necessary.
21	**Verify Containment Fan Coolers - RUNNING**	Manually start fan coolers.
22	**Check If SG Secondary Pressure Boundaries Are Intact:**	
	a. Check pressures in all SGs - • NO SG PRESSURE DECREASING IN AN UNCONTROLLED MANNER • NO SG COMPLETELY DEPRESSURIZED	a. Go to AE-2, AP600 FAULTED STEAM GENERATOR ISOLATION, Step 1.
23	**Check If SG Tubes Are Intact:** • Turbine island vent discharge radiation - NORMAL • SG blowdown radiation - NORMAL	Go to AE-3, AP600 STEAM GENERATOR TUBE RUPTURE, Step 1.
24	**Check If RCS Is Intact:** • Containment radiation - NORMAL • Containment pressure - NORMAL • Containment level - NORMAL	Go to AE-1, AP600 LOSS OF REACTOR OR SECONDARY COOLANT, Step 1.

STEP	ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED
25	**Check If Passive Safety Systems Should Be Terminated:**	
	a. RCS subcooling based on core exit TCs - GREATER THAN (S01) °F	a. Go to Step 27.
	b. RCS heat sink: • Total feed flow to SGs - GREATER THAN (F01) GPM -OR- • Narrow range level in at least one SG - GREATER THAN (L03)% -OR- • PRHR - OPERATING	b. IF neither condition satisfied, THEN go to Step 27.
	c. RCS pressure - STABLE OR INCREASING	c. Go to Step 27.
	d. PRZR level - GREATER THAN (L05)%	d. Go to Step 27.
26	**Go To AES 1.1, AP600 PASSIVE SAFETY SYSTEMS TERMINATION, Step 1**	
27	**Initiate Monitoring Of Critical Safety Function Status Trees**	

STEP	ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED
28	**Check SG Levels:**	
	a. Narrow range level - GREATER THAN (L03)%	a. Maintain total feed flow greater than (F01) gpm until narrow range level greater than (L03)% in at least one SG.
	b. Control feed flow to maintain narrow range level between (L03)% and 50%	b. IF narrow range level in any SG continues to increase in an uncontrolled manner, THEN go to AE-3, AP600 STEAM GENERATOR TUBE RUPTURE, Step 1.
29	**Check SGS Main Steamline Radiation - NORMAL**	Go to AE-3, AP600 STEAM GENERATOR TUBE RUPTURE, Step 1.

STEP	ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED
30	**Check If ADS Should Be Actuated:**	
	a. CMT level - LESS THAN (L01)%	a. IF RCS hot leg level indication greater than (L32), THEN go to Step 31. IF NOT, THEN manually actuate ADS.
	b. Verify first stage ADS isolation valves - OPEN	b. Manually open valves as necessary.
	c. Check second stage ADS valves - OPEN	c. WHEN (T01) seconds have elapsed from first stage ADS signal, THEN verify second stage ADS valves open. IF NOT, THEN manually open second stage ADS valves as necessary.
	d. Check third stage ADS valves - OPEN	d. WHEN (T02) seconds have elapsed from second stage ADS signal, THEN verify third stage ADS valves open. IF NOT, THEN manually open third stage ADS valves as necessary.
	e. Align RNS to inject into RCS	
	f. Verify proper valve alignment [Include additional AP600 details in EOPs]	f. Manually align valves as necessary.
	g. Go to AE-1, AP600 LOSS OF REACTOR OR SECONDARY COOLANT, Step 1.	
31	**Check Plant Vent Radiation - NORMAL**	Evaluate cause of abnormal conditions. IF the cause is a loss of RCS inventory outside containment, THEN go to AECA-1.1, AP600 LOCA OUTSIDE CONTAINMENT, Step 1.

STEP	ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED
32	**Reset SI**	
33	**Reset Containment Isolation**	
34	**Establish Following Support Systems Into Containment:** • Instrument Air • VWS • CCS	
35	**Check If Diesel Generators Should Be Stopped:**	
	a. Verify ECS ac busses - ENERGIZED BY OFFSITE POWER	a. Try to restore offsite power to ECS ac busses. IF offsite power can NOT be restored, THEN load the following equipment on ac busses: [Include additional AP600 details in EOPs]
	b. Stop any unnecessary diesel generator and place in standby	
36	**Check If PRHR Should Be Isolated**	
	a. Check the following: • SFW - IN OPERATION • Narrow range level in at least one SG - GREATER THAN (L03)%	a. Go to Step 37.
	b. Close PRHR isolation valves	

STEP	ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED

37 **Return To Step 12**

- END -

FOOTNOTES

Refer to FOOTNOTE DEFINITION Document for a description of all footnoted parameters used in this guideline.

A. PURPOSE

This guideline provides the necessary instructions to stabilize and control the plant following a reactor trip without a safety injection.

B. SYMPTOMS OR ENTRY CONDITIONS

This guideline is entered from AE-0, AP600 REACTOR TRIP OR SAFETY INJECTION, Step 3 when SI is neither actuated nor required.

STEP	ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED

CAUTION *If SI actuation occurs during this guideline, AE-0, AP600 REACTOR TRIP OR SAFETY INJECTION, should be performed.*

NOTE *Foldout page should be open.*

1 **Check RCS Temperatures -**

- RCS AVERAGE TEMPERATURE STABLE AT OR TRENDING TO (T04) °F IF ANY RCP RUNNING

-OR-

- RCS COLD LEG TEMPERATURES STABLE AT OR TRENDING TO (T04) °F IF NO RCP RUNNING

IF temperature less than (T04) °F and decreasing, THEN:

a) Stop dumping steam.

b) IF cooldown continues, THEN control total feed flow. Maintain total feed flow greater than (F01) gpm until narrow range level greater than (L03)% in at least one SG.

c) IF cooldown continues, THEN close main steamline isolation and bypass valves.

d) IF cooldown continues and both SFW in operation and narrow range level greater than (L03)% in both SGs, THEN isolate PRHR.

[Include additional AP600 details in EOPs]

IF temperature greater than (T04) °F and increasing, THEN:

- Dump steam to condenser.

-OR-

- Dump steam using SG PORVs.

-OR-

- Initiate PRHR.

STEP	ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED
2	**Verify All ECS AC Busses - ENERGIZED BY OFFSITE POWER**	Try to restore offsite power to ECS ac busses. IF offsite power can NOT be restored, THEN load the following equipment on ac busses: [Include additional AP600 details in EOPs]
3	**Check FW Status:**	
	a. Check RCS average temperatures - LESS THAN (T08) °F	a. Continue with Step 3c. WHEN temperature less than (T08) °F, THEN do Step 3b and c.
	b. Verify main FW flow control valves - CLOSED	b. Manually close valves.
	c. Verify feed flow to SGs	c. Establish feed flow to the SGs using SFW line. IF feed flow NOT available AND SG narrow range level less than (L36)%, THEN verify PRHR actuated. IF NOT, THEN manually actuate PRHR.
4	**Verify All Control Rods Fully Inserted**	IF two or more control rods NOT fully inserted, THEN immediately borate (B01) ppm for each control rod not fully inserted.

STEP	ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED
5	**Check RCS Makeup Status:**	
	a. PRZR level - GREATER THAN (L37)%	a. Verify one makeup pump running. IF NOT, THEN manually start one makeup pump.
	b. PRZR level - LESS THAN (L38)%	b. Verify all makeup pumps stopped. IF NOT, THEN manually stop all makeup pumps.
	c. Verify demineralized water isolation valves - CLOSED	c. Manually close valves.
	d. Operate makeup and letdown as necessary to maintain PRZR level - BETWEEN (L37)% AND (L38)%	
6	**Check CMT Status:**	
	a. PRZR level - GREATER THAN (L17)%	a. Verify CMT injection valves open. IF NOT, THEN manually open valves. Continue with Step 7. WHEN PRZR level greater than (L17)%, THEN do Step 6b.
	b. Verify CMT injection valves - CLOSED	b. Manually close valves.

STEP	ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED
7	**Check PRZR Pressure Control:**	
	a. Pressure - GREATER THAN (P11) PSIG	a. Verify SI actuation. IF NOT, THEN manually actuate SI. Go to AE-0, AP600 REACTOR TRIP OR SAFETY INJECTION, Step 4.
	b. Pressure - STABLE AT OR TRENDING TO (P12) PSIG	b. IF pressure less than (P12) psig and decreasing, THEN: 1) Verify PRZR spray valves closed. IF NOT, THEN manually close. IF valve(s) can NOT be closed, THEN close PRZR spray valve(s) block valve. IF valve(s) can NOT be closed, THEN stop RCP(s) supplying failed spray valve(s). 2) Verify PRZR heaters on. IF NOT, THEN manually turn on. IF pressure greater than (P12) PSIG and increasing, THEN: 1) Verify PRZR heaters off. IF NOT, THEN manually turn off. 2) Control pressure using normal PRZR spray. IF normal spray NOT available, THEN use auxiliary spray.

STEP	ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED
8	**Check SG Levels:**	
	a. Narrow range level - GREATER THAN (L03)%	a. Maintain total feed flow greater than (F01) gpm until narrow range level greater than (L03)% in at least one SG.
	b. Control feed flow to maintain narrow range level between (L03)% and 50%	b. IF narrow range level in any intact SG continues to increase, THEN stop feed to that SG.
9	**Transfer Condenser Steam Dump To Pressure Control Mode**	IF condenser NOT available, THEN use SG PORVs.
	NOTE *RCPs 1A and 1B should be run to provide normal PRZR spray.*	
10	**Check RCP Status - AT LEAST TWO RUNNING**	Try to start RCPs 1A and 1B: a. Establish conditions for starting RCPs: [Include additional AP600 details in EOPs]. b. Start RCPs 1A and 1B. IF no RCP can be started, THEN refer to ATTACHMENT A to verify natural circulation. IF natural circulation NOT verified, THEN increase dumping steam.

STEP	ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED
11	**Check If Source Range Detectors Should Be Energized:**	
	a. Check intermediate range flux - LESS THAN (V02)	a. Continue with Step 12. WHEN flux less than (V02), THEN do Step 11b.
	b. Verify source range detectors - ENERGIZED	b. Manually energize source range detectors.
12	**Shut Down Unnecessary Plant Equipment:** [Include additional AP600 details in EOPs]	
13	**Maintain Stable Plant Conditions:** • PRZR pressure - AT (P12) PSIG • PRZR level - BETWEEN (L37)% AND (L38)% • SG narrow range levels - BETWEEN (L03)% AND 50% • RCS average temperature - AT (T04) °F	
14	**Determine If Natural Circulation Cooldown Is Required:**	
	a. Criteria - MET [Include additional AP600 details in EOPs]	a. Go to appropriate plant procedure.
	b. Go to AES-0.2, AP600 NATURAL CIRCULATION COOLDOWN, Step 1	

- END -

ATTACHMENT A

The following conditions support or indicate natural circulation flow:

- RCS subcooling based on core exit TCs - GREATER THAN (S01) °F
- SG pressures - STABLE OR DECREASING
- RCS hot leg temperatures - STABLE OR DECREASING
- Core exit TCs - STABLE OR DECREASING
- RCS cold leg temperatures - AT SATURATION TEMPERATURE FOR SG PRESSURE

FOOTNOTES

Refer to FOOTNOTE DEFINITION Document for a description of all footnoted parameters used in this guideline.

A. PURPOSE

This guideline provides actions to recover from a loss of reactor or secondary coolant.

B. SYMPTOMS OR ENTRY CONDITIONS

This guideline is entered from:

1) AE-0, AP600 REACTOR TRIP OR SAFETY INJECTION, Step 24, with any of the following symptoms: high containment radiation, high containment pressure, or high containment level.

2) AE-0, AP600 REACTOR TRIP OR SAFETY INJECTION, Step 30, AES-1.2, AP600 POST LOCA COOLDOWN AND DEPRESSURIZATION, Step 8, and AE-3, AP600 STEAM GENERATOR TUBE RUPTURE, Step 13, if ADS has been actuated.

3) AES-1.1, AP600 PASSIVE SAFETY SYSTEMS TERMINATION, Step 4 and Step 22, and AFR-I.2, AP600 RESPONSE TO LOW PRESSURIZER LEVEL, Step 4, if SI has to be reinitiated.

4) AE-2, AP600 FAULTED STEAM GENERATOR ISOLATION, Step 5, after identification and isolation of a faulted SG.

5) AECA-1.1, AP600 LOCA OUTSIDE CONTAINMENT, Step 2, after actions to isolate a LOCA outside containment have been taken.

6) AFR-C.1, AP600 RESPONSE TO INADEQUATE CORE COOLING, Step 16 and Step 25, and AFR-C.2, AP600 RESPONSE TO DEGRADED CORE COOLING, Step 15, after core cooling has been re-established.

7) AFR-H.1, AP600 RESPONSE TO LOSS OF HEAT SINK, Step 2, if RCS pressure is less than all non-faulted SG(s) pressure.

8) AFR-H.1, AP600 RESPONSE TO LOSS OF HEAT SINK, Step 16, after ADS has been actuated.

STEP	ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED

CAUTION *If PRHR is not available, one SG should be maintained available for RCS cooldown.*

NOTE *Foldout page should be open.*

1	**Check If Any SGs Are Faulted:**	
	a. Check pressures in all SGs - • NO SG PRESSURE DECREASING IN AN UNCONTROLLED MANNER • NO SG COMPLETELY DEPRESSURIZED	a. Verify all faulted SG(s) isolated: • Steamlines. • Feedlines. IF NOT, THEN go to AE-2, AP600 FAULTED STEAM GENERATOR ISOLATION, Step 1.
2	**Check Intact SG Levels:**	
	a. Narrow range level - GREATER THAN (L03)% [(L04)% FOR ADVERSE CONTAINMENT]	a. Maintain total feed flow greater than (F01) gpm until narrow range level greater than (L03)% [(L04)% for adverse containment] in at least one SG.
	b. Control feed flow to maintain narrow range level between (L03)% [(L04)% for adverse containment] and 50%	b. IF narrow range level in any SG continues to increase in an uncontrolled manner, THEN go to AE-3, AP600 STEAM GENERATOR TUBE RUPTURE, Step 1.
3	**Check SGS Main Steamline Radiation - NORMAL**	Go to AE-3, AP600 STEAM GENERATOR TUBE RUPTURE, Step 1.

STEP	ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED

CAUTION *If adverse containment conditions exist, RCS makeup should be operated in manual to maintain pressurizer level.*

4 **Check RCS Makeup Status**

a.	PRZR level - GREATER THAN (L05)%[(L23)% FOR ADVERSE CONTAINMENT]	a. Verify one makeup pump running. IF NOT, THEN manually start one makeup pump. IF level continues to decrease or cannot be restored, THEN start second makeup pump.
b.	PRZR level - LESS THAN (L06)%[(L31)% FOR ADVERSE CONTAINMENT]	b. Verify all makeup pumps stopped. IF NOT, THEN manually stop all makeup pumps.

STEP	ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED
5	**Check If Passive Safety Systems Should Be Terminated:**	
	a. RCS subcooling based on core exit TCs - GREATER THAN (S01) °F [(S02) °F FOR ADVERSE CONTAINMENT]	a. Go to Step 7.
	b. RCS heat sink: • Total feed flow to intact SGs - GREATER THAN (F01) GPM -OR- • Narrow range level in at least one intact SG - GREATER THAN (L03)% [(L04)% FOR ADVERSE CONTAINMENT] -OR- • PRHR - IN OPERATION	b. IF neither condition satisfied, THEN go to Step 7.
	c. RCS pressure - STABLE OR INCREASING	c. Go to Step 7.
	d. PRZR level - GREATER THAN (L05)% [(L23)% FOR ADVERSE CONTAINMENT]	d. Go to Step 7.
6	**Go To AES-1.1, AP600 PASSIVE SAFETY SYSTEMS TERMINATION, Step 1**	

STEP	ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED
7	**Check If ADS Should Be Actuated:**	
	a. CMT level - LESS THAN (L01)%	a. IF RCS hot leg level indication greater than (L32) [(L33)% FOR ADVERSE CONTAINMENT], THEN go to Step 8. IF NOT, THEN manually actuate ADS.
	b. Verify first stage ADS isolation valves - OPEN	b. Manually open valves as necessary.
	c. Check second stage ADS valves - OPEN	c. WHEN (T01) seconds have elapsed from first stage ADS signal, THEN verify second stage ADS valves open. IF NOT, THEN manually open second stage ADS valves as necessary.
	d. Check third stage ADS valves - OPEN	d. WHEN (T02) seconds have elapsed from second stage ADS signal, THEN verify third stage ADS valves open. IF NOT, THEN manually open third stage ADS valves as necessary.
	e. Align RNS to inject into RCS	
	f. Verify proper valve alignment [Include additional AP600 details in EOPs]	f. Manually align valves as necessary.

STEP	ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED
8	**Check If Passive Containment Cooling Should Be Stopped:**	
	a. Passive containment cooling - OPERATING	a. Go to Step 9.
	b. Containment pressure - LESS THAN (P10) PSIG	b. Continue with Step 9. WHEN containment pressure less than (P10) psig, THEN do Steps 8c and d.
	c. Reset passive containment cooling signal	
	d. Stop passive containment cooling and place in standby: [Include additional AP600 details in EOPs]	
9	**Check RCS And SG Pressures:** • Check pressure in all SGs - STABLE OR INCREASING • Check RCS pressure - STABLE OR DECREASING	Return to Step 1.
10	**Check If Diesel Generators Should Be Stopped**	
	a. Verify ECS ac busses - ENERGIZED BY OFFSITE POWER	a. Try to restore offsite power to ECS ac busses. IF offsite power can NOT be restored, THEN load the following equipment on ac busses: [Include additional AP600 details in EOPs]
	b. Stop any unloaded diesel generator and place in standby	

STEP	ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED
11	**Initiate Evaluation Of Plant Status:**	
	a. Check plant vent radiation - NORMAL	a. Try to identify and isolate leakage: [Include additional AP600 details in EOPs] IF the cause is a loss of RCS inventory outside containment, THEN go to AECA-1.1, AP600 LOCA OUTSIDE CONTAINMENT, Step 1.
	b. Obtain samples: [Include additional AP600 details in EOPs]	
	c. Evaluate plant equipment: [Include additional AP600 details in EOPs]	
	d. Start additional plant equipment to assist in recovery: [Include additional AP600 details in EOPs]	
12	**Check If RCS Cooldown And Depressurization Is Required:**	
	a. RCS pressure - GREATER THAN (P03) PSIG [(P04) PSIG FOR ADVERSE CONTAINMENT]	a. IF RNS flow greater than (F02) gpm, THEN go to Step 13.
	b. Check ADS status - ADS NOT ACTUATED	b. Go to Step 13.
	c. Go to AES-1.2 AP600 POST LOCA COOLDOWN AND DEPRESSURIZATION Step 1.	

STEP	ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED
13	**Check If Fourth Stage ADS Should Be Actuated:**	
	a. CMT level - LESS THAN (L10)%	a. Perform the following: 1) IF CMT level decreases to less than (L10)%, THEN do Steps 13b and c. 2) IF RCS hot leg level indication decreases to less than (L32) [(L33)% FOR ADVERSE CONTAINMENT], THEN manually actuate fourth stage ADS and do Steps 13b and c. 3) Continue with Step 14.
	b. Verify fourth stage ADS isolation valves - OPEN	b. Manually open valves as necessary.
	c. Verify IRWST injection isolation valves - OPEN	c. Manually open valves as necessary.
14	**Check IRWST Level:**	
	a. IRWST level - LESS THEN (L11)%	a. Continue with Step 15. WHEN IRWST level less than (L11)%, THEN do Step 14b.
	b. Verify containment sump recirculation valves - OPEN	b. Manually align valves as necessary.

STEP	ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED
15	**Check If Intact SGs Should Be Depressurized To RCS Pressure:**	
	a. RCS pressure - LESS THAN INTACT SG PRESSURES	a. Go to Step 16.
	b. Check SGs radiation - NORMAL [Include additional AP600 details in EOPs]	b. Do not dump steam from a SG with high radiation. Isolate feed flow to a SG with high radioactivity.
	c. Dump steam to condenser from intact SGs until SG pressure less than RCS pressure	c. Dump steam using intact SG PORVs until SG pressure less than RCS pressure.
16	**Determine If Reactor Vessel Head Should Be Vented**	
17	**Evaluate Long Term Plant Status**	

- END -

FOOTNOTES

Refer to FOOTNOTE DEFINITION Document for a description of all footnoted parameters used in this guideline.

A. PURPOSE

This guideline provides actions to cool down and depressurize the RCS to cold shutdown conditions following a loss of reactor coolant inventory.

B. SYMPTOMS OR ENTRY CONDITIONS

This guideline is entered from AE-1, AP600 LOSS OF REACTOR OR SECONDARY COOLANT, Step 12 when RCS pressure is greater than the RNS cut-in pressure and ADS is not actuated.

STEP	ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED

NOTE *Foldout page should be open.*

1 **Verify All ECS AC Busses - ENERCIZED BY OFFSITE POWER**

Try to restore offsite power to ECS ac busses. IF offsite power can NOT be restored, THEN load the following equipment on ac busses:

[Include additional AP600 details in EOPs]

CAUTION

- *If IRWST level decreases to less than (L11), RNS alignment to the containment sump should be verified.*
- *If adverse containment conditions exist, RCS makeup should be operated in manual to maintain pressurizer level.*

2 **Check RCS Makeup Status**

a. PRZR level - GREATER THAN (L05)%[(L23)% FOR ADVERSE CONTAINMENT]

a. Verify one makeup pump running. IF NOT, THEN manually start one makeup pump. IF level continues to decrease or cannot be restored, THEN start second makeup pump.

b. PRZR level - LESS THAN (L06)%[(L31)% FOR ADVERSE CONTAINMENT]

b. Verify all makeup pumps stopped. IF NOT, THEN manually stop all makeup pumps.

c. Operate makeup and letdown as necessary to maintain PRZR level - BETWEEN (L05)% AND (L06)%[BETWEEN (L23)% AND (L31)% FOR ADVERSE CONTAINMENT]

STEP	ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED
3	**Check If PRHR Should Be Isolated**	
	a. Check the following: • SFW - IN OPERATION • Narrow range level in at least one SG - GREATER THAN (L03)% [(L04)% FOR ADVERSE CONTAINMENT]	a. Go to Step 4.
	b. Close PRHR isolation valves	
4	**Check Intact SG Levels:**	
	a. Narrow range level - GREATER THAN (L03)% [(L04)% FOR ADVERSE CONTAINMENT]	a. Maintain total feed flow greater than (F01) gpm until narrow range level greater than (L03)% [(L04)% for adverse containment] in at least one SG.
	b. Control feed flow to maintain narrow range level between (L03)% [(L04)% for adverse containment] and 50%	b. IF narrow range level in any SG continues to increase in an uncontrolled manner, THEN go to AE-3, AP600 STEAM GENERATOR TUBE RUPTURE, Step 1.

STEP	ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED

NOTE

- *Low steamline pressure SI and low T-cold SI should be blocked when PRZR pressure decreases to less than (P06) psig.*
- *After the low steamline pressure SI signal is blocked, main steamline isolation will occur if the high steam pressure rate setpoint is exceeded.*
- *Shutdown margin should be monitored during RCS cooldown.*

5 **Initiate RCS Cooldown To Cold Shutdown:**

a. Maintain cooldown rate in RCS cold legs - LESS THAN 100°F/HR

b. Dump steam to condenser from intact SG

b. Dump steam from intact SG using SG PORV.

c. Use RNS if in service

d. Use PRHR as necessary

6 **Turn All PRZR Heaters OFF**

STEP	ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED

CAUTION

- *Voiding may occur in the RCS during RCS depressurization. This will result in a rapidly increasing PRZR level.*
- *Cycling of the PRZR ADS valves should be minimized.*

7 **Depressurize RCS To Refill PRZR:**

a.	RCS subcooling based on core exit TCs - GREATER THAN (S01) °F [(S02) °F FOR ADVERSE CONTAINMENT]	a. Go to Step 8.
b.	Use auxiliary spray	b. Use one set of first stage PRZR ADS valves.
c.	PRZR level - GREATER THAN (L07)% (L09)% FOR ADVERSE CONTAINMENT]	c. Continue with Step 8. When level greater than (L07)% [(L09)% for adverse containment], THEN do Step 7d.
d.	Stop RCS depressurization	

STEP	ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED
8	**Check If ADS Should Be Actuated:**	
	a. CMT level - LESS THAN (L01)%	a. IF RCS hot leg level indication greater than (L32) [(L33)% FOR ADVERSE CONTAINMENT], THEN go to Step 9. IF NOT, THEN manually actuate ADS.
	b. Verify first stage ADS isolation valves - OPEN	b. Manually open valves as necessary.
	c. Check second stage ADS valves - OPEN	c. WHEN (T01)seconds have elapsed from first stage ADS signal, THEN verify second stage ADS valves open. IF NOT, THEN manually open second stage ADS valves as necessary.
	d. Check third stage ADS valves - OPEN	d. WHEN (T02)seconds have elapsed from second stage ADS signal, THEN verify third stage ADS valves open. IF NOT, THEN manually open third stage ADS valves as necessary.
	e. Align RNS to inject into RCS	
	f. Verify proper valve alignment [Include additional AP600 details in EOPs]	f. Manually align valves as necessary.
	g. Go to AE-1, AP600 LOSS OF REACTOR OR SECONDARY COOLANT, Step 13.	

STEP	ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED
9	**Check If CMT Injection Should Be Isolated:**	
	a. ADS - NOT ACTUATED	a. Go to Step 10.
	b. RCS makeup - OPERABLE	b. Go to Step 10.
	c. RCS subcooling based on core exit TCs - GREATER THAN (S01) °F [(S02) °F FOR ADVERSE CONTAINMENT]	c. Go to Step 10.
	d. PRZR level - GREATER THAN (L05)% [(L23)% FOR ADVERSE CONTAINMENT]	d. Go to Step 10.
	e. Close CMT injection valves	
10	**Verify CMT Injection Not Required:**	
	a. RCS subcooling based on core exit TCs - GREATER THAN (S01) °F [(S02) °F FOR ADVERSE CONTAINMENT]	a. Manually open CMT injection valves.
	b. PRZR level - GREATER THAN (L05)% [(L23)% FOR ADVERSE CONTAINMENT]	b. Manually open CMT injection valves.
11	**Check RCP Cooling:** • RCP CCS flow - NORMAL • RCP temperature(s) - NORMAL	Establish normal cooling to RCP(s). Refer to [Include additional AP600 details in EOPs].

STEP	ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED

NOTE *RCPs 1A and 1B should be run to provide normal PRZR spray.*

12 **Check If RCPs Should Be Started:**

a. All RCPs - STOPPED

a. Stop all but RCP 1A and 1B. Go to Step 13.

b. RCS subcooling based on core exit TCs - GREATER THAN (S01) °F [(S02) °F FOR ADVERSE CONTAINMENT]

b. Go to Step 13.

c. PRZR level - GREATER THAN (L07)% [(L09)% FOR ADVERSE CONTAINMENT]

c. Return to Step 7.

d. Try to start RCP 1A and 1B:

1) Establish conditions for starting RCPs:

[Include additional AP600 details in EOPs]

2) Start RCPs

d. IF no RCP can be started, THEN refer to ATTACHMENT A to verify natural circulation. IF natural circulation NOT verified, THEN increase dumping steam.

STEP	AGTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED

CAUTION

- *Voiding may occur in the RCS during RCS depressurization. This will result in a rapidly increasing PRZR level.*
- *Cycling of the PRZR ADS valves should be minimized.*
- *If CMT injection is necessary to maintain PRZR level, RNS pumps should be started to inject into the RCS when RCS pressure is less then (P03) [(P04)% FOR ADVERSE CONTAINMENT]*

13 **Depressurize RCS To Minimize RCS Subcooling:**

a. Use normal PRZR spray

a. Use auxiliary spray. IF auxiliary spray NOT available, THEN use one set of first stage PRZR ADS valves.

b. Turn on PRZR heaters as necessary

c. Depressurize RCS until EITHER of the following conditions satisfied:

- PRZR level - GREATER THAN (L13)% [(L14)% FOR ADVERSE CONTAINMENT]

-OR-

- RCS subcooling based on core exit TCs - LESS THAN (S03) °F [(S04) °F FOR ADVERSE CONTAINMENT]

14 **Verify Adequate Shutdown Margin:**

a. Sample RCS

b. Shutdown margin - ADEQUATE

b. Borate as necessary.

STEP	ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED
15	**Check If SI Accumulators Should Be Isolated:**	
	a. RCS subcooling based on core exit TCs - GREATER THAN (S01) °F [(S02) °F FOR ADVERSE CONTAINMENT]	a. IF both RCS hot leg temperatures less than (T05) °F, THEN go to Step 15c. IF NOT, THEN go to Step 16.
	b. PRZR level - GREATER THAN (L07)% [(L09)% FOR ADVERSE CONTAINMENT]	b. Return to Step 7.
	c. Restore power to isolation valves	
	d. Close all SI accumulator isolation valves	d. Vent any unisolated accumulators.

STEP	ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED
16	**Check If Diesel Generators Should Be Stopped:**	
	a. Verify ECS ac busses - ENERGIZED BY OFFSITE POWER	a. Try to restore offsite power to ECS ac busses. IF offsite power can NOT be restored, THEN loadthe following equipment on ac busses: [Include additional AP600 details in EOPs]
	b. Stop any unnecessary diesel generator and place in standby	
17	**Check If Passive Containment Cooling Should Be Stopped:**	
	a. Passive containment cooling - OPERATING	a. Go to Step 18.
	b. Containment pressure - LESS THAN (P10) PSIG	b. Continue with Step 18. WHEN containment pressure less than (P10) psig, THEN do Steps 17c and d.
	c. Reset passive containment cooling signal	
	d. Stop passive containment cooling and place in standby: [Include additional AP600 details in EOPs]	
18	**Check If Source Range Detectors Should Be Energized:**	
	a. Check intermediate range flux - LESS THAN (V02)	a. Continue with Step 19. WHEN flux less than (V02), THEN do Step 18b.
	b. Verify source range detectors - ENERGIZED	b. Manually energize source range detectors.

STEP	ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED
19	**Shut Down Unnecessary Plant Equipment:** [Include additional AP600 details in EOPs]	
20	**Check If RCP(s) Must Be Stopped:**	
	a. Check RCS pressure - GREATER THAN (P07) PSIG	a. Stop RCP(s).
	[Additional steps related to normal AP600 cooldown will be placed after Step 20]	
21	**Check If RNS Can Be Placed In Service:**	
	a. Check the following: • RCS temperatures - LESS THAN (T06) °F [(T07) °F FOR ADVERSE CONTAINMENT] • RCS pressure - LESS THAN (P08) PSIG [(P09) PSIG FOR ADVERSE CONTAINMENT]	a. Go to Step 22.
	b. Determine if RNS should be placed in service in accordance with [Include additional AP600 details in EOPs]	
22	**Check RCS Temperatures - LESS THAN 200 °F**	Return to Step 2.
23	**Evaluate Long Term Plant Status And Maintain Cold Shutdown Conditions**	

- END -

ATTACHMENT A

The following conditions support or indicate natural circulation flow:

RCS subcooling based on core exit TCs - GREATER THAN (S01) °F [(S02) °F FOR ADVERSE CONTAINMENT]

SG pressures - STABLE OR DECREASING

RCS hot leg temperatures - STABLE OR DECREASING

Core exit TCs - STABLE OR DECREASING

RCS cold leg temperatures - AT SATURATION TEMPERATURE FOR SG PRESSURE

FOLDOUT FOR AE-1 SERIES GUIDELINES

1. CMT INJECTION CRITERIA

   Open CMT injection valves if EITHER condition listed below occurs:

   - RCS subcooling based on core exit TCs - LESS THAN (S01) °F [(S02) °F FOR ADVERSE CONTAINMENT]
   - PRZR level - CANNOT BE MAINTAINED GREATER THAN (L05)% [(L23)% FOR ADVERSE CONTAINMENT]

2. RED PATH SUMMARY

   a. SUBCRITICALITY - Nuclear power greater than 5%.

   b. CORE COOLING - Core exit TCs greater than 1200 °F

   c. HEAT SINK - Narrow range level in all SGs less than (L03)%[(L04)% FOR ADVERSE CONTAINMENT] AND total feedwater flow less than (F01) gpm AND PRHR not in service

   d. INTEGRITY - Cold leg temperature decrease greater than 100 °F in last 60 minutes AND RCS cold leg temperature less than (T14) °F

   e. CONTAINMENT - Containment pressure greater than (P21) PSIG

3. SECONDARY INTEGRITY CRITERIA

   Go to AE-2, FAULTED STEAM GENERATOR ISOLATION, Step 1, if any SG pressure is decreasing in an uncontrolled manner or has completely depressurized, and has not been isolated.

4. AE-3 TRANSITION CRITERIA

   Go to AE-3, STEAM GENERATOR TUBE RUPTURE, Step 1, if any SG level increases in an uncontrolled manner or any SG has abnormal radiation.

FOOTNOTES

Refer to FOOTNOTE DEFINITION Document for a description of all footnoted parameters used in this guideline.

A. PURPOSE

This guideline provides actions to terminate leakage of reactor coolant into the secondary system following a steam generator tube rupture.

B. SYMPTOMS OR ENTRY CONDITIONS

This guideline is entered from:

1) AE-0, AP600 REACTOR TRIP OR SAFETY INJECTION, Step 23 when condenser air ejector radiation or SG blowdown radiation is abnormal.

2) AE-0, AP600 REACTOR TRIP OR SAFETY INJECTION, Step 29,
AE-1, AP600 LOSS OF REACTOR OR SECONDARY COOLANT, Step 3,
AE-2, AP600 FAULTED STEAM GENERATOR ISOLATION, Step 4,
and AFR-H.3, AP600 RESPONSE TO STEAM GENERATOR HIGH LEVEL, Step 7, when secondary radiation is abnormal.

3) AE-0, AP600 REACTOR TRIP OR SAFETY INJECTION, Step 28,
AE-1, AP600 LOSS OF REACTOR OR SECONDARY COOLANT, Step 2,
AES-1.2, AP600 POST LOCA COOLDOWN AND DEPRESSURIZATION, Step 4, when a SG narrow range level increases in an uncontrolled manner.

4) AE-1 series foldout page whenever any SG level increases in an uncontrolled manner or any SG has abnormal radiation.

STEP	ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED

NOTE

- *Foldout page should be open.*
- *Personnel should be available for sampling during this guideline.*

1 **Identify Ruptured SG(s):**

- Unexpected increase in any SG narrow range level

  -OR-

- High radiation from any SG sample

  -OR-

- High radiation from any SG steamline

  -OR-

- High radiation from any SG blowdown line:

  [Include additional AP600 details in EOPs]

Continue with Steps 4 through 8
WHEN ruptured SG(s) identified,
THEN do Steps 2 and 3

STEP	ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED

CAUTION *If PRHR is not available, one SG should be maintained available for RCS cooldown.*

2 **Isolate Flow From Ruptured SG(s):**

a. Adjust ruptured SG(s) PORV controller setpoint to (P05) PSIG

b. Check ruptured SG(s) PORV - CLOSED

b. WHEN ruptured SG pressure less than (P05) psig, THEN verify SG PORV closed. IF NOT closed, THEN place PORV controller in manual and close PORV. IF PORV can NOT be closed, THEN close PORV block valve.

c. Verify blowdown isolation valve(s) from ruptured SG(s) - CLOSED

c. Manually close valve(s).

d. Close ruptured SG(s) main steamline isolation and bypass valves

d. Perform the following:

1) Close remaining main steamline isolation and bypass valves.

2) Verify following valves closed.

[Include additional AP600 details in EOPs].

3) Use intact SG PORV for steam dump

IF the ruptured SG can NOT be isolated from the intact SG, THEN PRHR should be used for cooldown actions in this guideline.

e. [Include additional AP600 details in EOPs]

STEP	ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED

CAUTION *If any ruptured SG is faulted, feed flow to that SG should remain isolated during subsequent recovery actions unless needed for RCS cooldown.*

3 **Check Ruptured SG(s) Level:**

a. Narrow range level - GREATER THAN (L03)% [(L04)% FOR ADVERSE CONTAINMENT]

a. Maintain feed flow to ruptured SG until level greater than (L03)% [(L04)% for adverse containment]. Continue with Step 4. WHEN ruptured SG level greater than (L03)% [(L04)% for adverse containment], THEN stop feed flow to ruptured SG(s).

b. Stop feed flow to ruptured SG(s)

c. Narrow range level - LESS THAN (L12)%

c. Perform the following:

1) Verify SFW flow isolated to ruptured SG.

2) Verify all RCS makeup pumps stopped. IF NOT, THEN manually stop all makeup pumps.

3) Verify RCS makeup line isolated. IF NOT, THEN manually isolate.

4) Continue with Step 5. WHEN ruptured SG(s) narrow range level less than (L12)%, THEN do Step 4.

STEP	ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED

CAUTION

- *If IRWST level decreases to less than (L11), RNS alignment to the containment sump should be verified.*
- *If adverse containment conditions exist, RCS makeup should be operated in manual to maintain pressurizer level.*

4 **Check RCS Makeup Status**

a. PRZR level - GREATER THAN (L05)%[(L23)% FOR ADVERSE CONTAINMENT]

a. Verify one makeup pump running. IF NOT, THEN manually start one makeup pump. IF level continues to decrease or cannot be restored, THEN start second makeup pump.

b. PRZR level - LESS THAN (L06)%[(L31)% FOR ADVERSE CONTAINMENT]

b. Verify all makeup pumps stopped. IF NOT, THEN manually stop all makeup pumps.

c. Operate makeup and letdown as necessary to maintain PRZR level - BETWEEN (L05)% AND (L06)%[BETWEEN (L23)% AND (L31)% FOR ADVERSE CONTAINMENT]

5 **Check If SGs Are Not Faulted:**

a. Check pressures in both SGs-

- NO SG PRESSURE DECREASING IN AN UNCONTROLLED MANNER
- NO SG COMPLETELY DEPRESSURIZED

a. Verify faulted SG(s) isolated unless needed for RCS cooldown:

- Steamlines.
- Feedlines.

IF NOT, THEN go to AE-2, AP600 FAULTED STEAM GENERATOR ISOLATION, Step 1.

STEP	ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED
6	**Check If PRHR Should Be Isolated**	
	a. Check the following: • SFW - IN OPERATION • Narrow range level in the intact SG - GREATER THAN (L03)% [(L04)% FOR ADVERSE CONTAINMENT]	a. Go to Step 7.
	b. Close PRHR isolation valves	
7	**Check Intact SG Levels:**	
	a. Narrow range level - GREATER THAN (L03)% [(L04)% FOR ADVERSE CONTAINMENT]	a. Maintain total feed flow greater than (F01) gpm until narrow range level greater than (L03)% [(L04)% for adverse containment] in at least one SG.
	b. Control feed flow to maintain narrow range level between (L03)% [(L04)% for adverse containment] and 50%	b. IF narrow range level in any intact SG continues to increase in an uncontrolled manner, THEN return to Step 1.
8	**Verify All ECS AC Busses - ENERGIZED BY OFFSITE POWER**	Try to restore offsite power to ECS ac busses. IF offsite power can NOT be restored, THEN load the following equipment on ac busses: [Include additional AP600 details in EOPs]

STEP	ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED

CAUTION *Isolation of the ruptured SG from the intact SG to be used for RCS cooldown should be completed by closing the main steamline isolation and bypass valves for the ruptured SG or for the intact SG before continuing to Step 9, unless a ruptured SG is needed for RCS cooldown or the cooldown will be performed using PRHR.*

9 **Check If RCS Cooldown Rate Should Be Maximized**

a. Check the following:

- Ruptured SG pressure - DECREASING

-OR-

- RCS subcooling based on core exit TCs - LESS THAN (S01) °F [(S02) °F FOR ADVERSE CONTAINMENT]

-OR-

- CMT level - DECREASING

a. IF neither condition satisfied, THEN go to Step 10.

b. Maximize RCS cooldown rate NOT exceeding the Tech Spec limit

STEP	ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED

CAUTION *RCS and ruptured SG(s) pressures must be maintained less than the ruptured SG(s) PORV setpoint.*

NOTE

- *Low steamline pressure SI and low T-cold SI should be blocked when PRZR pressure decreases to less than (P06) psig.*
- *After the low steamline pressure SI signal is blocked, main steamline isolation will occur if the high steam pressure rate setpoint is exceeded.*
- *Shutdown margin should be monitored during RCS cooldown.*
- *Since ruptured SG(s) may continue to depressurize to less than the minimum RCS pressure necessary for continued RCP operation, cooldown to cold shutdown should not be delayed.*

10 **Initiate RCS Cooldown To Cold Shutdown:**

a. Maintain cooldown rate in RCS cold legs - LESS THAN 100°F/HR

b. Dump steam to condenser from intact SG

b. Dump steam from intact SG using SG PORV.

c. Use RNS if in service

d. Use PRHR as necessary

11 **Turn All PRZR Heaters OFF**

STEP	ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED

CAUTION

- *Voiding may occur in the RCS during RCS depressurization. This will result in a rapidly increasing PRZR level.*
- *Cycling of the PRZR ADS valves should be minimized.*

12 **Depressurize RCS To Refill PRZR:**

a.	Use auxiliary spray	a. Use one set of first stage PRZR ADS valves.
b.	PRZR level - GREATER THAN (L07)% [(L09)% FOR ADVERSE CONTAINMENT]	b. Continue with Step 13. When level greater than (L07)% [(L09)% for adverse containment], THEN do Step 12c.
c.	Stop RCS depressurization	

STEP	ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED
13	**Check If ADS Should Be Actuated:**	
	a. CMT level - LESS THAN (L01)%	a. IF RCS hot leg level indication greater than (L32) [(L33)% FOR ADVERSE CONTAINMENT], THEN go to Step 14. IF NOT, THEN manually actuate ADS.
	b. Verify first stage ADS isolation valves - OPEN	b. Manually open valves as necessary.
	c. Check second stage ADS valves - OPEN	c. WHEN (T01)seconds have elapsed from first stage ADS signal, THEN verify second stage ADS valves open. IF NOT, THEN manually open second stage ADS valves as necessary.
	d. Check third stage ADS valves - OPEN	d. WHEN (T02)seconds have elapsed from second stage ADS signal, THEN verify third stage ADS valves open. IF NOT, THEN manually open third stage ADS valves as necessary.
	e. Align RNS to inject into RCS	
	f. Verify proper valve alignment [Include addition	f. Manually align valves as necessary.
	g. Go to AE-1, AP600 LOSS OF REACTOR OR SECONDARY COOLANT, Step 13	

STEP	ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED
14	**Check If CMT Injection Should Be Isolated:**	
	a. ADS - NOT ACTUATED	a. Go to Step 15.
	b. RCS subcooling based on core exit TCs - GREATER THAN (S01) °F [(S02) °F FOR ADVERSE CONTAINMENT]	b. Go to Step 15.
	c. PRZR level - GREATER THAN (L05)% [(L23)% FOR ADVERSE CONTAINMENT]	c. Go to Step 15.
	d. Close CMT injection valves	
15	**Verify CMT Injection Not Required:**	
	a. RCS subcooling based on core exit TCs - GREATER THAN (S01) °F [(S02) °F FOR ADVERSE CONTAINMENT]	a. Manually open CMT injection valves.
	b. PRZR level - GREATER THAN (L05)% [(L23)% FOR ADVERSE CONTAINMENT]	b. Manually open CMT injection valves.

STEP	ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED
16	**Initiate Evaluation Of Plant Status:**	
	a. Check plant vent radiation - NORMAL	a. Try to identify and isolate leakage: [Include additional AP600 details in EOPs]
	b. Obtain samples: [Include additional AP600 details in EOPs]	
	c. Evaluate plant equipment: [Include additional AP600 details in EOPs]	
	d. Start additional plant equipment to assist in recovery: [Include additional AP600 details in EOPs]	
17	**Check RCP Cooling:** • RCP CCS flow - NORMAL • RCP temperature(s) - NORMAL	Establish normal cooling to RCP(s). Refer to [Include additional AP600 details in EOPs].

STEP	ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED

CAUTION *Inadvertent criticality may occur following any natural circulation or PRHR cooldown if the first RCP started is in the ruptured loop.*

NOTE *RCPs 1A and 1B should be run to provide normal PRZR spray.*

18	**Check If RCPs Should Be Started:**		
	a. All RCPs - STOPPED	a.	Stop all but RCP 1A and 1B. Go to Step 19.
	b. RCS subcooling based on core exit TCs - GREATER THAN (S01) °F [(S02) °F FOR ADVERSE CONTAINMENT]	b.	Go to Step 19.
	c. PRZR level - GREATER THAN (L07)% [(L09)% FOR ADVERSE CONTAINMENT]	c.	Return to Step 12.
	d. Try to start RCP 1A and 1B: 1) Establish conditions for starting RCPs: [Include additional AP600 details in EOPs] 2) Start RCPs	d.	IF no RCP can be started, THEN refer to ATTACHMENT A to verify natural circulation. IF natural circulation NOT verified, THEN increase dumping steam from intact SG.

STEP	ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED

CAUTION

- *Voiding may occur in the RCS during RCS depressurization. This will result in a rapidly increasing PRZR level.*
- *Cycling of the PRZR ADS valves should be minimized.*
- *RCS and ruptured SG(s) pressures must be maintained less than the ruptured SG(s) PORV setpoint.*
- *If CMT injection is necessary to maintain PRZR level, RNS pumps should be started to inject into the RCS when RCS pressure is less then (P03) [(P04)% FOR ADVERSE CONTAINMENT]*

19 **Depressurize RCS To Minimize RCS Subcooling:**

a. Use normal PRZR spray

a. Use auxiliary spray. IF auxiliary spray NOT available, THEN use one set of first stage PRZR ADS valves.

b. Turn on PRZR heaters as necessary

Step continued on next page

STEP	ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED
	c. Depressurize RCS until EITHER of the following conditions satisfied: • RCS pressure - LESS THAN RUPTURED SG PRESSURE IF BACKFILL DESIRED -OR- • RCS pressure - EQUAL TO RUPTURED SG PRESSURE IF BACKFILL NOT DESIRED -OR- • PRZR level - GREATER THAN (L13)% [(L14)% FOR ADVERSE CONTAINMENT] -OR- • RCS subcooling based on core exit TCs - LESS THAN (S03) °F [(S04) °F FOR ADVERSE CONTAINMENT]	
20	**Check If Diesel Generators Should Be Stopped:**	
	a. Verify ECS ac busses - ENERGIZED BY OFFSITE POWER	a. Try to restore offsite power to ECS ac busses. IF offsite power can NOT be restored, THEN load the following equipment on ac busses: [Include additional AP600 details in EOPs]
	b. Stop any unnecessary diesel generator and place in standby	

STEP	ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED
21	**Check If Passive Containment Cooling Should Be Stopped:**	
	a. Passive containment cooling - OPERATING	a. Go to Step 22.
	b. Containment pressure - LESS THAN (P10) PSIG	b. Continue with Step 22. WHEN containment pressure less than (P10) psig, THEN do Steps 21c and d.
	c. Reset passive containment cooling signal	
	d. Stop passive containment cooling and place in standby: [Include additional AP600 details in EOPs]	
22	**Minimize Secondary System Contamination:** [Include additional AP600 details in EOPs]	
23	**Turn On PRZR Heaters As Necessary To Saturate PRZR Water At Ruptured SG(s) Pressure**	
24	**Verify Adequate Shutdown Margin:**	
	a. Sample ruptured SG(s)	
	b. Sample RCS	
	c. Shutdown margin - ADEQUATE	c. Borate as necessary.

STEP	ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED
25	**Check If SI Accumulators Should Be Isolated:**	
	a. RCS subcooling based on core exit TCs - GREATER THAN (S01) °F [(S02) °F FOR ADVERSE CONTAINMENT]	a. IF both RCS hot leg temperatures less than (T05) °F, THEN go to Step 25c. IF NOT, THEN go to Step 26.
	b. PRZR level - GREATER THAN (L07)% [(L09)% FOR ADVERSE CONTAINMENT]	b. Return to Step 12.
	c. Restore power to isolation valves	
	d. Close all SI accumulator isolation valves	d. Vent any unisolated accumulators.
26	**Check If Source Range Detectors Should Be Energized:**	
	a. Check intermediate range flux - LESS THAN (V02)	a. Continue with Step 27. WHEN flux less than (V02), THEN do Step 26b.
	b. Verify source range detectors - ENERGIZED	b. Manually energize source range detectors.
27	**Shut Down Unnecessary Plant Equipment:** [Include additional AP600 details in EOPs]	
28	**Check If RCP(s) Must Be Stopped:**	
	a. Check RCS pressure - GREATER THAN (P07) PSIG	a. Stop RCP(s).

STEP	ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED

CAUTION
- *Steam should not be released from a ruptured SG if water may exist in its steamline.*
- *Ruptured SG pressure may decrease rapidly when steam is released.*
- *Voiding may occur in the RCS during RCS depressurization. This may result in a rapidly increasing PRZR level.*

29 **Check If Ruptured SG Pressure Should Be Reduced:**

a. Ruptured SG pressure - GREATER THAN RCS PRESSURE — a. Go to Step 30.

b. Perform the following:

- Decrease RCS makeup and increase letdown to initiate backfill

-OR-

- Initiate blowdown from ruptured SG(s)

-OR-

- Dump steam from ruptured SG(s)

c. Check RCS pressure - LESS THAN (P08) PSIG [(P09) PSIG FOR ADVERSE CONTAINMENT] — c. Go to Step 30.

d. Stop ruptured SG depressurization

STEP	ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED

CAUTION • Feed flow should not be established to any ruptured SG which is also faulted unless needed for RCS cooldown.

30 **Check Ruptured SG(s) Narrow Range Level - GREATER THAN (L03)% [(L04)% FOR ADVERSE CONTAINMENT]**

Refill ruptured SG to (L15)% [(L16)% for adverse containment] using feed flow. IF either of the following conditions occurs, THEN stop feed flow to ruptured SG:

- Ruptured SG pressure decreases in an uncontrolled manner.

-OR-

- Ruptured SG pressure increases to (P05) psig.

31 **Check If RNS Can Be Placed In Service:**

a. Check the following:

- RCS temperatures - LESS THAN (T06) °F [(T07) °F FOR ADVERSE CONTAINMENT]
- RCS pressure - LESS THAN (P08) PSIG [(P09) PSIG FOR ADVERSE CONTAINMENT]

a. Return to Step 10.

b. Determine if RNS should be placed in service in accordance with [Include additional AP600 details in EOPs]

32 **Check RCS Temperatures - LESS THAN 200 °F**

Return to Step 10.

33 **Evaluate Long Term Plant Status And Maintain Cold Shutdown Conditions**

- END -

ATTACHMENT A

The following conditions support or indicate natural circulation flow:

RCS subcooling based on core exit TCs - GREATER THAN (S01) °F [(S02) °F FOR ADVERSE CONTAINMENT]

SG pressures - STABLE OR DECREASING

RCS hot leg temperatures - STABLE OR DECREASING

Core exit TCs - STABLE OR DECREASING

RCS cold leg temperatures - AT SATURATION TEMPERATURE FOR SG PRESSURE

FOLDOUT FOR AE-3 GUIDELINE

1. CMT INJECTION CRITERIA

   Open CMT injection valves if EITHER condition listed below occurs:

   - RCS subcooling based on core exit TCs - LESS THAN (S01)°F [(S02)°F FOR ADVERSE CONTAINMENT]
   - PRZR level - CANNOT BE MAINTAINED GREATER THAN (L05)% [(L23)% FOR ADVERSE CONTAINMENT]

2. RED PATH SUMMARY

   a. SUBCRITICALITY - Nuclear power greater than 5%.

   b. CORE COOLING - Core exit TCs greater than 1200°F

   c. HEAT SINK - Narrow range level in all SGs less than (L03)%[(L04)% FOR ADVERSE CONTAINMENT] AND total feedwater flow less than (F01) gpm AND PRHR not in service

   d. INTEGRITY - Cold leg temperature decrease greater than 100°F in last 60 minutes AND RCS cold leg temperature less than (T14)°F

   e. CONTAINMENT - Containment pressure greater than (P21) PSIG

3. SECONDARY INTEGRITY CRITERIA

   Go to AE-2, FAULTED STEAM GENERATOR ISOLATION, Step 1, if any SG pressure is decreasing in an uncontrolled manner or has completely depressurized, and has not been isolated.

4. MULTIPLE TUBE RUPTURE CRITERIA

   Return to AE-3, STEAM GENERATOR TUBE RUPTURE, Step 1, if any intact SG level increases in an uncontrolled manner or any intact SG has abnormal radiation.

FOOTNOTES

Refer to FOOTNOTE DEFINITION Document for a description of all footnoted parameters used in this guideline.

A. PURPOSE

This guideline provides actions to restore core cooling.

B. SYMPTOMS OR ENTRY CONDITIONS

This guideline is entered from AF-0.2, CORE COOLING Critical Safety Function Status Tree, on a RED condition.

STEP	ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED
1	**Turn On Hydrogen Igniters**	
2	**Verify CMT Actuated:** • CMT injection valves - OPEN	Actuate CMT initiation. IF valves will NOT open, THEN manually open valves as necessary.
3	**Verify All RCPs Tripped**	Manually trip RCPs.
4	**Start All RCS Makeup Pumps**	
5	**Check RCP Support Conditions - AVAILABLE** [Include additional AP600 details in EOPs]	Try to establish support conditions.
6	**Check SI Accumulator Isolation Valve Status:** a. Restore power to isolation valves b. Isolation valves - OPEN	b. Open isolation valves unless closed after accumulator discharge.
7	**Check Core Exit TCs:** a. Core Exit TCs - LESS THAN 1200°F b. Return to guideline and step in effect	a. Go to Step 8.

STEP	ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED

CAUTION *If IRWST level decreases to less than (L11), RNS alignment to the containment sump should be verified.*

8	**Depressurize RCS To Inject IRWST:**		
	a.	Actuate ADS	
	b.	Verify first stage ADS isolation valves - OPEN	b. Manually open valves as necessary.
	c.	Check second stage ADS valves - OPEN	c. WHEN (T01) seconds have elapsed from first stage ADS signal, THEN verify second stage ADS valves open. IF NOT, THEN manually open second stage ADS valves as necessary.
	d.	Check third stage ADS valves - OPEN	d. WHEN (T02) seconds have elapsed from second stage ADS signal, THEN verify third stage ADS valves open. IF NOT, THEN manually open third stage ADS valves as necessary.
	e.	Align RNS to inject into RCS	e. IF RNS injection into RCS can NOT be established, THEN actuate fourth stage ADS.
	f.	Verify proper valve alignment [Include additional AP600 details in EOPs]	f. Manually align valves as necessary.
9	**Check Core Exit TCs:**		
	a.	Core Exit TCs - LESS THAN 1200°F	a. IF decreasing, THEN return to Step 1. IF NOT, THEN go to Step 10.
	b.	Return to guideline and step in effect	

STEP	ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED

CAUTION *A faulted or ruptured SG should not be used in subsequent steps unless PRHR is not available and no intact SG is available.*

10 **Check Intact SG Levels:**

a. Narrow range level - GREATER THAN (L03)% [(L04)% FOR ADVERSE CONTAINMENT]

a. Maintain total feed flow greater than (F01) gpm until narrow range level greater than (L03)% [(L04)% for adverse containment] in at least one SG. IF total feed flow greater than (F01) gpm can NOT be established, THEN continue attempts to establish a heat sink in at least one SG and go to Step 18. OBSERVE NOTE PRIOR TO STEP 18.

b. Control feed flow to maintain narrow range level between (L03)% [(L04)% for adverse containment] and 50%

STEP	ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED

NOTE

- *Partial uncovery of SG tubes is acceptable in the following steps.*
- *After the low steamline pressure SI signal is blocked, main steamline isolation will occur if the high steam pressure rate setpoint is exceeded.*

11	**Depressurize All Intact SGs To (P15) PSIG:**		
	a.	Dump steam to condenser at maximum rate	a. Dump steam at maximum rate using SG PORVs.
	b.	Check SG pressures - LESS THAN (P15) PSIG	b. IF SG pressure decreasing, THEN return to Step 10. IF NOT, THEN verify PRHR actuated and go to Step 18. OBSERVE NOTE PRIOR TO STEP 18.
	c.	Check RCS hot leg temperatures - AT LEAST TWO LESS THAN (T05) °F	c. IF RCS hot leg temperatures decreasing, THEN return to Step 10. IF NOT, THEN verify PRHR actuated AND go to Step 18. OBSERVE NOTE PRIOR TO STEP 18.
	d.	Stop SG depressurization	
12	**Check If SI Accumulators Should Be Isolated:**		
	a.	At least two RCS hot leg temperatures - LESS THAN (T05) °F	a. Go to Step 18. OBSERVE NOTE PRIOR TO STEP 18.
	b.	Close all SI accumulator isolation valves	b. Vent any unisolated accumulator.

STEP	ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED
13	**Depressurize All Intact SGs To Atmospheric Pressure:**	
	a. Dump steam to condenser at maximum rate	a. Dump steam at maximum rate using SG PORVs. IF steam can NOT be dumped, THEN verify PRHR actuated AND go to Step 18. OBSERVE NOTE PRIOR TO STEP 18.
14	**Verify RNS Flow**	Continue efforts to establish RNS flow. IF core exit TCs less than 1200°F, THEN return to Step 13. IF NOT, THEN go to Step 18. OBSERVE NOTE PRIOR TO STEP 18.
15	**Check Core Cooling:**	
	a. Core exit TCs - LESS THAN 1200°F	a. Go to Step 18. OBSERVE NOTE PRIOR TO STEP 18.
	b. At least two RCS hot leg temperatures - LESS THAN 350°F	b. Return to Step 13.
	c. RCS hot leg level indication - GREATER THAN (L32)%[(L33)% FOR ADVERSE CONTAINMENT]	c. Return to Step 13.
16	**Go To AE-1, AP600 LOSS OF REACTOR OR SECONDARY COOLANT, Step 13**	
17	**Initiate Reactor Cavity Flooding**	
	• Open cavity flooding squib valve	

STEP	ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED
	NOTE *Normal conditions are desired but not required for starting the RCPs.*	
18	**Check If RCPs Should Be Started:**	
	a. Core exit TCs - GREATER THAN 1200°F	a. Go to Step 19.
	b. Check if an idle RCS cooling loop is available: • Narrow range SG level - GREATER THAN (L03)% [(L04)% FOR ADVERSE CONTAINMENT] • RCP in associated loop - AVAILABLE AND NOT OPERATING	b. Perform the following: 1. Open all other vent paths to containment. 2. Go to Step 19.
	c. Start RCP in one idle RCS cooling loop	
	d. Return to Step 18a.	
19	**Check Core Exit TCs - LESS THAN 1200°F**	IF core exit temperatures decreasing, THEN return to Step 18. IF core exit temperatures increasing and RCPs running in all available RCS cooling loops, THEN go to SACRG-1, SEVERE ACCIDENT CONTROL CONTROL ROOM GUIDELINE INITIAL RESPONSE, Step 1.
20	**Try to Depressurize The RCS By Cooling Down With PRHR**	Try to locally depressurize SGs to atmospheric pressure.

STEP	ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED
21	**Check If SI Accumulators Should Be Isolated:**	
	a. RNS flow indicators - AT LEAST INTERMITTENT FLOW	a. Return to Step 20.
	b. Close all SI accumulator isolation valves	b. Vent any unisolated accumulator.
22	**Check If RCPs Should Be Stopped:**	
	a. At least two RCS hot leg temperatures - LESS THAN 350°F	a. Go to Step 23.
	b. Stop all RCPs	
23	**Verify RNS Flow**	Perform the following: a. Continue efforts to establish RNS flow. b. Actuate fourth stage ADS. c. Verify IRWST injection isolation valves open. IF NOT, THEN manually open valves.
24	**Check Core Cooling:** • Core exit TCs - LESS THAN 1200°F • RCS hot leg level indication - GREATER THAN (L32)%[(L33)% FOR ADVERSE CONTAINMENT] • At least two RCS hot leg temperatures - LESS THAN 350°F	Return to Step 18.
25	**Go To AE-1, AP600 LOSS OF REACTOR OR SECONDARY COOLANT, Step 13**	

- END -

FOOTNOTES

Refer to FOOTNOTE DEFINITION Document for a description of all footnoted parameters used in this guideline.

A. PURPOSE

This guideline provides actions to restore adequate core cooling.

B. SYMPTOMS OR ENTRY CONDITIONS

This guideline is entered from AF-0.2, CORE COOLING Critical Safety Function Status Tree, on an ORANGE condition.

STEP	ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED
1	**Verify CMT Actuated:** • CMT injection valves - OPEN	Actuate CMT initiation. IF valves will NOT open, THEN manually open valves as necessary.
	CAUTION *Symptoms for AFR-C.1, AP600 RESPONSE TO INADEQUATE CORE COOLING should be closely monitored during subsequent steps.*	
2	**Verify All RCPs Tripped**	Manually trip RCPs.
	CAUTION *If adverse containment conditions exist, RCS makeup should be operated in manual to maintain pressurizer level.*	
3	**Check RCS Makeup Status:**	
	a. PRZR level - GREATER THAN (L05)%[(L23)% FOR ADVERSE CONTAINMENT]	a. Start all makeup pumps.
	b. PRZR level - LESS THAN (L06)%[(L31)% FOR ADVERSE CONTAINMENT]	b. Verify all makeup pumps stopped. IF NOT, THEN manually stop all makeup pumps.
4	**Check Core Cooling:**	
	a. Core Exit TCs - LESS THAN (T13) °F	a. IF decreasing THEN return to Step 1. IF NOT, THEN go to Step 5.
	b. Return to guideline and step in effect.	

STEP	ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED
5	**Check SI Accumulator Isolation Valve Status:**	
	a. Restore power to isolation valves	
	b. Isolation valves - OPEN	b. Open isolation valves unless closed after accumulator discharge.
	CAUTION *If IRWST level decreases to less than (L11), RNS alignment to the containment sump should be verified.*	
6	**Depressurize RCS To Inject IRWST:**	
	a. Actuate ADS	
	b. Verify first stage ADS isolation valves - OPEN	b. Manually open valves as necessary.
	c. Check second stage ADS valves - OPEN	c. WHEN (T01) seconds have elapsed from first stage ADS signal, THEN verify second stage ADS valves open. IF NOT, THEN manually open second stage ADS valves as necessary.
	d. Check third stage ADS valves - OPEN	d. WHEN (T02) seconds have elapsed from second stage ADS signal, THEN verify third stage ADS valves open. IF NOT, THEN manually open third stage ADS valves as necessary.
	e. Align RNS to inject into RCS	e. IF RNS injection into RCS can NOT be established, THEN actuate fourth stage ADS.
	f. Verify proper valve alignment [Include additional AP600 details in EOPs]	f. Manually align valves as necessary.

STEP	ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED
7	**Check Core Cooling:**	
	a. Core Exit TCs - LESS THAN (T13) °F	a. IF decreasing THEN return to Step 1. IF NOT, THEN go to Step 8.
	b. RCS hot leg level indication - GREATER THAN (L32)%[(L33)% FOR ADVERSE CONTAINMENT]	b. IF increasing, THEN return to Step 1. IF NOT, THEN go to Step 8.
	c. Return to guideline and step in effect.	
	CAUTION *A faulted or ruptured SG should not be used in subsequent steps unless PRHR is not available and no intact SG is available.*	
8	**Check Intact SG Levels:**	
	a. Narrow range level - GREATER THAN (L03)% [(L04)% FOR ADVERSE CONTAINMENT]	a. Maintain total feed flow greater than (F01) gpm until narrow range level greater than (L03)% [(L04)% for adverse containment] in at least one SG.
	b. Control feed flow to maintain narrow range level between (L03)% [(L04)% for adverse containment] and 50%	

STEP	ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED

CAUTION *The following step will cause accumulator injection which may cause a red path condition in AF-0.4, INTEGRITY Status Tree. This guideline should be completed before transition to AFR-P.1, AP600 RESPONSE TO IMMINENT PRESSURIZED THERMAL SHOCK.*

NOTE *After the low steamline pressure SI signal is blocked, main steamline isolation will occur if the high steam pressure rate setpoint is exceeded.*

9	**Depressurize All Intact SGs To (P15) PSIG:**	
	a. Maintain cooldown rate in RCS cold legs - LESS THAN 100°F/HR	
	b. Dump steam to condenser	b. Manually or locally dump steam from SGs: • Use PORV. - OR - • [Include additional AP600 details in EOPs].
	c. Check SG pressures - LESS THAN (P15) PSIG	c. Return to Step 8.
	d. Stop SG depressurization	
10	**Check RNS Pumps - RUNNING**	Start pumps as necessary.
11	**Check If SI Accumulators Should Be Isolated:**	
	a. At least two RCS hot leg temperatures - LESS THAN (T05)°F	a. Go to Step 12.
	b. Close all SI accumulator isolation valves	b. Vent any unisolated accumulator.

STEP	ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED
12	**Depressurize All Intact SGs To Atmospheric Pressure:** a. Maintain cooldown rate in RCS cold legs - LESS THAN 100°F/HR b. Dump steam to condenser	b. Manually or locally dump steam from SGs: • Use PORV. - OR - • [Include additional AP600 details in EOPs].
13	**Verify RNS Flow**	Perform the following: a. Continue efforts to establish RNS flow. b. Actuate fourth stage ADS. c. Verify IRWST injection isolation valves open. IF NOT, THEN manually open valves.
14	**Check Core Cooling:** • Core Exit TCs - LESS THAN (T13)°F • RCS hot leg level indication - GREATER THAN (L32)%[(L33)% FOR ADVERSE CONTAINMENT] • At least two RCS hot leg temperatures - LESS THAN 350°F	Return to Step 12.
15	**Go to AE-1, AP600 LOSS OF REACTOR OR SECONDARY COOLANT, Step 13**	

- END -

FOOTNOTES

Refer to FOOTNOTE DEFINITION Document for a description of all footnoted parameters used in this guideline.

A. PURPOSE

This guideline provides actions to respond to a loss of heat sink in all steam generators.

B. SYMPTOMS OR ENTRY CONDITIONS

This guideline is entered from:

1) AE-0, AP600 REACTOR TRIP OR SAFETY INJECTION, Step 15, when minimum SFW flow is not verified AND narrow range level in all SGs is less than (L03)% [(L04)% FOR ADVERSE CONTAINMENT] AND PRHR can not be initiated.

2) AF-0.3, HEAT SINK Critical Safety Function Status Tree on a RED condition.

STEP	ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED
1	**Try To Establish PRHR Flow:**	
	a. Actuate PRHR initiation	
	b. Verify PRHR isolation valves - OPEN	b. Manually open valves as necessary.
	c. Verify PRHR flow	c. Manually open valves as necessary. IF PRHR flow can NOT be established, THEN go to Step 2.
	d. Return to guideline and step in effect	
	CAUTION • *If total feed flow is less than (F01) gpm due to operator action to control RCS temperature, this guideline should not be performed.* • *Feed flow should not be reestablished to any faulted SG if a non-faulted SG is available.*	
2	**Check If Secondary Heat Sink Is Required:**	
	a. RCS pressure - GREATER THAN ANY NON-FAULTED SG PRESSURE	a. Go to AE-1, AP600 LOSS OF REACTOR OR SECONDARY COOLANT, Step 1.
	b. RCS temperature - GREATER THAN (T06) °F [(T07) °F FOR ADVERSE CONTAINMENT]	b. Try to place normal RNS System in service to cool RCS while continuing in this guideline. Refer to [Include additional AP600 details in EOPs]. IF adequate cooling with normal RNS System established, THEN return to guideline and step in effect.

STEP	ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED

CAUTION • *If parameter (V04) [(V05) for adverse containment] is exceeded due to loss of secondary heat sink, Step 9 should be immediately initiated for feed and bleed cooldown.*

3 **Try To Establish SFW Flow To At Least One SG:**

a. Check control room indications for cause of SFW failure:

- Condensate storage tank level
- SFW pump power supply
- SFW valve alignment
- Low T-cold SFW isolation
- High-2 SG NR level SFW isolation

b. Try to restore SFW flow

c. Check total flow to SGs - GREATER THAN (F01) GPM

c. Dispatch operator to locally restore SFW flow. Go to Step 4.

d. Return to guideline and step in effect

STEP	ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED
4	**Try To Establish Main FW Flow To At Least One SG**	
	a. Check Condensate System - IN SERVICE	a. Try to place Condensate System in service. IF NOT, THEN go to Step 8.
	b. Check FW isolation valves - OPEN	b. Perform the following: 1) Reset SI if necessary. 2) Reset FW isolation. 3) Open FW isolation valves. IF no FW isolation valve can be opened, THEN go to Step 8.
	c. Establish Main FW flow: [Include additional AP600 details in EOPs]	c. Go to Step 6.
5	**Check SG Levels:**	
	a. Narrow range level in at least one SG - GREATER THAN (L03)% [(L04)% FOR ADVERSE CONTAINMENT]	a. IF feed flow to at least one SG verified, THEN maintain flow to restore narrow range level to greater than (L03)% [(L04)% for adverse containment]. IF NOT verified, THEN go to Step 6.
	b. Return to guideline and step in effect	

STEP	ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED

CAUTION *Following block of automatic SI actuation, manual SI actuation may be required if conditions degrade.*

6 **Try To Establish Feed Flow From Condensate System:**

a. Depressurize RCS to less than (P06) PSIG:

1) Use normal spray

1) Use auxiliary spray. IF auxiliary spray NOT available, THEN use one set of first stage PRZR ADS valves.

b. Block SI signals:

- Low Steamline Pressure SI
- Low PRZR Pressure SI
- Low T-cold SI

c. Depressurize at least one SG to less than (P20) PSIG:

1) Dump steam to condenser at maximum rate

1) Manually or locally dump steam from SGs:

- Use PORV.

-OR-

- [Include additional AP600 details in EOPs].

IF NOT, THEN go to Step 8.

d. Establish condensate flow:

[Include additional AP600 details in EOPs]

d. Go to Step 8.

STEP	ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED
7	**Check SG Levels:**	
	a. Narrow range level in at least one SG - GREATER THAN (L03)% [(L04)% FOR ADVERSE CONTAINMENT]	a. IF feed flow to at least one SG verified, THEN maintain flow to restore narrow range level to greater than (L03)% [(L04)% for adverse containment]. IF NOT verified, THEN go to Step 8.
	b. Return to guideline and step in effect	
8	**Check For Loss Of Secondary Heat Sink:**	
	a. Parameter (V04) [(V05) for adverse containment] - EXCEEDED	a. Return to Step 1.
	CAUTION *Steps 9 through 12 must be performed quickly in order to establish RCS heat removal by RCS feed and bleed.*	
9	**Actuate SI**	
10	**Verify CMT Actuated:** • CMT injection valves - OPEN	Actuate CMT initiation. IF valves will NOT open, THEN manually open valves as necessary.
11	**Verify All RCPs Tripped**	Manually trip RCPs.

STEP	ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED

CAUTION *If IRWST level decreases to less than (L11), RNS alignment to the containment sump should be verified.*

12	**Establish RCS Bleed Path:**		
	a.	Actuate ADS	
	b.	Verify first stage ADS isolation valves - OPEN	b. Manually open valves as necessary.
	c.	Check second stage ADS valves - OPEN	c. WHEN (T01) seconds have elapsed from first stage ADS signal, THEN verify second stage ADS valves open. IF NOT, THEN manually open second stage ADS valves as necessary.
	d.	Check third stage ADS valves - OPEN	d. WHEN (T02) seconds have elapsed from second stage ADS signal, THEN verify third stage ADS valves open. IF NOT, THEN manually open third stage ADS valves as necessary.
	e.	Align RNS to inject into RCS	e. IF RNS injection into RCS can NOT be established, THEN actuate fourth stage ADS.
	f.	Verify proper valve alignment [Include additional AP600 details in EOPs]	f. Manually align valves as necessary.
13	**Perform Steps 1 Through 11 Of E-0, REACTOR TRIP OR SAFETY INJECTION While Continuing With This Guideline**		

STEP	ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED

CAUTION *If adverse containment conditions exist, RCS makeup should be operated in manual to maintain pressurizer level.*

14 **Check RCS Makeup Status:**

a. PRZR level - GREATER THAN (L05)%[(L23)% FOR ADVERSE CONTAINMENT]

a. Verify one makeup pump running. IF NOT, THEN manually start one makeup pump. IF level continues to decrease or cannot be restored, THEN start second makeup pump.

b. PRZR level - LESS THAN (L06)%[(L31)% FOR ADVERSE CONTAINMENT]

b. Verify all makeup pumps stopped. IF NOT, THEN manually stop all makeup pumps.

CAUTION
- *If containment pressure increases to greater than (P01), containment spray should be verified.*

15 **Continue Attempts To Establish Secondary Heat Sink In At Least One SG:**

- SFW flow
- Main FW flow
- Condensate flow
- Other low pressure flow

16 **Go To AE-1, AP600 LOSS OF REACTOR OR SECONDARY COOLANT, Step 13**

- END -

FOOTNOTES

Refer to FOOTNOTE DEFINITION Document for a description of all footnoted parameters used in this guideline.

A. PURPOSE

This guideline provides actions to respond to a steam generator high level condition and to address the steam generator overfill concern.

B. SYMPTOMS OR ENTRY CONDITIONS

This guideline is entered from:

1) AF-0.3, HEAT SINK Critical Safety Function Status Tree on a YELLOW condition, and

2) AFR-H.2, AP600 RESPONSE TO STEAM GENERATOR OVERPRESSURE, Step 3, if the affected SG narrow range level is high.

STEP	ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED

CAUTION *If SG narrow range level has increased to greater than (L27)% [(L28)% for adverse containment] an evaluation should be made for SG overfill considerations. Steam should not be released from any SG with level greater than (L27)% [(L28)% for adverse containment] prior to overfill evaluation.*

NOTE *Throughout this guideline, "affected" refers to either SG in which narrow range level is greater than (L12)%.*

1	**Identify Affected SG(s):**	
	a. Narrow range level - GREATER THAN (L12)%	a. IF less than (L12)% in all SGs, THEN return to guideline and step in effect.
2	**Verify FW Isolation:**	
	a. Main FW pumps - STOPPED	a. Manually stop pumps.
	b. Flow control valves - CLOSED	b. Manually close valves.
	c. Feedwater isolation valves - CLOSED	c. Manually close valves.
3	**Verify SFW Flow To Affected SG(s) - ISOLATED**	

STEP	ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED
4	**Check Affected SG(s) Level:**	
	a. Narrow range level - LESS THAN (L27)% [(L28)% FOR ADVERSE CONTAINMENT]	a. Go to Step 5.
	b. Narrow range level - DECREASING	b. Go to Step 5.
	c. Control SFW flow to maintain narrow range level between (L03)% [(L04)% for adverse containment] and 50%	
	d. Return to guideline and step in effect	
5	**Adjust Affected SG(s) PORV Controller Setpoint To (P05) PSIG**	
6	**Close Affected SG(s) Main Steamline Isolation and Bypass Valves**	
7	**Check SGS Main Steamline Radiation - NORMAL**	IF AE-3 guideline is in effect, THEN return to guideline and step in effect. IF NOT, THEN go to AE-3 AP600 STEAM GENERATOR TUBE RUPTURE, Step 1.
8	**Establish Blowdown From Affected SG(s):** [Include additional AP600 details in EOPs]	
9	**Return To Guideline And Step In Effect**	

- END -

FOOTNOTES

Refer to FOOTNOTE DEFINITION Document for a description of all footnoted parameters used in this guideline.

Number	Title	Rev./Date
AFR-I.1	AP600 RESPONSE TO HIGH PRESSURIZER LEVEL	Rev. 3 5/31/97

A. PURPOSE

This guideline provides actions to respond to a high pressurizer level.

B. SYMPTOMS OR ENTRY CONDITIONS

This guideline is entered from AF-0.6, INVENTORY Critical Safety Function Status Tree on a YELLOW condition.

STEP	ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED
1	**Check CMT Injection Valves - ALL CLOSED**	Return to guideline and step in effect.
2	**Check RCS Makeup Status:**	
	a. RCS makeup pumps - STOPPED	a. Stop all makeup pumps.
3	**Check Letdown - IN SERVICE**	Establish letdown: [Include additional AP600 details in EOPs]. IF letdown can NOT be established, THEN establish reactor head vent flow. [Include additional AP600 details in EOPs].
4	**Check PRZR Pressure:**	
	a. Pressure - LESS THAN (P02) PSIG	a. Control makeup and letdown as necessary to decrease PRZR pressure to less than (P02) psig.
5	**Turn On PRZR Heaters**	

STEP	ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED
6	**Check PRZR Spray Valves:**	
	a. Normal spray valves - CLOSED	a. Manually close spray valves. IF valve(s) can NOT be closed, THEN close PRZR spray valve(s) block valve. IF valve(s) can NOT be closed, THEN stop RCP(s) supplying failed spray valve(s).
	b. Auxiliary spray valve - CLOSED	b. Manually close auxiliary spray valve. IF valve can NOT be closed, THEN open normal RCS makeup line.
7	**Control Letdown As Necessary To Maintain RCS Pressure Stable**	
8	**Check PRZR Level - LESS THAN (L24)%**	Return to Step 7.
9	**Return To Guideline And Step In Effect**	

- END -

FOOTNOTES

Refer to FOOTNOTE DEFINITION Document for a description of all footnoted parameters used in this guideline.

AP600 Emergency Response Guidelines
Background Information

List of Affected Pages for Revision 3

Background Book 1

Document	Page	Section(s)
AE-0	4-11	Basis, Actions, Instrumentation, Control/Equipment
	4-24	Basis, Actions, Instrumentation, Control/Equipment
	4-24a	new page
	4-28	Additional Information
	4-28a	new page
	4-38	Actions
	4-39	Additional Information
AES-0.1	4-8	Additional Information
	4-10	Basis, Instrumentation, Control/Equipment
	4-10a	new page
	4-22	Knowledge
	4-22a	new page
AES-0.2	4-4	Basis
	4-12	Knowledge
AE-1	4-13	Actions
	4-14	Additional Information
	4-15	Knowledge
AES-1.1	4-12	Knowledge
	4-22	Basis
	4-30	Knowledge
	4-30a	new page
AES-1.2	4-20	Basis, Actions
	4-21	Additional Information
	4-22	Basis, Instrumentation
	4-25	Basis
	4-37	Knowledge
AE-3	4-11	Basis, Actions, Instrumentation, Control/Equipment
	4-12	page rollover
	4-19	Additional Information
	4-38	Basis, Actions
	4-39	Additional Information
	4-47	Basis
	4-57	Knowledge

AP600

Emergency Response Guidelines

AP600 Document Number GW-GJR-100

Revision 3

May 31, 1997

AP600

Emergency Response Guidelines

AP600 Document Number GW-GJR-100

Background Information

Book 1

Revision 3

May 31, 1997

BACKGROUND INFORMATION

FOR

AP600

EMERGENCY RESPONSE GUIDELINE

AE-0

AP600 REACTOR TRIP OR SAFETY INJECTION

Rev. 3

May 31, 1997

STEP 8

STEP: Verify PRHR Actuated

PURPOSE: To ensure that PRHR is actuated

BASIS:

During a plant transient resulting in a reactor trip, nonsafety grade core heat removal will be provided by the SGs, steam system and the SFWS. In the event that these systems are unavailable then safety-grade core heat removal is provided by the passive residual heat removal system (PRHR).

At this point safety injection has been determined to be required and PRHR actuation is included in the safety injection actuation "sequence" (i.e., whenever the CMTs have actuated PRHR). PRHR is required upon CMT actuation to mitigate the impact (over filling the pressurizer) of increasing RCS inventory as a result of CMT heatup and fluid expansion during an event where significant CMT recirculation occurs (such as for spurious safety injection actuation). Therefore the operator verifies that PRHR has actuated. If the PRHR isolation valves have not opened, the operator is instructed to manually open the individual valves. The operator also verifies that the IRWST gutter drain isolation valves close.

ACTIONS:

- Verify PRHR isolation valves are open
- Manually open valves
- Actuate PRHR initiation
- Verify IRWST gutter drain isolation valves are closed

INSTRUMENTATION:

Status indications for:

- PRHR isolation valves position indication
- IRWST gutter drain isolation valves position indication

CONTROL/EQUIPMENT:

Controls for:

- PRHR isolation valves
- IRWST gutter drain isolation valves

KNOWLEDGE:

- The operator should know that PRHR is actuated whenever CMT actuation occurs.
- If the protection and safety monitoring system is unsuccessful in actuating the PRHR, the operator should be aware that the DAS has provisions for manually actuating the PRHR.

ADDITIONAL INFORMATION:

N/A

STEP 9

STEP: Verify All RCPs Tripped

PURPOSE: To ensure that all RCPs are tripped

BASIS:

The RCPs get tripped on CMT actuation. The RCPs are not permitted to be operating after CMT actuation since RCP operation will impact proper CMT operation. RCP trip is delayed 15 seconds to allow reactor trip to occur first.

ACTIONS:

- Verify all RCPs tripped
- Manually trip all RCPs

INSTRUMENTATION:

RCP Indication

CONTROL EQUIPMENT:

Controls for manual trip of all RCPs

KNOWLEDGE:

If the protection and safety monitoring system is unsuccessful in tripping the RCPs, the operator should be aware that the DAS has provisions for manually actuating the CMTs, which will result in tripping the RCPs.

ADDITIONAL INFORMATION:

N/A

STEP 17 - CAUTION

CAUTION: If adverse containment conditions exist, RCS makeup should be operated in manual to maintain pressurizer level

PURPOSE: To alert the operator that RCS makeup should be operated in manual if adverse containment conditions exist

BASIS:

RCS makeup is controlled in the automatic mode using the pressurizer level setpoints which correspond to normal containment conditions. In the automatic mode, one makeup pump is started on low pressurizer level and the makeup pump(s) are stopped on high pressurizer level. For adverse containment conditions, RCS makeup should be operated in manual to maintain pressurizer level between the adverse containment setpoint values.

ACTIONS:

N/A

INSTRUMENTATION:

N/A

CONTROL/EQUIPMENT:

N/A

KNOWLEDGE:

N/A

ADDITIONAL INFORMATION:

N/A

STEP 17

STEP: Check RCS Makeup Status

PURPOSE: To ensure that the chemical and volume control makeup pumps are operating properly

BASIS:

The nonsafety-related chemical and volume control (CVS) makeup pumps provide makeup to the RCS for RCS inventory control. Operation of the makeup pumps is automatically controlled on pressurizer level between the low and high pressurizer level setpoints during normal operations. Following CMT actuation, the control level setpoints are automatically adjusted so that the makeup pumps automatically control pressurizer level between (L05) and (L06). One makeup pump is started on low pressurizer level and the makeup pump(s) are stopped on high pressurizer level. This step ensures that the CVS makeup pumps are operating properly by checking pressurizer level. The demineralized water isolation valves receive an isolation signal on a safeguards actuation and are therefore verified to have closed.

ACTIONS:

- Determine if pressurizer level is greater than (L05)% [(L23)% for adverse containment]
- Determine if pressurizer level is less than (L06)% [(L31)% for adverse containment]
- Verify that one CVS makeup pump is running
- Start one CVS makeup pump
- Verify all makeup pumps stopped
- Verify demineralized water isolation valves closed

INSTRUMENTATION:

Indication for:

- CVS makeup flow
- CVS makeup pump status
- CVS makeup valve position
- Pressurizer level
- Demineralized water isolation valve position

CONTROL/EQUIPMENT:

Controls for:

- CVS makeup pumps
- Demineralized water isolation valves

KNOWLEDGE:

N/A

STEP 17 (Cont.)

ADDITIONAL INFORMATION:

- (L05) Pressurizer post-S low level setpoint for starting RCS makeup for normal containment conditions
- (L06) Pressurizer post-S high level setpoint for stopping RCS makeup for normal containment conditions
- (L23) Pressurizer low level setpoint for starting RCS makeup for adverse containment conditions
- (L31) Pressurizer high level setpoint for stopping RCS makeup for adverse containment conditions

STEP 20

STEP: Verify VWS Operation

PURPOSE: To ensure VWS pumps are running and valves properly aligned

BASIS:

The chilled water system (VWS) supplies chilled water to all air handling units of the plant heating, ventilation and air conditioning systems, and provides proper equipment environmental conditions. Therefore, operation of the VWS is verified.

ACTIONS:

- Verify that at least one VWS pump is running
- Start VWS pumps as necessary
- Verify proper valve alignment
- Manually align valves as necessary

INSTRUMENTATION:

- VWS pumps status indications
- VWS valve indications

CONTROL/EQUIPMENT:

- Controls for VWS pumps
- VWS valve controls

KNOWLEDGE:

N/A

ADDITIONAL INFORMATION:

Include additional details in EOPs

STEP 21

STEP: Verify Containment Fan Coolers - RUNNING

PURPOSE: To ensure containment fan coolers are running to limit containment pressure, temperature, and humidity

BASIS:

Containment fan coolers provide non-safety grade cooling of the containment atmosphere to limit containment pressure, temperature, and humidity during accident conditions.

ACTIONS:

- Determine if containment fan coolers are running
- Manually start the fan cooler

INSTRUMENTATION:

Containment fan coolers status indication

CONTROL/EQUIPMENT:

Containment fan coolers controls

KNOWLEDGE:

N/A

ADDITIONAL INFORMATION:

Containment fan coolers have two-speed motors. If containment pressure/temperature are above the limits for high-speed operation, the fan coolers should be run at slow speed.

When preparing the EOPs, consideration should be given to the potential for water hammer in the chilled water piping following a heatup of containment and subsequent reinitiation of the containment fan coolers and chilled water system consistent with the huidance provided in GL96-06. The following precautions and limitations have been identified in order to prevent flashing and potential water hammer in the chilled water piping.

- Following an event which results in heatup of the containment air/steam above 228°F, the isolated cooling water supply and return containment isolation valves should not be opened to restore chilled water flow to the operating fan coolers, until the containment atmosphere temperature has been reduced to ≤228°F.

- Following an event which results in heatup of the containment air/steam above 228°F, cooling water flow should not be initiated to fan cooler coils unless the fans for these coolers have been running for a sufficiently long time to ensure the water in the coils is at equilibrium temperature

with the containment atmosphere temperature, and until the containment atmosphere temperature has been reduced to ≤228°F.

- The chilled water flow to operating fan coolers should be stopped and isolated using the containment isolation valves, whenever the containment atmosphere temperature exceeds 228°F.

- Following an event which results in heatup of the containment air/steam above 228°F, chilled water flow to operating fan coolers should be initiated by first closing the manual valve in the chilled water return line header (exiting containment), opening the remotely-operated containment isolation valves, and then slowly opening the manual valve to slowly fill the potentially voided system piping.

The temperature of 228°F is the saturation temperature for the chilled water system at which voiding could occur. As this temperature is dependent on the elevations of the chilled water system surge tank and the elevation of the containment fan cooler units, this number should be revalidated with as-built information.

STEP 29

STEP: Check SGS Main Steamline Radiation - NORMAL

PURPOSE: To identify any ruptured (failure in primary to secondary pressure boundary) SGs

BASIS:

Abnormal radiation in a SG indicates primary to secondary leakage. Since the turbine island vent and blowdown lines may have been isolated at the initiation of the transient, it may be necessary to check each SG at this time. Optimal recovery in dealing with a SGTR is provided in AE-3, AP600 STEAM GENERATOR TUBE RUPTURE.

ACTIONS:

- Determine if SGS main steamline radiation level is normal
- Transfer to AE-3, AP600 STEAM GENERATOR TUBE RUPTURE, Step 1

INSTRUMENTATION:

SGS main steamline radiation instrumentation

CONTROL/EQUIPMENT:

N/A

KNOWLEDGE:

Defining "normal" as the value of a process parameter experienced during routine plant operations

ADDITIONAL INFORMATION:

N/A

STEP 30

STEP: Check If ADS Should Be Actuated

PURPOSE: To determine if ADS should be actuated based on prevailing plant conditions

BASIS:

If the operator has progressed to this step, then passive safety systems may still be required and the operator is directed to see if automatic depressurization system (ADS) actuation is required. ADS actuation is required if CMT level cannot be maintained above the first stage ADS actuation setpoint or if RCS hot leg level is low. If ADS actuation is required, then the operator verifies that the first three ADS actuation stages have operated successfully. The second and third stages ADS are actuated after the first stage following a time delay.

If ADS is actuated, the operator is directed to go to guideline AE-1, AP600 LOSS OF REACTOR OR SECONDARY COOLANT.

ACTIONS:

- Determine if ADS should be actuated
- Determine if CMT level is less than (L01)%
- Determine if RCS hot leg level is greater than (32)%
- Determine if (T01) seconds have elapsed from first stage ADS actuation signal
- Determine if (T02) seconds have elapsed from second stage ADS actuation signal
- Verify actuation of first three ADS actuation stages was successful
- Manually open first, second and third stage ADS actuation valves
- Align normal residual heat removal system to inject into RCS
- Manually align valves as necessary

INSTRUMENTATION:

Indication for:

- CMT level
- RCS hot leg level
- ADS actuation
- ADS actuation isolation valve position
- Normal residual heat removal system valves position
- Normal residual heat removal system pumps status

CONTROL/EQUIPMENT:

- Manual ADS actuation valve controls
- Controls for normal residual heat removal system valves
- Normal residual heat removal system pump controls

KNOWLEDGE:

The operator should be aware that the DAS has provisions for actuating ADS.

STEP 30 (Cont.)

ADDITIONAL INFORMATION:

- (L01) CMT low level ADS actuation
- (L32) RCS hot leg level greater than bottom of hot legs for normal containment conditions
- (T01) Time delay for second stage ADS actuation
- (T02) Time delay for third stage ADS actuation
- Include additional details for valve alignments in EOPs such as verifying the closure of ADS discharge header drain isolation valves.
- The operator must manually block the containment isolation signal to the RNS containment isolation valves prior to aligning the system for injection

STEP 31

STEP: Check Plant Vent Radiation - NORMAL

PURPOSE: To ensure that there is no primary leakage into the auxiliary building

BASIS:

During the initiation of the transient, there should be no abnormal indications in the auxiliary building. If abnormal radiation levels exist, the operating crew should attempt to identify the cause of the abnormal conditions. If the cause is determined to be a loss of RCS inventory outside containment, then the operator should go to AECA-1.1, AP600 LOCA OUTSIDE CONTAINMENT, to try to terminate the leakage.

ACTIONS:

- Determine if plant vent radiation is normal
- Determine if cause of abnormal radiation is loss of RCS inventory outside containment
- Evaluate cause of abnormal radiation conditions
- Transfer to AECA-1.1, AP600 LOCA OUTSIDE CONTAINMENT, Step 1

INSTRUMENTATION:

Plant vent radiation monitors

CONTROL/EQUIPMENT:

N/A

KNOWLEDGE:

- Determining loss of RCS inventory outside containment
- Defining "normal" as the value of a process parameter experienced during routine plant operations

ADDITIONAL INFORMATION:

N/A

BACKGROUND INFORMATION

FOR

AP600

EMERGENCY RESPONSE GUIDELINE

AES-0.1

AP600 REACTOR TRIP RESPONSE

Rev. 3

May 31, 1997

STEP 3

STEP: Check FW Status

PURPOSE: To ensure the proper feedwater alignment following a reactor trip

BASIS:

Following a reactor trip, the main feedwater pumps continue to operate while flow is automatically switched from the main feed line to the startup feedwater line. The main feedwater flow control valves isolate if RCS average temperature reaches a setpoint to prevent an uncontrolled RCS cooldown from excessive feeding of the SGs through the main feed line. Verifying feed flow to the SGs ensures a secondary heat sink for decay heat removal. The feedwater source is from the main feed pumps or the startup feedwater pumps (if the main feed pumps are stopped). If feedwater is not available and SG narrow range level is below the setpoint for PRHR actuation, PRHR should be actuated.

ACTIONS:

- Determine if RCS average temperatures are less than (T08)°F
- Determine if main feedwater flow control valves are closed
- Verify feedwater flow to SGs
- Close main feedwater flow control valves
- Establish feedwater flow the SGs
- Determine if SG narrow range level is less than (L36)%
- Actuate PRHR

INSTRUMENTATION:

- RCS average temperature
- Main feedwater flow control valve position indication
- Feedwater flow to SGs indication
- Startup feedwater pump status indication
- SG narrow range level indication
- PRHR indication

CONTROL/EQUIPMENT:

- Controls for main feedwater flow control valves
- Controls for startup feedwater pumps
- Controls for main feedwater pumps
- Controls for PRHR

KNOWLEDGE:

N/A

STEP 3 (Cont.)

ADDITIONAL INFORMATION:

- (T08) RCS low average temperature
- (L36) SG narrow range level setpoint for PRHR actuation
- Section 3 of the Adverse Systems Interactions report (WCAP-14477) should be referred to for additional insights when writing EOPs

STEP 4

STEP: Verify All Control Rods Fully Inserted

PURPOSE: To ensure all control rods are inserted for adequate shutdown margin

BASIS:

A subcritical core is verified if all rods are at the bottom based on rod position indication. If this indication reveals that one rod is not inserted, no immediate action is required since the core is designed for adequate shutdown margin with one rod stuck out. However, if more than one rod fails to insert fully, the shutdown reactivity margin must be made up through emergency boration to account for the reactivity worth of the stuck rods.

ACTIONS:

- Determine if all control rods are fully inserted
- Determine if two or more control rods are not fully inserted
- Borate (B01) ppm for each control rod not fully inserted

INSTRUMENTATION:

- Control rod position indication
- CVS makeup pump suction three way control valve position indication

CONTROL/EQUIPMENT:

CVS makeup pump suction three way control valve control

KNOWLEDGE:

N/A

ADDITIONAL INFORMATION:

(B01) Boration requirement for stuck rod

STEP 5

STEP: Check RCS Makeup Status

PURPOSE: To ensure that the CVS makeup pumps are operating properly

BASIS:

The nonsafety-grade CVS makeup pumps provide makeup to the RCS for RCS inventory control. Operation of the makeup pumps is automatically controlled on pressurizer level between the low and high pressurizer level setpoints during normal operation. Following reactor trip, the control level setpoints are automatically adjusted so that the makeup pumps automatically control pressurizer level between (L37) and (L38). One makeup pump is started on low pressurizer level and the makeup pump(s) are stopped on high pressurizer level. This step ensures that the CVS makeup pumps are operating properly by checking pressurizer level. Pressurizer level should be maintained between the makeup pump start and stop level setpoint values. If boration or auxiliary spray is desired, letdown may be placed in service. The demineralized water isolation valves receive an isolation signal on a reactor trip and are therefore verified to have closed.

ACTIONS:

- Determine if pressurizer level is greater than (L37)%
- Determine if pressurizer level is less than (L38)%
- Verify that one CVS makeup pump is running
- Start one CVS makeup pump
- Verify all makeup pumps stopped
- Operate makeup and letdown to maintain pressurizer level between (L37)% and (L38)%

INSTRUMENTATION:

Indication for:

- CVS makeup flow
- CVS makeup pump status
- CVS makeup valve position
- Pressurizer level
- Letdown flow
- Demineralized water isolation valve position

CONTROL/EQUIPMENT:

Controls for:

- CVS makeup pumps
- Letdown control valves
- Demineralized water isolation valves

KNOWLEDGE:

N/A

STEP 5 (Cont.)

ADDITIONAL INFORMATION:

- (L37) Pressurizer post-trip no-load minimum level setpoint for starting RCS makeup
- (L38) Pressurizer post-trip no-load maximum level setpoint for stopping RCS makeup

STEP 13

STEP: Maintain Stable Plant Conditions

PURPOSE: To maintain stable plant conditions

BASIS:

After stabilizing the plant following the reactor trip, the plant should be maintained in a stable condition while investigating the cause of the trip and determining if a startup or cooldown should be performed.

ACTIONS:

Maintain stable plant conditions:

- Pressurizer pressure at (P12) psig
- Pressurizer level between (L37)% and (L38)%
- SG narrow range levels between (L03)% and 50%
- RCS average temperature at (T04)°F

INSTRUMENTATION:

Indications for:

- Pressurizer pressure
- Pressurizer level
- SG narrow range level
- RCS temperature

CONTROL/EQUIPMENT:

Controls for:

- Pressurizer spray valves (normal or auxiliary)
- Makeup and letdown
- Feedwater flow control valves
- SG PORVs
- Condenser steam dump valves

KNOWLEDGE:

N/A

ADDITIONAL INFORMATION:

- (P12) Pressurizer normal operating pressure
- (L03)% SG level above U-tubes for normal containment conditions
- (T04) No-load RCS temperature
- (L37)% Pressurizer post-trip no-load minimum level setpoint for starting RCS makeup
- (L38)% Pressurizer post-trip no-load maximum level for stopping RCS makeup

STEP 14

STEP: Determine If Natural Circulation Cooldown Is Required

PURPOSE: To determine if a cooldown must be done on natural circulation

BASIS:

If the plant staff determines that a natural circulation cooldown is required, then a transition to AES-0.2, AP600 NATURAL CIRCULATION COOLDOWN, is made.

ACTIONS:

- Determine if a natural circulation cooldown is required
- Transfer to appropriate plant procedure
- Transfer to AES-0.2, NATURAL CIRCULATION COOLDOWN, Step 1

INSTRUMENTATION:

Instrumentation to determine if a natural circulation cooldown is required

CONTROL/EQUIPMENT:

N/A

KNOWLEDGE:

During a prolonged station blackout event, the accident management plan should contain manual procedures to permit manual override of the timer-driven ADS actuation, to be implemented no later than 22 hours following the loss of offsite and onsite AC power. Criteria for manually overriding the timer-driven ADS actuation include that the plant is in a stable condition, with the CMTs full, the pressurizer water level is stable, and the IRWST water level is stable. It is intended that the manual override of the timer-driven ADS actuation would be implemented about 20-22 hours from the start of the event. Loads supplied by the 24-hour battery, including the PMS actuation cabinets would be de-energized at the time of the override decision. This would preserve the battery power of the two electrical divisions powered by the 24-hour battery and these batteries would have at least a two-hour charge for a later ADS actuation, if needed. The operators would continue to monitor plant parameters via instrumentation that is powered from one of the two electrical divisions with 72-hour battery capacity.

If the event continues beyond 24 hours, the 72-hour batteries allow the operators to monitor the plant parameters to decide if ADS actuation is needed. Since the batteries are conserved, as described above, sufficient power is available for actuation of ADS during the 22-72 hour time frame. After 72 hours, the ancillary diesel generators will allow continued monitoring the plant conditions. If ancillary diesel generators cannot be started, and other ac power sources cannot be brought to the site from other locations, the accident management plan for this beyond design basis scenario should direct the operators to manually actuate the automatic depressurization system while post-accident monitoring capability is still available.

STEP 14 (Cont.)

ADDITIONAL INFORMATION:

If a Technical Specification limitation that requires a cooldown before an RCP can be started is violated, a natural circulation cooldown should be performed.

BACKGROUND INFORMATION

FOR

AP600

EMERGENCY RESPONSE GUIDELINE

AES-0.2

AP600 NATURAL CIRCULATION COOLDOWN

Rev. 3

May 31, 1997

STEP 1 - NOTE 1

NOTE: Foldout page should be open

PURPOSE: To remind the operator that the foldout page for the AE-0 series of guidelines should be open

BASIS:

The foldout page provides a list of important items that should be continuously monitored. If any of the parameters exceed their limits, the appropriate operations should be initiated.

ACTIONS:

N/A

INSTRUMENTATION:

N/A

CONTROL/EQUIPMENT:

N/A

KNOWLEDGE:

Since each foldout page for a particular series of guidelines is potentially unique, the operator should know what items comprise each foldout page. Refer to the FOLDOUT PAGE Section in the appropriate background documents.

ADDITIONAL INFORMATION:

N/A

STEP 1 - NOTE 2

NOTE: RCPs 1A and 1B should be run to provide normal PRZR spray

PURPOSE: To inform the operator of a preferred order for starting RCPs

BASIS:

Subsequent steps require operator actions to control RCS pressure. The preferred means of control is normal pressurizer spray since this conserves reactor coolant inventory. Since spray line connections are provided in only two loops, the RCPs should be run in those loops.

In addition, operation of either RCP 1A or RCP 1B precludes the possibility of developing reverse flow through the PRHR HX, which can potentially lead to the degradation of the PRHR as a heat sink. When any RCP is operating, either RCP 1A or 1B shall be operating.

ACTIONS:

N/A

INSTRUMENTATION:

N/A

CONTROL/EQUIPMENT:

N/A

KNOWLEDGE:

N/A

ADDITIONAL INFORMATION:

N/A

STEP 6

STEP: Initiate RCS Cooldown To Cold Shutdown

PURPOSE: To begin a controlled RCS cooldown to cold shutdown at a specified maximum rate, with preferred and alternate methods

BASIS:

To establish the cooldown of the RCS, steam should be released through the condenser steam dump valves. However, if the main condenser is not available for steam dump, the cooldown should be established using of the SG PORVs, and releasing steam to the atmosphere. If the SG PORVs are not available, passive residual heat removal (PRHR) should be used to cooldown. With control air pressure available and no main condenser, the plant steam pressure will be controlled at the set pressure of the PORVs on the SGs. The plant cooldown is initiated by decreasing the pressure setpoint of the PORVs. The cooldown rate should be controlled and maintained less than the maximum cooldown rate for a natural circulation cooldown. Steam dump must be discontinued if the actual cooldown rate exceeds these permissible values.

To prevent uneven RCS temperature distributions, the pressure difference between SGs must be minimized. This ensures that decay heat removal is evenly distributed to each active coolant loop.

SG level is maintained at the no-load level to provide a stable heat sink for the decay heat removal.

Deviation from the required cooldown rate could lead to excessive heat removal rates during the RCS cooldown. Since the intent of this guideline is to perform a controlled RCS cooldown and stay within Technical Specification limits, the requirement to maintain RCS temperature and pressure within these limits is explicitly emphasized in this Step and Steps 10 and 13. Though this is not a pressurized thermal shock concern, emphasis needs to be placed on maintaining RCS temperature, and pressure within certain limits needs to be emphasized. For this Step and Step 10, the requirement on RCS temperature and pressure is to stay within the Technical Specification limits. Step 13 contains additional requirements on RCS temperature and pressure.

ACTIONS:

- Maintain cooldown rate in RCS cold legs less than (T09)°F/hr
- Dump steam to the condenser using normal steam dump system
- Dump steam to the atmosphere using SG PORVs
- Use PRHR for cooldown
- Maintain SG narrow range level at (L19)%
- Control feedwater flow
- Maintain RCS temperature and pressure within limits of (C01)

STEP 6 (Cont.)

INSTRUMENTATION:

Indication for:

- RCS cold leg temperature indication
- Steam dump system indications
- SG PORV status
- SG narrow range level
- Feedwater flow
- RCS temperature
- RCS pressure
- PRHR isolation valves position

CONTROL/EQUIPMENT:

Controls for:

- Steam dump to condenser
- SG PORVs
- Feedwater flow
- PRHR isolation valves

KNOWLEDGE:

If PRHR is being used for the cooldown, the operator should take actions to cool the IRWST.

ADDITIONAL INFORMATION:

- (T09) Maximum cooldown rate for natural circulation cooldown
- (L19) SG no-load level
- (C01) Technical Specification limit for natural circulation cooldown rate

BACKGROUND INFORMATION

FOR

AP600

EMERGENCY RESPONSE GUIDELINE

AE-1

AP600 LOSS OF REACTOR OR SECONDARY COOLANT

Rev. 3

May 31, 1997

STEP 7

STEP: Check If ADS Should Be Actuated

PURPOSE: To determine if ADS should be actuated based on prevailing plant conditions

BASIS:

If the operator has progressed to this step, then passive safety systems are still required and the operator is directed to check and see if automatic RCS depressurization is required. Automatic depressurization system (ADS) actuation is required if core makeup tank (CMT) level cannot be maintained above the first stage ADS actuation setpoint or if RCS hot leg level is low. If ADS actuation is required, then the operator verifies that the first three ADS stages have operated successfully. The second and third stage ADS are actuated after a time delay.

If ADS is actuated, (or if CMT level is approaching the first stage ADS setpoint) the operator is directed to align the normal residual heat removal system to inject the in-containment refueling water storage tank (IRWST) to the RCS to prevent, the need for, fourth stage ADS actuation. The normal residual heat removal system provides injection into the RCS from the IRWST at about 100 psig. This injection stops the CMT injection and prevents the fourth stage ADS valves from being actuated. This feature prevents containment pressurization and flooding. Therefore, at this time if ADS is actuated, the normal residual heat removal system is aligned from the IRWST to inject into the RCS.

ACTIONS:

- Determine if ADS should be actuated
- Determine if CMT level is less than (L01)%
- Determine if RCS hot leg level is greater than (L32)% [(L33)% for adverse containment]
- Determine if (T01) seconds have elapsed from first stage ADS signal
- Determine if (T02) seconds have elapsed from second stage ADS signal
- Verify actuation of first three ADS stages
- Manually open first, second and third stage ADS valves
- Align normal residual heat removal system to inject into RCS
- Manually align valves as necessary

INSTRUMENTATION:

Indication for:

- CMT level
- RCS hot leg level
- ADS actuation
- ADS valve position
- ADS isolation valve position
- Normal residual heat removal system suction valve position
- Normal residual heat removal system discharge valve position
- Normal residual heat removal system pump status indication

STEP 7 (Cont.)

CONTROL/EQUIPMENT:

Controls for:

- ADS valves
- ADS isolation valves
- Normal residual heat removal system suction valve
- Normal residual heat removal system discharge valve
- Normal residual heat removal system pump

KNOWLEDGE:

N/A

ADDITIONAL INFORMATION:

- (L01) CMT low level ADS actuation
- (T01) Time delay for second stage ADS actuation
- (T02) Time delay for third stage ADS actuation
- (L32) RCS hot leg level greater than bottom of hot leg for normal containment conditions
- (L33) RCS hot leg level greater than bottom of hot leg for adverse containment conditions
- Include additional details for valve alignments in EOPs such as verifying the closure of ADS discharge header drain isolation valves
- The operator must manually block the containment isolation signal to the RNS containment isolation valves prior to aligning the system for injection

STEP 8

STEP: Check If Passive Containment Cooling Should Be Stopped

PURPOSE: To stop passive containment cooling if operating and no longer needed

BASIS:

Passive containment cooling (PCS) is actuated on the containment PCS actuation pressure (HI-2 containment pressure). In AE-0, AP600 REACTOR TRIP OR SAFETY INJECTION, the operator verifies that PCS is operating if required. During a LOCA, the need for continued PCS operation is monitored by this step. After containment pressure is reduced below the containment pressure to terminate PCS, it is reset so that it can be stopped to prevent passive containment cooling water storage tank depletion. If after PCS reset, the containment pressure increases above the containment PCS actuation setpoint, PCS should automatically actuate. In addition, the ORANGE path of the Containment Status Tree sends the operator to AFR-Z.1, AP600 RESPONSE TO HIGH CONTAINMENT PRESSURE. Step 3 of AFR-Z.1 checks the need for PCS and verifies that PCS is operational if required.

ACTIONS:

- Determine if passive containment cooling is operating
- Determine if containment pressure is less than (P10) psig
- Reset passive containment cooling signal
- Stop passive containment cooling and place in standby

INSTRUMENTATION:

Indication for:

- PCS isolation valve position
- Containment pressure
- PCS Reset status

CONTROL/EQUIPMENT:

Controls for:

- PCS reset
- PCS isolation valves

KNOWLEDGE:

This step is a continuous action step. If PCS reactuates after it was stopped, the operator should leave it in service until the containment fan coolers are running and can maintain containment conditions.

ADDITIONAL INFORMATION:

(P10) Containment pressure to terminate PCS

STEP 9

STEP: Check RCS And SG Pressures

PURPOSE: To determine if the passive safety systems termination criteria should be rechecked

BASIS:

Since guideline AE-1 is used to recover from both a LOCA and secondary side break, a second check on SG pressures is necessary in case there is a faulted SG which was not fully depressurized at the time the passive safety systems termination criteria were checked. A check on RCS pressure is also necessary in case the SG pressures are stable and there is a faulted SG which is depressurizing at the time the passive safety systems termination criteria were checked. If there is a faulted SG which is still depressurizing in an uncontrolled manner or if the RCS pressure is increasing, the operator is directed to return to Step 1, since the initial steps in AE-1 should be rechecked. Eventually, the faulted SG will blow down to atmospheric pressure and dry out, RCS pressure will stabilize or increase, and all passive safety systems termination criteria in AE-1 should be met. If the operator proceeds past this step in AE-1 with a depressurizing SG, the operator could be directed to AES-1.2, AP600 POST LOCA COOLDOWN AND DEPRESSURIZATION, and encounter more restrictive passive safety systems termination criteria than necessary.

ACTIONS:

- Determine if both SG pressures are stable or increasing
- Determine if RCS pressure is stable or decreasing

INSTRUMENTATION:

Indication for:

- SG pressure
- RCS pressure

CONTROL/EQUIPMENT:

N/A

KNOWLEDGE:

- With a LOCA and no faulted SG, the SG pressure could be decreasing slightly. This is considered a "stable" SG pressure. This step addresses the presence of a secondary side break in which the faulted SG is still depressurizing in an uncontrolled manner. If this is the case, the passive safety systems termination criteria may not be met when the check is encountered, and the operator should return to Step 1 in AE-1. The operator should proceed to AES-1.2 until all SG pressures have been stabilized or are increasing and RCS pressure has stabilized or is decreasing.

- "Uncontrolled" means not under the control of the operator, and incapable of being controlled by the operator using available equipment.

ADDITIONAL INFORMATION:

N/A

BACKGROUND INFORMATION

FOR

AP600

EMERGENCY RESPONSE GUIDELINE

AES-1.1

AP600 PASSIVE SAFETY SYSTEMS TERMINATION

Rev. 3

May 31, 1997

STEP 7

STEP: Realign Other Components To Pre-SI Configuration

PURPOSE: To realign systems to their pre-safety injection configuration

BASIS:

Since the passive safety systems are being terminated, other systems/components that are actuated on a safety injection signal are realigned to their pre-safety injection actuation configuration

ACTIONS:

Realign other systems/components (actuated on a safety injection signal) to their pre-safety injection configuration

INSTRUMENTATION:

Instrumentation for other systems/components (actuated on a safety injection signal) needed to support realignment to the pre-safety injection configuration

CONTROL/EQUIPMENT:

Controls for other systems/components (actuated on a safety injection signal) needed to support realignment to the pre-safety injection configuration

KNOWLEDGE:

N/A

ADDITIONAL INFORMATION:

N/A

STEP 8

STEP: Check If Passive Containment Cooling Should Be Stopped

PURPOSE: To stop passive containment cooling if operating and no longer needed

BASIS:

Passive containment cooling (PCS) is actuated on the containment PCS actuation pressure (HI-2 containment pressure). In AE-0, AP600 REACTOR TRIP OR SAFETY INJECTION, the operator verifies that PCS is operating if required. During a LOCA, the need for continued operation of PCS is monitored by this step. After containment pressure is reduced below the containment pressure to terminate PCS, PCS is reset so that PCS can be stopped to prevent passive containment cooling water storage tank depletion. If, after PCS reset, at any time the containment pressure increases above the containment PCS actuation setpoint, PCS will again automatically actuate. In addition, the ORANGE path of the Containment Status Tree sends the operator to AFR-Z.1, AP600 RESPONSE TO HIGH CONTAINMENT PRESSURE. AFR-Z.1 checks the need for PCS and verifies that PCS is operational if required.

ACTIONS:

- Determine if passive containment cooling is operating
- Determine if containment pressure is less than (P10) psig
- Reset passive containment cooling signal
- Stop passive containment cooling and place in standby

INSTRUMENTATION:

- PCS valve position indication
- Containment pressure indication
- Passive containment cooling reset status indication

CONTROL/EQUIPMENT:

Controls for:

- Passive containment cooling reset
- Passive containment cooling isolation valves

KNOWLEDGE:

This step is a continuous action step. If PCS reactuates after it was stopped, the operator should leave it in service until the containment fan coolers are running and can maintain containment conditions.

ADDITIONAL INFORMATION:

(P10) Containment pressure to terminate PCS

STEP 16

STEP: Verify All ECS AC Busses - ENERGIZED BY OFFSITE POWER

PURPOSE: To verify electrical power supply is available to all essential equipment used in this guideline

BASIS:

If offsite power is lost to any ac electrical bus, manual action may be required to establish an electrical power supply to non-safeguards equipment used during recovery, such as instrument air compressor, PRZR heaters, makeup pumps, etc. If offsite power cannot be restored, essential non-safeguards equipment used in subsequent steps, such as instrument the air compressor, must be loaded on the ac emergency busses.

ACTIONS:

- Determine if all ECS ac busses are powered by offsite power
- Try to restore offsite power to all ECS ac busses
- Load essential equipment on the ECS ac busses

INSTRUMENTATION:

- Diesel-backed bus voltage
- Power supply to diesel-backed busses
- Status indication for equipment to be loaded on the ECS ac busses
- Indication of available diesel capacity

CONTROL/EQUIPMENT:

- Controls to restore offsite power
- Breaker controls for additional equipment to be loaded on the ECS ac busses

KNOWLEDGE:

This step is a continuous action step. Since power to the ECS ac busses could be lost at any time, this step applies throughout the guideline as needed.

PLANT-SPECIFIC INFORMATION:

- Means to restore offsite power
- List of equipment on each service bus which can be loaded on the ECS ac bus, if necessary for recovery

STEP 17 - NOTE

NOTE: RCPs 1A and 1B should be run to provide normal pressurizer spray

PURPOSE: To inform the operator that an RCP should be run in the loops which provides pressurizer spray if possible

BASIS:

Subsequent steps require operator actions to control RCS pressure. The preferred means of control is normal pressurizer spray since this conserves reactor coolant inventory. Since spray line connections are provided in only two loops, the RCPs should be run in those loops, if possible.

In addition, operation of either RCP 1A or RCP 1B precludes the possibility of developing reverse flow through the PRHR HX, which can potentially lead to the degradation of the PRHR as a heat sink. When any RCP is operating, either RCP 1A or 1B shall be operating.

ACTIONS:

N/A

INSTRUMENTATION:

N/A

CONTROL/EQUIPMENT:

N/A

KNOWLEDGE:

N/A

ADDITIONAL INFORMATION:

N/A

STEP 22

STEP: Verify CMT Injection Not Required

PURPOSE: To evaluate plant conditions relative to established criteria, and to reinitiate CMT injection if conditions cannot be maintained

BASIS:

The combination of RCS subcooling and pressurizer level verifies that RCS conditions are under adequate operator control. Loss of control will require injection from the CMTs.

ACTIONS:

- Determine if RCS subcooling based on core exit thermocouples is greater than (S01)°F [(S02)°F for adverse containment]
- Determine if pressurizer level is greater than (L05)% [(L23)% for adverse containment]
- Manually open CMT injection valves

INSTRUMENTATION:

Indication for:

- Core exit thermocouples temperature
- RCS pressure
- Pressurizer level
- CMT injection valves position

CONTROL/EQUIPMENT:

CMT injection valves controls

KNOWLEDGE:

This step is a continuous action step.

ADDITIONAL INFORMATION:

- (S01) Minimum RCS subcooling for normal containment conditions
- (S02) Minimum RCS subcooling for adverse containment conditions
- (L05) Pressurizer low level setpoint for starting RCS makeup for normal containment conditions
- (L23) Pressurizer low level setpoint for starting RCS makeup for adverse containment conditions

STEP 23

STEP: Go To Appropriate Plant Procedure

PURPOSE: To determine the next course of action following recovery from a safety injection

BASIS:

At this point in this guideline, passive safety systems have been terminated, the plant is stabilized and normal control is reestablished. The cause of safety injection actuation should be evaluated and a determination should be made for the next course of action, whether it be a plant cooldown or restart. These subsequent actions are part of the plant procedures and are not part of the Emergency Regulatory Guideline (ERG) set. A transition to the appropriate plant procedure is made at this time.

ACTIONS:

Transfer to appropriate plant procedure

INSTRUMENTATION:

N/A

CONTROL/EQUIPMENT:

N/A

KNOWLEDGE:

Since this guideline terminates safety injection flow and it is possible that the RCS makeup flow is keeping up with a small leak/LOCA, the operator should be aware of symptoms that would indicate that a small leak/LOCA has occurred. Symptoms for a small leak/LOCA could be indicated by performing an RCS inventory balance or by monitoring local area radiation monitors for an increase in activity. If symptoms indicate an RCS leak, then appropriate action should be initiated.

During a prolonged station blackout event, the accident management plan should contain manual procedures to permit manual override of the timer-driven ADS actuation, to be implemented no later than 22 hours following the loss of offsite and onsite AC power. Criteria for manually overriding the timer-driven ADS actuation include that the plant is in a stable condition, with the CMTs full, the pressurizer water level is stable, and the IRWST water level is stable. It is intended that the manual override of the timer-driven ADS actuation would be implemented about 20-22 hours from the start of the event. Loads supplied by the 24-hour battery, including the PMS actuation cabinets would be de-energized at the time of the override decision. This would preserve the battery power of the two electrical divisions powered by the 24-hour battery and these batteries would have at least a two-hour charge for a later ADS actuation, if needed. The operators would continue to monitor plant parameters via instrumentation that is powered from one of the two electrical divisions with 72-hour battery capacity.

STEP 23 (Cont.)

If the event continues beyond 24 hours, the 72-hour batteries allow the operators to monitor the plant parameters to decide if ADS actuation is needed. Since the batteries are conserved, as described above, sufficient power is available for actuation of ADS during the 22-72 hour time frame. After 72 hours, the ancillary diesel generators will allow continued monitoring the plant conditions. If ancillary diesel generators cannot be started, and other ac power sources cannot be brought to the site from other locations, the accident management plan for this beyond design basis scenario should direct the operators to manually actuate the automatic depressurization system while post-accident monitoring capability is still available.

ADDITIONAL INFORMATION:

Appropriate plant cooldown or startup procedure

BACKGROUND INFORMATION

FOR

AP600

EMERGENCY RESPONSE GUIDELINE

AES-1.2

AP600 POST LOSS-OF-COOLANT ACCIDENT

COOLDOWN AND DEPRESSURIZATION

Rev. 3

May 31, 1997

STEP 7 (Cont.)

ADDITIONAL INFORMATION:

- (S01) Minimum RCS subcooling for normal containment conditions
- (S02) Minimum RCS subcooling for adverse containment conditions
- (L07) Pressurizer level on span for normal containment conditions
- (L09) Pressurizer level on span for adverse containment conditions

STEP 8

STEP: Check If ADS Should Be Actuated

PURPOSE: To determine if ADS should be actuated based on prevailing plant conditions

BASIS:

If the operator has progressed to this step, then passive safety systems are still required and the operator is then directed to check if automatic RCS depressurization (ADS) is required. ADS actuation is required if CMT level cannot be maintained above the first stage ADS actuation setpoint, or if RCS hot leg level is low. If ADS actuation is required, then the operator verifies that the first three ADS actuation stages have operated successfully. The second and third stage ADS are actuated after the first stage after a time delay.

If ADS is actuated, or if CMT level is approaching the first stage ADS setpoint, the operator is directed to align the normal residual heat removal system to inject the IRWST to the RCS to prevent the need for fourth stage ADS actuation. The normal residual heat removal system provides injection into the RCS from the IRWST at about 100 psig. This injection stops the CMT injection and prevents the fourth stage ADS actuation valves from being actuated. This feature prevents containment pressurization and flooding. The operator will then continue recovery in AP600 AE-1, loss of reactor or secondary coolant.

ACTIONS:

- Determine if ADS should be actuated
- Determine if CMT level is less than (L01)%
- Determine if RCS hot leg level is greater than (L32)% [(L33)% for adverse containment]
- Determine if (T01) seconds have elapsed from first stage ADS signal
- Determine if (T02) seconds have elapsed from second stage ADS signal
- Verify actuation of first three ADS stages was successful
- Manually open first, second and third stage ADS valves
- Align normal residual heat removal system to inject from the IRWST into RCS
- Manually align valves as necessary

INSTRUMENTATION:

Indication for:

- CMT level
- RCS hot leg level
- ADS actuation
- ADS isolation valve position
- Normal residual heat removal system suction valve position
- Normal residual heat removal system discharge valve position
- Normal residual heat removal system pump status

STEP 8 (Cont.)

CONTROL/EQUIPMENT:

Controls for:

- ADS valves
- Normal residual heat removal system suction valves
- Normal residual heat removal system discharge valves
- Normal residual heat removal system pumps

KNOWLEDGE:

N/A

ADDITIONAL INFORMATION:

- (L01) CMT low level ADS actuation
- (T01) Time delay for second stage ADS actuation
- (T02) Time delay for third stage ADS actuation
- (L32) RCS hot leg level greater than bottom of hot legs for normal containment conditions
- (L33) RCS hot leg level greater than bottom of hot legs for adverse containment conditions
- Include additional details for valve alignments in EOPs such as verifying the closure of ADS discharge header drain isolation valves
- The operator must manually block the containment isolation signal to the RNS containment isolation valves prior to aligning the system for injection

STEP 9

STEP: Check If CMT Injection Should Be Isolated

PURPOSE: To isolate CMT injection if proper conditions exist

BASIS:

The CMTs can be isolated if RCS inventory is being maintained by the CVS makeup pumps. Adequate RCS inventory is confirmed by the existence of the combination of RCS subcooling and pressurizer level. The CVS makeup pumps are verified to be operable since a LOCA is in progress and they are needed to maintain RCS inventory when the CMT injection valves are closed.

ACTIONS:

- Determine if RCS subcooling based on core exit thermocouples is greater than (S01)°F [(S02)°F for adverse containment]
- Determine if pressurizer level is greater than (L05)% [(L23)% for adverse containment]
- Close CMT injection valves

INSTRUMENTATION:

Indication for:

- Core exit thermocouples temperature
- RCS pressure
- Pressurizer level
- CMT valve position
- CVS makeup pump status

CONTROL/EQUIPMENT:

Controls for CMT isolation valves

KNOWLEDGE:

N/A

ADDITIONAL INFORMATION:

- (S01) Minimum RCS subcooling for normal containment conditions
- (S02) Minimum RCS subcooling for adverse containment conditions
- (L05) Pressurizer low level setpoint for starting RCS makeup for normal containment conditions
- (L23) Pressurizer low level setpoint for starting RCS makeup for adverse containment conditions

STEP 12 - NOTE

NOTE: RCPs 1A and 1B should be run to provide normal PRZR spray

PURPOSE: To inform the operator that an RCP should be run in the loops which provide pressurizer spray if possible

BASIS:

Subsequent steps require operator actions to control RCS pressure. The preferred means of control is normal pressurizer spray since this conserves reactor coolant inventory. Since spray line connections are provided in only two loops, the RCPs should be run in those loops.

In addition, operation of either RCP 1A or RCP 1B precludes the possibility of developing reverse flow through the PRHR HX, which can potentially lead to the degradation of the PRHR as a heat sink. When any RCP is operating, either RCP 1A or 1B shall be operating.

ACTIONS:

N/A

INSTRUMENTATION:

N/A

CONTROL/EQUIPMENT:

N/A

KNOWLEDGE:

N/A

ADDITIONAL INFORMATION:

N/A

STEP 12

STEP: Check If RCPs Should Be Started

PURPOSE: To establish forced coolant flow, if possible

BASIS:

RCP operation is preferred to provide normal pressurizer spray and to provide homogeneous fluid temperatures and boron concentrations. This step establishes conditions for starting an RCP to prevent RCP damage and minimize any perturbations in RCS conditions. These conditions include RCS subcooling to prevent cavitation at the pump suction during startup, and pressurizer level to minimize changes in RCS pressure and to provide reactor coolant inventory trends. Normal RCP startup requirements, such as RCP cooling, should also be enforced to prevent pump damage.

Depressurization of the RCS may generate a steam bubble in the upper head region of the reactor vessel, if no RCP is running. This bubble could rapidly condense during pump startup, drawing liquid from the pressurizer and reducing reactor coolant subcooling. If pressurizer inventory is not sufficient, level may decrease offspan. In addition, local flashing of reactor coolant could occur if RCS subcooling is not adequate.

If all RCPs are stopped, and cannot be started, the operator should monitor system conditions to verify natural circulation flow. Conditions indicative of natural circulation are outlined in Attachment A and include RCS subcooling, stable or decreasing core exit thermocouples, and cold leg temperatures in the active loops, approximately equal to saturation at the associated steam generator pressure.

ACTIONS:

- Check RCP status
- Check RCS subcooling
- Check pressurizer level
- Establish conditions for starting an RCP
- Start RCPs
- Stop all but RCP 1A and 1B
- Increase steam flow from intact SGs

INSTRUMENTATION:

Indication for:

- Pressurizer level
- RCP status
- RCP support conditions status
- RCS subcooling
- Core exit thermocouple temperature
- Wide range RCS pressure
- RCS loop flow
- RCS hot leg temperature
- RCS cold leg temperature

STEP 17

STEP: Check If Passive Containment Cooling Should Be Stopped

PURPOSE: To stop passive containment cooling if operating and no longer needed

BASIS:

Passive containment cooling (PCS) is actuated on the containment PCS actuation pressure (HI-2 containment pressure). In AE-0, AP600 REACTOR TRIP OR SAFETY INJECTION, the operator verifies that PCS is operating if required. During a LOCA, this step monitors the need for continued operation of PCS. After containment pressure is reduced below the containment pressure to terminate PCS, PCS is reset so that it can be stopped to prevent passive containment cooling water storage tank depletion. If, after PCS reset, the containment pressure increases above the containment PCS actuation setpoint, PCS should automatically actuate. In addition, the ORANGE path of the Containment Status Tree sends the operator to AFR-Z.1, AP600 RESPONSE TO HIGH CONTAINMENT PRESSURE. AFR-Z.1 checks the need for PCS and verifies that PCS is operational.

ACTIONS:

- Determine if passive containment cooling is operating
- Determine if containment pressure is less than (P10) psig
- Reset passive containment cooling signal
- Stop passive containment cooling and place in standby

INSTRUMENTATION:

- PCS valve position indication
- Containment pressure indication
- Passive containment cooling reset status indication

CONTROL/EQUIPMENT:

Controls for:

- Passive containment cooling reset
- Passive containment cooling isolation valves

KNOWLEDGE:

This step is a continuous action step. If PCS reactuates after it was stopped, the operator should leave it in service until the containment fan coolers are running and can maintain containment conditions.

ADDITIONAL INFORMATION:

(P10) Containment pressure to terminate PCS

STEP 18

STEP: Check If Source Range Detectors Should Be Energized

PURPOSE: To verify that source range detectors are energized when the core neutron flux is in the source range

BASIS:

When intermediate range flux decreases below the intermediate range permissive to block source range high flux trip (P-6), the source range detectors should be automatically energized, and subsequent flux monitoring should use the source range indication.

ACTIONS:

- Check intermediate range flux
- Energize source range detectors

INSTRUMENTATION:

- Intermediate range flux
- Source range count rate

CONTROL/EQUIPMENT:

Source range high voltage control

KNOWLEDGE:

N/A

ADDITIONAL INFORMATION:

(V02) Intermediate range permissive to block source range high flux trip (P-6)

BACKGROUND INFORMATION

FOR

WESTINGHOUSE OWNERS GROUP

EMERGENCY RESPONSE GUIDELINE

AE-3

AP600 STEAM GENERATOR TUBE RUPTURE

Rev. 3

May 31, 1997

STEP 3

STEP: Check Ruptured SGs Level

PURPOSE:

- To reduce feedwater flow to the ruptured SGs to make it easier for the operator to use feedwater flow later in the recovery
- To establish and maintain a water level in the ruptured SGs above the top of the U-tubes in order to promote thermal stratification to prevent ruptured SG depressurization

BASIS:

Following a steam generator tube rupture (SGTR), primary-to-secondary leakage into the affected SG will exceed steam flow and lead to an accumulation of water in the SG. Automatic isolation of feedwater flow occurs when the SG narrow range level reaches the HI-2 setpoint (note that CVS flow is also isolated on this signal). Manually isolating feedwater flow before the SG level reaches the HI-2 setpoint will make it easier for the operator to use feedwater flow later in the recovery to refill the ruptured SG (during the backfill process), to maintain level in the intact SG, and to control pressurizer level using the CVS pumps. If water level reaches the HI-2 setpoint, SFW and CVS flow isolation is verified.

It is important to maintain the water level in the ruptured SG above the top of the U-tubes. When the primary system is cooled in subsequent steps, the SG tubes in the ruptured SG will approach the temperature of the reactor coolant. If the steam space in the ruptured SG expands to contact these colder tubes, condensation will occur which would decrease the ruptured SG pressure. As previously demonstrated, this would reduce the reactor coolant subcooling margin and/or increase primary-to-secondary leakage, possibly delaying safety injection termination or causing safety injection reinitiation. Consequently, the water level must be maintained above the top of the tubes to insulate the steam space. In addition to insulating the steam space, this ensures a secondary side heat sink in the event that no intact SG is available and also provides protection against misdiagnosis of the ruptured SG due to an imbalance of feedwater flow.

ACTIONS:

- Check ruptured SG narrow range level
- Close feedwater flow control valves
- Verify CVS makeup pumps are stopped
- Verify CVS makeup line isolated

INSTRUMENTATION:

Indication for:

- SG narrow range level
- Feedwater flow
- Feedwater flow control valves position
- CVS makeup pump status
- CVS makeup valve position

STEP 3 (Cont.)

CONTROL/EQUIPMENT:

Controls for:

- Feedwater flow control valves
- CVS makeup pumps
- CVS makeup valves

KNOWLEDGE:

- The operator should stop feedwater flow as early as permitted to minimize the potential for a HI-2 SG level signal.

- In most cases, the ruptured SG level will continue to increase even after feedwater flow has been completely terminated. However, for some multiple failure events, such as an unisolable SGTR (i.e., ruptured SG cannot be isolated from any intact SG), level may decrease during RCS cooldown due to steaming. Consequently, level in the ruptured SG should be monitored periodically to ensure that it remains above the tubes unless the ruptured SG is also faulted. In addition to ensuring heat sink if no intact SG is available, radiological releases are also minimized.

ADDITIONAL INFORMATION:

- (L03) SG level above U-tubes for normal containment conditions
- (L04) SG level above U-tubes for adverse containment conditions

STEP 6

STEP: Check If PRHR Should Be Isolated

PURPOSE: To isolate PRHR if proper conditions exist

BASIS:

If PRHR is in operation, it can be isolated if a heat sink is available. Startup feedwater in operation and narrow range level in the intact SG ensures that a secondary heat sink is available.

ACTIONS:

- Determine if startup feedwater is in operation
- Determine if intact SG narrow range level greater than (L03)% ([L04]) for adverse containment
- Close PRHR isolation valves

INSTRUMENTATION:

- Startup feedwater pump status indication
- Narrow range level indication for each SG
- PRHR isolation valves position indication

CONTROL/EQUIPMENT:

PRHR isolation valves controls

KNOWLEDGE:

N/A

ADDITIONAL INFORMATION:

- (F01) Feedwater flow to remove decay heat at 10 minutes
- (L03) SG level above U-tubes for normal containment conditions
- (L04) SG level above U-tubes for adverse containment conditions
- Section 3 of the Adverse Systems Interaction report (WCAP-14477) should be referred to for additional insights when writing EOPs

STEP 7

STEP: Check Intact SG Levels

PURPOSE:

- To control feedwater flow to the intact SGs to prevent excessive RCS cooldown and SG overfill
- To maintain an adequate secondary side heat sink
- To identify a previously undetected SG tube failure which could potentially result in SG overfill

BASIS:

In most cases, feedwater flow will exceed steam flow from the intact SGs resulting in an accumulation of water in the SGs. This excess feedwater flow will also result in a cooldown of the RCS at a rate dependent upon the feedwater flow rate and heat generation rate in the primary system. Consequently, feedwater flow must be adjusted to control SG level and reactor coolant temperature. This step also provides for monitoring level in the intact SGs to detect multiple or subsequent tube failures. In that case, the operator is returned to Step 1 to isolate the affected SG and repeat the recovery actions.

If reactor trip occurs from a high power level, the water level may shrink below the narrow range so that temporarily no reliable indication of SG water level is available. During this time, feedwater flow should be maintained greater than (F01) to ensure an adequate secondary side heat sink. This minimum feedwater flow requirement satisfies the feedwater flow requirement of the Heat Sink Status Tree until level in at least one SG is restored into the narrow range. The control range ensures adequate inventory with level readings on span.

ACTIONS:

- Check narrow range levels of intact SGs
- Throttle feedwater flow control valves

INSTRUMENTATION:

Indication for:

- SG narrow range level
- Feedwater flow
- Feedwater flow control valves position

CONTROL/EQUIPMENT:

Feedwater flow control valves

STEP 12

STEP: Depressurize RCS To Refill PRZR

PURPOSE: To restore pressurizer level

BASIS:

Following a loss of reactor coolant event, pressurizer level will most likely be offscale low. To restore the level, which provides a direct indication of reactor coolant inventory trends when used in combination with RCS subcooling, one must decrease RCS pressure using pressurizer pressure control. Auxiliary spray is the preferred means for decreasing RCS pressure since it provides the best pressure control. If auxiliary spray is not available, the pressurizer first stage ADS valves provide an alternative means to decrease RCS pressure. When level returns on span, RCS depressurization is stopped to prevent filling the pressurizer with water.

The tube rupture analyses have demonstrated that pressurizer level will continue to increase after the depressurization is stopped due to backfill from the ruptured SG. Therefore, if auxiliary spray is used to restore level, it will be automatically isolated once pressurizer level reaches 20% if the CVS pumps are in automatic control.

ACTIONS:

- Open the pressurizer ADS valves
- Spray pressurizer with auxiliary spray
- Determine if pressurizer level is on span

INSTRUMENTATION:

Indication for:

- Pressurizer level
- Pressurizer ADS valve position
- Auxiliary spray valve position

CONTROL/EQUIPMENT:

- Pressurizer ADS valves
- Auxiliary spray valves

KNOWLEDGE:

- Auxiliary spray may still be used (i.e., the CVS pump would be operated in manual mode) if pressurizer level is above 20% if letdown is available.

ADDITIONAL INFORMATION:

- (L07) Pressurizer level just on span
- (L09) Pressurizer level just on span with adverse containment errors

STEP 13

STEP: Check If ADS Should Be Actuated

PURPOSE: To determine if ADS should be actuated based on prevailing plant conditions

BASIS:

ADS is required if CMT level cannot be maintained above the first stage ADS actuation setpoint or if RCS hot leg level is low. If ADS is required, then the operator verifies that the first three ADS stages have operated successfully. The second and third stage ADS are actuated after the first stage after a time delay.

If ADS is actuated, the operator is directed to verify that the normal residual heat removal system is aligned to inject the IRWST to the RCS to prevent, if possible, fourth stage ADS actuation. The normal residual heat removal system provides injection into the RCS from the IRWST at about 100 psig. This injection stops the CMT injection and prevents the fourth stage ADS valves from being actuated. This feature prevents containment pressurization and flooding. Therefore, at this time if ADS is actuated, the normal residual heat removal system is verified that its aligned from the IRWST to inject into the RCS.

If ADS is actuated, the operators will go to AP600 AE-1, loss of reactor or secondary coolant for further recovery since the primary system will be depressurized.

ACTIONS:

- Determine if ADS should be actuated
- Determine if CMT level is less than (L01)%
- Determine if RCS hot leg level is greater than (L32)
- Determine if (T01) seconds have elapsed from first stage ADS signal
- Determine if (T02) seconds have elapsed from second stage ADS signal
- Verify actuation of first three ADS stages was successful
- Manually open first, second and third stage ADS valves
- Verify normal residual heat removal system aligned to inject into RCS
- Establish normal residual heat removal system injection into RCS
- Manually align valves as necessary

INSTRUMENTATION:

Indication for:

- CMT level
- RCS hot leg level
- ADS actuation
- ADS isolation valve position
- Normal residual heat removal system valves position
- Normal residual heat removal system pumps status

STEP 13 (Cont.)

CONTROL/EQUIPMENT:

- Manual ADS valve controls
- Controls for normal residual heat removal system valves
- Normal residual heat removal system pump controls

KNOWLEDGE:

N/A

ADDITIONAL INFORMATION:

- (L01) CMT low level ADS actuation
- (T01) Time delay for second stage ADS actuation
- (T02) Time delay for third stage ADS actuation
- (L32) RCS hot leg level greater than bottom of hot legs for normal containment conditions
- (L33) RCS hot leg level greater than bottom of hot legs for adverse containment conditions
- Include additional details for valve alignments in EOPs such as verifying the closure of ADS discharge header drain isolation valves
- The operator must manually block the containment isolation signal to the RNS containment isolation valves prior to aligning the system for injection

STEP 14

STEP: Check If CMT Injection Should Be Isolated

PURPOSE: To isolate CMT injection if proper conditions exist

BASIS:

For a normal tube rupture, primary-to-secondary leakage should be terminated by this point of the recovery. The CMTs tend to hamper additional recovery actions by unnecessarily adding inventory to the RCS. The addition of this inventory will limit the backfill of the ruptured SG (which also adds inventory to the RCS) since the only means of removing this inventory is by letdown and shrinkage due to cooldown.

If the RCS is subcooled and pressurizer level is on span, the CMTs are no longer required and can be isolated. Note that if a failure occurs after the CMTs are isolated that requires CMT flow to be reestablished, the outlet valves will automatically open on a pressurizer level signal. Also, the next step in this guideline provides criteria for reestablishing CMT injection if subcooling is lost or the pressurizer level falls offscale low.

ACTIONS:

- Determine if ADS is actuated
- Determine if RCS subcooling based on core exit thermocouples is greater than (S01)°F [(S02)°F for adverse containment]
- Determine if pressurizer level is greater than (L05)% [(L23)% for adverse containment]
- Close CMT injection valves

INSTRUMENTATION:

Indication for:

- ADS valve position
- RCS subcooling
- Pressurizer level
- CMT valve position

CONTROL/EQUIPMENT:

CMT isolation valves controls

KNOWLEDGE:

N/A

STEP 18 - NOTE

NOTE: RCPs 1A and 1B should be run to provide normal PRZR spray

PURPOSE: To inform the operator that an RCP should be run in loops 1A and 1B to provide pressurizer spray

BASIS:

Subsequent steps require operator actions to control RCS pressure. The preferred means of control is normal pressurizer spray since this conserves reactor coolant inventory. An RCP should be run in one of the loops with spray line connections, if possible.

In addition, operation of either RCP 1A or RCP 1B precludes the possibility of developing reverse flow through the PRHR HX, which can potentially lead to the degradation of the PRHR as a heat sink. When any RCP is operating, either RCP 1A or 1B shall be operating.

ACTIONS:

N/A

INSTRUMENTATION:

N/A

CONTROL/EQUIPMENT:

N/A

KNOWLEDGE:

If an RCP in a loop with a ruptured SG is started, steam flow from that SG via a secondary side break will increase. Although this may increase radiological releases due to steam relief, it will also reduce accumulation of water in the SG and decrease the possibility of overfill. Consequently, for such multiple failure events in which SG overfill appears imminent, starting an RCP in the affected loop may be beneficial.

ADDITIONAL INFORMATION:

Which RCPs can provide spray and the preferred order of operation

STEP 18

STEP: Check If An RCP Should Be Started

PURPOSE: To establish forced coolant flow, if possible

BASIS:

RCP operation is preferred to provide normal pressurizer spray and to ensure homogeneous fluid temperatures and boron concentrations. This step provides guidance on establishing conditions for starting an RCP to prevent RCP damage and minimize any perturbations in RCS conditions. These include RCS subcooling to prevent cavitation at the pump suction during startup and pressurizer level to minimize changes in RCS pressure and provide reactor coolant inventory trends. Normal RCP startup requirements, such as RCP cooling, should also be enforced to prevent pump damage.

If all RCPs are stopped and none can be started, the operator should monitor system conditions to verify natural circulation flow. The conditions indicative of natural circulation are provided as Attachment A and include RCS subcooling, stable or decreasing core exit thermocouples, and cold leg temperatures in the active loops approximately equal to saturation at the associated SG pressure. The cold leg temperature may be less than the saturation at the associated SG pressure due to PRHR operation or due to colder CVS flow entering the cold leg loop upstream of the temperature instrumentation.

ACTIONS:

- Check RCP status
- Check RCS subcooling
- Check pressurizer level
- Establish conditions for starting an RCP
- Start one RCP
- Stop all but one RCP
- Increase steam flow from intact SGs

INSTRUMENTATION:

Indication for:

- Pressurizer level
- RCP status
- RCP support conditions status
- RCS subcooling
- Core exit thermocouples
- Wide range RCS pressure
- RCS loop flow
- RCS hot leg temperature
- RCS cold leg temperature

STEP 21

STEP: Check If Passive Containment Cooling Should Be Stopped

PURPOSE: To stop passive containment cooling if operating and no longer needed

BASIS:

Passive containment cooling system (PCS) is actuated on the containment PCS actuation pressure (HI-2 containment pressure). In AE-0, AP600 REACTOR TRIP OR SAFETY INJECTION, the operator verifies that PCS is operating if required. During a LOCA, the need for continued operation of PCS is monitored by this step. After containment pressure is reduced below the containment pressure to terminate PCS, PCS is reset so that PCS can be stopped to prevent PCS water storage tank depletion. If, after PCS reset, at any time the containment pressure increases above the containment PCS actuation setpoint, PCS should again automatically actuate. In addition, the ORANGE path of the Containment Status Tree sends the operator to AFR-Z.1, AP600 RESPONSE TO HIGH CONTAINMENT PRESSURE. Step 3 of AFR-Z.1 checks the need for PCS and verifies that PCS is operational if it's required. .

ACTIONS:

- Determine if passive containment cooling is operating
- Determine if containment pressure is less than (P10) psig
- Reset passive containment cooling signal
- Stop passive containment cooling and place in standby

INSTRUMENTATION:

- PCS valve position indication
- Containment pressure indication
- Passive containment cooling reset status indication

CONTROL/EQUIPMENT:

Controls for:

- Passive containment cooling reset
- Passive containment cooling isolation valves

KNOWLEDGE:

This step is a continuous action step. If PCS reactuates after it was stopped, the operator should leave it in service until the containment fan coolers are running and can maintain containment conditions.

ADDITIONAL INFORMATION:

(P10) Containment pressure to terminate PCS

STEP 22

STEP: Minimize Secondary System Contamination

PURPOSE: To minimize the spread of contamination throughout the secondary system

BASIS:

Prior to isolation of the ruptured SG, steam flow from that SG may have contaminated the secondary including the condenser hot well and the blowdown system. Additional steps to minimize the spread of this contamination should be considered, including isolating recirculation from the hot well to the condensate storage tank, bypassing the condensate polishing demineralizers, and transferring auxiliary steam to the auxiliary boiler.

ACTIONS:

Specific actions to minimize secondary system contamination

INSTRUMENTATION:

N/A

CONTROL/EQUIPMENT:

Specific controls and equipment to minimize secondary system contamination

KNOWLEDGE:

N/A

ADDITIONAL INFORMATION:

Specific details regards means to reduce secondary system of contamination

AP600 Emergency Response Guidelines
Background Information

List of Affected Pages for Revision 3

Background Book 2

Document	Page	Section(s)
AFR-S.1	2-7	editorial change, top of page
	2-8, 2-9	page rollovers
AFR-C.1	4-10	Actions
	4-11	Additional Information
AFR-C.2	4-10	Actions
	4-11	Additional Information
AFR-H.1	4-27	Actions
	4-28	Additional Information
AFR-H.3	4-7	Step, Purpose, Actions
AFR-I.1	4-3	page deleted
	4-4	Purpose, Basis, Actions, Instrumentation, Knowledge
	4-5	Basis
	4-9	Step, Basis, Actions, Instrumentation, Control/Equipment

AP600

Emergency Response Guidelines

AP600 Document Number GW-GJR-100

Background Information

Book 2

Revision 3

May 31, 1997

BACKGROUND INFORMATION

FOR

AP600

EMERGENCY RESPONSE GUIDELINE

AFR-S.1

AP600 RESPONSE TO NUCLEAR POWER GENERATION/ATWS

Rev. 3

May 31, 1997

Case 1 assumes that DAS only is used to mitigate an ATWS event. PRHR is automatically actuated on low SG wide range level, and after 10 minutes, the operator manually actuates the CMTs via the DAS. Ten minutes is a reasonable time for the operator to initiate actions to achieve subcriticality and is consistent with time frames used for previous Westinghouse designs. The major assumptions for Case 1 are as follows:

1. The transient is initialized from nominal full power conditions.

2. A range of conditions was considered, and it was determined that the physics parameters at the beginning of life for the equilibrium cycle were the most limiting with respect to achieving subcriticality. The critical parameters are the high initial RCS boron concentration (1611 ppm) and the low boron worth. The effects of these two parameters on minimizing shutdown margin outweigh the effect that a more negative moderator temperature coefficient (MTC) at end of life conditions has on increasing positive reactivity insertion during the cooldown phase.

3. The MTC used in the analysis is -7.3 pcm/°F. This value gives a peak RCS pressure of approximately 3200 psig during the ATWS. This value was determined for the analysis in Reference 1, which was performed at beginning of life Cycle 1 conditions (limiting for the short term pressure transient). Due to the difference in physics parameters at beginning of life for the equilibrium cycle, the peak RCS pressure is somewhat less than 3200 psig for this case.

4. The ANS-5.1-1979 decay heat model (+ 2 sigma) is used.

5. Both pressurizer safety valves are available. The relief model assumes 3 percent and 10 percent pressure accumulation for steam and water relief. The AP600 does not have pressurizer power-operated relief valves.

6. Main feedwater supply to both SGs falls to zero in 4 seconds, with no main feedwater afterwards.

7. The DAS actuates PRHR on the wide-range SG low-level signal. The analysis setpoint is assumed to be conservatively low, and, therefore, delays actuation.

8. DAS setpoints are typically set so that the DAS functions include delays that allow time for the PMS function to actuate. Since a conservatively low DAS wide-range SG level setpoint is assumed for this analysis, no additional delay on this signal is assumed.

9. The turbine trips 4.0 seconds after the wide-range SG low level DAS setpoint is reached.

10. The PRHR valves are assumed to be fully opened 10 seconds after the low wide-range SG level setpoint is reached. The PRHR heat exchanger is assumed operable, and nominal heat transfer is assumed.

11. The design value of 40 percent steam dump to the condenser is modeled for conservatism.

12. Steam line isolation, which would actuate on the low steam line pressure "S" signal, is conservatively assumed unavailable due to the common mode failure in the PMS. Steam line isolation has a negligible effect on the longterm transient.

13. Startup feedwater is unavailable.

14. Following turbine trip, steam relief through the spring-loaded steam line safety valves is assumed if the steam line pressure exceeds the safety-valve setpoint (1100 psia) with a 3 percent allowance for accumulation.

15. Automatic CMT actuation is not modeled for this case. During the transient, the low steam line pressure "S" signal is generated by PMS, but the resulting CMT actuation and reactor coolant pump (RCP) trip signals are assumed to fail due to the common mode electrical failure. Instead, the operator is assumed to manually actuate the CMTs after 10 minutes via the DAS. Both CMTs are assumed operable; nominal values are assumed for initial CMT boron concentration (3300 ppm), enthalpy (69.0 Btu/lbm), and flow resistances.

If the reactor trip failure is due to either a mechanical failure or an electrical failure of the reactor trip portion of the PMS, the PMS provides additional protection features. Specifically, one feature which would still be available is automatic CMT actuation/RCP trip on the low steam line pressure "S" signal. For Case 2, only the CMT actuation/RCP trip function is credited from the PMS. All other assumptions for Case 2 are identical to that of Case 1. This case demonstrates the differences in plant behavior if the PMS functions properly. Turbine trip and steam line isolation would also be provided by the PMS before the DAS signal is reached. These functions have a significant beneficial effect on the short term pressure transient, but have a negligible effect on the long term transient. Thus, these analyses do not focus on the effects of earlier CMT actuation/RCP trip.

2.4.4 Results

Case 1

Transient plots of interest include RCS pressure (Figure 2-1), pressurizer water volume (Figure 2-2), RCS temperature (Figure 2-3) and total core reactivity (Figure 2-4). The sequence of events for Case 1 is provided in Table 2-1. For this case, a common-mode failure of the entire PMS is assumed, so only the DAS is credited. The DAS provides turbine trip at 76 seconds and PRHR

actuation at 82 seconds on the low SG level (wide-range) signal. The CMTs are assumed to be manually actuated by the operator via DAS 10 minutes after initiation of the event.

The RCS pressure for Case 1 is shown in Figure 2-1. As shown in Figures 2-1 and 2-3, the RCS initially heats up and pressurizes due to loss of normal feedwater. The turbine trip, PRHR actuation, and inherent reactivity feedback effects prevent the RCS from overpressurizing in the short term. For this case, pressure reaches 3079 psia shortly before secondary dryout occurs. Note that for the Reference 1 short term ATWS analysis, which uses beginning of life cycle 1 fuel data, RCS pressure reaches a maximum value of 3198 psia. The reactivity feedback (Figure 2-4) reduces the power level significantly, and within the first few minutes, the heat removal from actuation of the PRHR exceeds the core heat flux. Actuation of the PRHR continues to cool the RCS which produces positive reactivity insertion. The RCS begins to heat up again and repressurize. The heatup process generates negative reactivity feedback, which reduces power, and this oscillatory process continues until the CMTs are manually actuated after 10 minutes via the DAS.

The steam dump functions of the main steam system and plant control system maintains no-load T_{AVG}, by removing steam and reducing secondary side pressure significantly during the initial heatup phase. The RCPs are automatically tripped upon CMT actuation, and flow is reduced to natural circulation conditions.

TABLE 2-1
TIME SEQUENCE OF EVENTS FOR THE LONG TERM LOSS OF NORMAL FEEDWATER ANTICIPATED TRANSIENT WITHOUT SCRAM EVENT CASE 1: CORE MAKEUP TANKS MANUALLY ACTUATED AFTER TEN MINUTES VIA DIVERSE ACTUATION SYSTEM

Event	Time (Sec)
Main feedwater supply to all SGs is terminated	0-4
Low SG water level (narrow range) reactor trip PMS setpoint reached (failure of rod insertion assumed)	45
Low steam line pressure "S" PMS setpoint reached (signal ignored for Case 1)	60
Pressurizer safety valves open	63
Low SG water level (wide range) DAS setpoint reached	72
SG tubes uncovered	74
Turbine trip assumed to occur on DAS generated signal	76
Passive residual heat exchanger valves opened on DAS generated signal	82
Pressurizer fills with water	97
Peak RCS pressure is reached (3079 psia)	115
SG dryout	147
Pressurizer safety valves reseat	182
Pressurizer regains steam space	249
Reactor is brought subcritical for remainder of transient	548
CMTs are assumed to be manually actuated via the DAS	600
RCPs tripped automatically upon CMT actuation	603
Pressurizer safety valves reopen	3396
Pressurizer fills with water	6656
Transient terminated	7200

BACKGROUND INFORMATION

FOR

AP600

EMERGENCY RESPONSE GUIDELINE

AFR-C.1

AP600 RESPONSE TO INADEQUATE CORE COOLING

Rev. 3

May 31, 1997

STEP 8 - CAUTION

CAUTION: If IRWST level decreases to less than (L11), normal residual heat removal system alignment to the containment sump should be verified

PURPOSE: To ensure coolant flow to the core by switching to normal residual heat removal system recirculation if the IRWST level decreases below the switchover setpoint

BASIS:

If the switchover level in the IRWST is reached, the operator should verify that passive core cooling has transferred to passive recirculation to maintain coolant flow to the core. When IRWST level decreases to (L11), the isolation valves in the passive core cooling system recirculation lines open to provide a continuous supply of injection. The recirculation lines provide safety-related long term core cooling. If available, the normal residual heat removal system pumps can also take suction from the recirculation lines and supplement passive recirculation core cooling.

ACTIONS:

Determine if IRWST level decreases to less than (L11)

INSTRUMENTATION:

IRWST level indication

CONTROL/EQUIPMENT:

N/A

KNOWLEDGE:

The operator is expected to know the alternate functions of the normal residual heat removal system, passive core cooling system recirculation alignment in this case, as it applies to this caution.

ADDITIONAL INFORMATION:

(L11) Enter specific value corresponding to IRWST recirculation line alignment setpoints.

STEP 8

STEP: Depressurize RCS To Inject IRWST

PURPOSE: To depressurize the RCS using ADS so that IRWST injection can take place to provide core cooling

BASIS:

The IRWST provides safety-related low pressure injection into the RCS for emergency core cooling purposes. At this point in AFR-C.1, the higher pressure injection sources are inadequate for mitigating the inadequate core cooling condition. Therefore, the RCS is depressurized using ADS which provides controlled RCS depressurization, allowing passive IRWST injection to occur.

The normal residual heat removal system has alignment capability for injecting the IRWST into the RCS. This action supplements the safety-related passive IRWST injection as described in the previous paragraph. Also, the CAUTION for this step alerts the operator to switch over the normal residual heat removal system to recirculation if/when the switchover setpoint is reached in the IRWST.

ACTIONS:

- Actuate ADS
- Manually open first stage ADS valves if necessary
- Check if second stage ADS valves are open
- When (T01) seconds has elapsed after first stage valve opening, manually open second stage valves
- Check if third stage ADS valves are open
- When (T02) seconds have elapsed after second stage valve opening, manually open third stage valves
- Align normal residual heat removal system to inject into RCS
- Actuate fourth stage ADS if normal residual heat removal system injection cannot be established
- Manually align valves as necessary

INSTRUMENTATION:

Indication for:

- ADS actuation status (PMS and DAS)
- ADS isolation valves position
- Normal residual heat removal system valve position
- Normal residual heat removal system RNS status

CONTROL/EQUIPMENT:

- Manual ADS actuation (PMS and DAS)
- Normal residual heat removal system valves controls
- Normal residual heat removal system pumps controls

STEP 8 (Cont.)

KNOWLEDGE:

If the "normal" protection system is unsuccessful in actuating or opening the ADS isolation valves, the operator should be aware that DAS contains provisions for manually actuating ADS or opening the ADS isolation valves from the DAS panel.

ADDITIONAL INFORMATION:

- (T01) Enter time delay for second stage ADS actuation
- (T02) Enter time delay for thid stage ADS actuation
- Include additional details for valve alignments in EOPs such as verifying the closure of ADS discharge header drain isolation valves
- The operator must manually block the containment isolation signal to the RNS containment isolation valves prior to aligning the system for injection

STEP 9

STEP: Check Core Exit TCs

PURPOSE: To check if core exit thermocouple temperatures still indicate an inadequate core cooling condition

BASIS:

The trend in core exit thermocouple temperatures is used to check the effectiveness of emergency core cooling on restoring adequate core cooling. If temperature is decreasing, no further action may be necessary.

If core exit thermocouple temperatures are less than 900°F plus adverse containment errors or 1200°F, whichever is greater, emergency core cooling has been successful. This step will transfer the operator to the guideline and step in effect.

If core exit thermocouple temperatures are greater than 900°F plus adverse containment errors or 1200°F, whichever is greater, and not decreasing, then this guideline must be continued to perform the alternative actions for restoring adequate core cooling.

ACTIONS:

- Determine if core exit thermocouple temperatures are less than 900°F plus adverse containment errors or 1200°F, whichever is greater
- Determine if core exit thermocouple temperatures are decreasing
- Return to guideline and step in effect

INSTRUMENTATION:

Core exit thermocouple temperature indication and trending

CONTROL/EQUIPMENT:

N/A

KNOWLEDGE:

N/A

ADDITIONAL INFORMATION:

The temperatures discussed in the BASIS section above may change depending on specific post accident transmitter errors.

BACKGROUND INFORMATION

FOR

AP600

EMERGENCY RESPONSE GUIDELINE

AFR-C.2

AP600 RESPONSE TO DEGRADED CORE COOLING SHOCK

Rev. 3

May 31, 1997

STEP 6 - CAUTION

CAUTION: If IRWST level decreases to less than (L11), RNS alignment to the containment sump should be verified.

PURPOSE: To ensure coolant flow to the core by switching to normal residual heat removal system recirculation if the IRWST level decreases below the switchover setpoint

BASIS:

If the switchover level in the IRWST is reached, which could happen at any time during the course of guideline AFR-C.2 depending upon the amount of RCS inventory losses, the operator should immediately verify that passive core cooling has transferred to passive recirculation to maintain coolant flow to the core. When IRWST level decreases to (L11), there should be sufficient water available in the safety injection recirculation sump to switch the suction supply of the normal residual heat removal system to the containment sump to supplement passive recirculation core cooling to the core.

ACTIONS:

Determine if IRWST level decreases to less than (L11)

INSTRUMENTATION:

IRWST level indication

CONTROL/EQUIPMENT:

N/A

KNOWLEDGE:

The operator is expected to know the alternate functions of the normal residual heat removal system (i.e., safety injection recirculation alignment in this case) as it applies to this caution step.

ADDITIONAL INFORMATION:

(L11) Enter specific value corresponding to IRWST switchover setpoint in plant specific units.

STEP 6

STEP: Depressurize RCS To Inject IRWST

PURPOSE: To depressurize the RCS using ADS so that IRWST injection can take place to provide core cooling

BASIS:

The IRWST provides low pressure injection into the RCS for emergency core cooling purposes. At this point in AFR-C.2, the higher pressure injection sources have been determined to be inadequate for mitigating the inadequate core cooling condition. Therefore the RCS is depressurized using ADS which provides controlled RCS depressurization thereby allowing passive IRWST injection to occur.

The normal residual heat removal system has alignment capability for injecting the IRWST into the RCS. This action supplements the safety-related passive IRWST injection as described in the previous paragraph. Also, the CAUTION for this step alerts the operator to switch over the normal residual heat removal system to recirculation if/when the switchover setpoint is reached in the IRWST.

ACTIONS:

- Actuate ADS
- Manually open first stage ADS valves if necessary
- Check if second stage ADS valves are open
- When (T01) seconds has elapsed after first stage valve opening, manually open second stage valves
- Check if third stage ADS valves are open
- When (T02) seconds has elapsed after second stage valve opening, manually open third stage valves
- Align normal residual heat removal system to inject into RCS
- Actuate fourth stage ADS if normal residual heat removal system cannot be aligned to inject
- Manually align valves as necessary

INSTRUMENTATION:

Indication for:

- ADS actuation status (PMS and DAS)
- ADS isolation valves position
- Normal residual heat removal system valve position
- Normal residual heat removal system status

CONTROL/EQUIPMENT:

- Manual ADS actuation (PMS and DAS)
- Normal residual heat removal system valves controls
- Normal residual heat removal system pumps controls

STEP 6 (Cont.)

KNOWLEDGE:

If the "normal" protection system is unsuccessful in actuating or opening the ADS isolation valves, the operator should be aware that the DAS has provisions for manually actuating ADS or manually opening the ADS isolation valves from the DAS panel.

ADDITIONAL INFORMATION:

- (T01) Enter specific time delay for second stage ADS actuation
- (T02) Enter specific time delay for third stage ADS actuation
- Include additional details for valve alignments in EOPs such as verifying the closure of ADS discharge header drain isolation valves
- The operator must manually block the containment isolation signal to the RNS containment isolation valves prior to aligning the system for injection.

STEP 7

STEP: Check Core Cooling

PURPOSE: To check if core cooling has been restored

BASIS:

The trends in core exit thermocouple temperatures and RCS hot leg level are used to check the effectiveness of RCS makeup and/or emergency core cooling (CMTs, accumulators and IRWST) in restoring core cooling. If the trend in core exit thermocouple temperatures is decreasing and RCS hot leg level is increasing, then no further action may be necessary. The operator is instructed to return to Step 1 and repeat the initial guideline steps until the core exit thermocouple temperatures are less than 670°F plus adverse containment errors or 700°F, whichever is greater, and hot leg level is greater than the bottom of the RCS hot legs.

If core exit thermocouple temperatures are less than 670°F plus adverse containment errors or 700°F, whichever is greater, and RCS hot leg level is greater than the bottom of the hot leg, then RCS makeup and/or emergency core cooling (CMTs, accumulators and IRWST) has been successful in restoring RCS inventory and core cooling. This step will transfer the operator to the guideline and step in effect.

If core exit thermocouple temperatures are greater than 670°F plus adverse containment errors or 700°F, whichever is greater, and not decreasing, and hot RCS leg level is less than the bottom of the hot leg, then the operator must continue with this guideline to perform the alternative actions for restoring core cooling.

ACTIONS:

- Determine if core exit thermocouple temperatures are less than 670°F plus adverse containment errors or 700°F, whichever is greater
- Determine if core exit thermocouple temperatures are decreasing
- Determine if RCS hot leg level is greater than (L32) [(L33) for adverse containment]
- Return to guideline and step in effect
- Return to Step 1 if inadequate core cooling indicated

INSTRUMENTATION:

Indication for:

- Core exit thermocouple temperature
- RCS hot leg level

BACKGROUND INFORMATION

FOR

AP600

EMERGENCY RESPONSE GUIDELINE

AFR-H.1

AP600 RESPONSE TO LOSS OF HEAT SINK

Rev. 3

May 31, 1997

STEP 12

STEP: Establish RCS Bleed Path

PURPOSE: To verify that an effective high pressure bleed path is established after establishing the high pressure RCS feed path

BASIS:

For the bleed path to be effective, the operator should ensure that the ADS actuation valves are properly aligned. The operator should manually align valves, if necessary, to establish an effective RCS bleed path. The operator should attempt to maximize RCS feed flow as this will maximize RCS bleed and feed heat removal effectiveness.

ACTIONS:

- Actuate ADS
- Manually open first stage ADS actuation valves if necessary
- Check if second stage ADS actuation valves are open
- When (T01) seconds has elapsed after first stage valve opening, manually open second stage valves
- Check if third stage ADS actuation valves are open
- When (T02) seconds has elapsed after second stage valve opening, manually open third stage valves
- Align normal residual heat removal system to inject into the RCS
- Actuate fourth stage ADS if normal residual heat removal system injection cannot be established
- Manually align valves as necessary

INSTRUMENTATION:

Indication for:

- ADS actuation status (PMS and DAS)
- ADS actuation isolation valves position
- Normal residual heat removal system valve position
- Normal residual heat removal system status

CONTROLS:

- Manual ADS actuation (PMS and DAS)
- Normal residual heat removal system valves controls
- Normal residual heat removal system pumps controls

KNOWLEDGE:

If the "normal" protection system is unsuccessful in actuating or opening the ADS actuation isolation valves, the operator should be aware that the DAS has provisions for manually actuating ADS actuation or manually opening the ADS actuation isolation valves from the DAS panel.

STEP 12 (Cont.)

ADDITIONAL INFORMATION:

- (T01) Enter specific time delay for second stage ADS actuation.
- (T02) Enter specific time delay for third stage ADS actuation.
- Include additional details for valve alignments in EOPs such as verifying the closure of ADS discharge header drain isolation valves
- The operator must manually block the containment isolation signal to the RNS containment isolation valves prior to aligning the system for injection

BACKGROUND INFORMATION

FOR

AP600

EMERGENCY RESPONSE GUIDELINE

AFR-H.3

AP600 RESPONSE TO STEAM GENERATOR HIGH LEVEL

Rev. 3

May 31, 1997

STEP 3

STEP: Verify SFW Flow To Affected SG(s) - Isolated

PURPOSE: To verify isolation of startup feedwater flow which is a potential source of water overfilling the affected SGs

BASIS:

Startup feedwater flow isolation to the affected SGs allows the operator to minimize further level increases. Startup feedwater flow can still be maintained to the unaffected SGs to control plant conditions.

ACTIONS:

Verify isolation of startup feedwater flow to affected SGs

INSTRUMENTATION:

Startup feedwater flow indication

CONTROL/EQUIPMENT:

Startup feedwater flow valve controls

KNOWLEDGE:

N/A

ADDITIONAL INFORMATION:

N/A

STEP 4

STEP: Check Affected SG Level

PURPOSE: To evaluate the effects of main FW and SFW isolation actions

BASIS:

The operator should continue to monitor affected SG narrow-range level to determine if level is decreasing. If level is less than the value corresponding to SG level at the upper tap and decreasing, operator actions have been successful. The operator then controls startup feedwater flow to maintain narrow-range level in the normal operating band and transfers back to the guideline in effect to continue plant recovery. If level is still above the upper tap value or level is not decreasing, the operator is directed to Steps 6 through 8 where the affected SGs are isolated and evaluated for a possible tube failure.

ACTIONS:

- Determine if affected SG narrow range level is less than (L27)% [(L28)% for adverse containment]
- Determine if affected SG narrow range level is decreasing
- Control startup feedwater flow to maintain narrow range level between (L03)% [(L04)% for adverse containment] and 50%
- Return to guideline and step in effect

INSTRUMENTATION:

- SG narrow range level indication
- Startup feedwater flow indication

CONTROL/EQUIPMENT:

Startup feedwater flow control valve controls

KNOWLEDGE:

N/A

ADDITIONAL INFORMATION:

- (L27) Enter specific value corresponding to SG level at the upper tap, including allowances for normal channel accuracy.
- (L28) Enter specific value corresponding to SG level at the upper tap, including allowances for normal channel accuracy, post accident transmitter errors, and reference leg process errors.
- (L03) Enter specific value showing SG level in the narrow range, including allowances for normal channel accuracy.
- (L04) Enter specific value showing SG level in the narrow range, including allowances for normal channel accuracy, post accident transmitter errors, and reference leg process errors, not to exceed 50%

BACKGROUND INFORMATION

FOR

AP600

EMERGENCY RESPONSE GUIDELINE

AFR-I.1

AP600 RESPONSE TO HIGH PRESSURIZER LEVEL

Rev. 3

May 31, 1997

THIS PAGE WAS DELETED FOR REVISION 3

STEP 2

STEP: Check RCS Makeup Status

PURPOSE: To determine if RCS makeup pumps have stopped

BASIS:

The RCS makeup pumps receive a "stop" signal on high pressurizer level. The operator should check that they have stopped and, if not, stop them.

ACTIONS:

- Determine if RCS makeup pumps are stopped
- Stop all makeup pump

INSTRUMENTATION:

Indications for:

- Makeup pumps status

CONTROL/EQUIPMENT:

Makeup pump controls

KNOWLEDGE:

N/A

ADDITIONAL INFORMATION:

N/A

STEP 3

STEP: Check Letdown - IN SERVICE

PURPOSE: To determine whether letdown is in service and, if not, to establish a controlled bleed path from the RCS

BASIS:

Letdown provides a controlled mechanism for offsetting RCS inventory additions through the makeup system. It also supplies high temperature RCS water for heating the normal makeup flow in the regenerative heat exchanger. To establish stable conditions and control pressurizer level in subsequent steps, letdown should be established. To establish letdown cooling to the regenerative heat exchanger must be established. This can be done by running RCPs or starting RCS makeup. The preferred method should be inserted in the EOPs.

Establishing RCS makeup is not desired since pressurizer level is high and the makeup pumps are automatically stopped. If no cooling to the regenerative heat exchanger can be established then normal letdown should not be established. Reactor head vent flow should be established to provide a bleed path to aid in responding to high pressurizer level conditions.

ACTIONS:

- Determine if letdown is in service
- Determine if letdown cannot be established
- Establish letdown
- Establish reactor head vent flow

INSTRUMENTATION:

Instrumentation for establishing:

- Letdown (valve position indication for letdown isolation valves and letdown flow indication)
- Reactor head vent flow (reactor head vent isolation valve position indication)

CONTROL/EQUIPMENT:

Controls for establishing:

- Letdown (letdown isolation valve)
- Reactor head vent flow (reactor head vent isolation valve)

KNOWLEDGE:

If excessive activity levels in the RCS are suspected, then an evaluation of the consequences of establishing letdown should be made prior to taking that action.

ADDITIONAL INFORMATION:

- Preferred sequence of actions for establishing letdown
- Preferred sequence of actions for establishing reactor head vent flow

STEP 4

STEP: Check PRZR Pressure

PURPOSE: To verify that pressurizer pressure is below the normal spray setpoint pressure

BASIS:

It is necessary to reduce the pressurizer pressure below the normal spray setpoint so that in later steps when pressurizer heaters are energized any possible increase in pressure will not actuate pressurizer spray.

ACTIONS:

- Determine if pressurizer pressure is less than (P02) psig
- Control makeup and letdown flow as necessary to decrease pressurizer pressure to less than (P02) psig

INSTRUMENTATION:

Indications for:

- Pressurizer pressure
- Makeup flow
- Letdown flow

CONTROL/EQUIPMENT:

Controls for:

- Makeup flow
- Letdown flow

KNOWLEDGE:

N/A

ADDITIONAL INFORMATION:

(P02) Pressurizer spray valve closure setpoint

STEP 7

STEP: Control Letdown As Necessary To Maintain RCS Pressure Stable

PURPOSE: To hold RCS pressure constant while pressurizer heaters increase the pressurizer fluid temperature

BASIS:

Letdown is adjusted as required to maintain a constant RCS pressure. This action together with the energized pressurizer heaters will cause a steam bubble to form and/or grow in the pressurizer.

ACTIONS:

Control letdown flow as necessary to maintain stable RCS pressure

INSTRUMENTATION:

Indication for:

- RCS pressure
- Letdown flow

CONTROL/EQUIPMENT:

Controls for:

- Letdown flow

KNOWLEDGE:

N/A

ADDITIONAL INFORMATION:

N/A

STEP 8

STEP: Check PRZR Level - LESS THAN (L24)%

PURPOSE: To determine from pressurizer level indication that a bubble is present in the pressurizer

BASIS:

Once the pressurizer level is below the high level reactor trip setpoint, the pressurizer bubble has been reestablished and the pressurizer level is considered to be in the acceptable range. The operator is instructed to continue to maintain the RCS pressure stable and the pressurizer heaters energized until pressurizer level is less than the high level reactor trip setpoint.

ACTIONS:

Determine if pressurizer level is less than (L24)%

INSTRUMENTATION:

Pressurizer level indication

CONTROL/EQUIPMENT:

N/A

KNOWLEDGE:

N/A

ADDITIONAL INFORMATION:

(L24) Pressurizer high level reactor trip setpoint