Draft Submittal
(Pink Paper)

Reactor Operator Written Exam

CATAWBA
2007-301

Catawba Nuclear Station
2007 NRC Exam
Reactor Operator

Question 1

Bank Question: 07-01 ***Answer: A***

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1 Pt(s) Which one of the following statements correctly identifies and supports the basis for verifying a reactor trip in EP/1/A/5000/E-0 (Reactor Trip or Safety Injection)?

A. The safeguards systems that protect the plant during accidents are designed assuming only decay heat and pump heat are being added to the reactor coolant system.

B. Subcriticality is the highest priority critical safety function and is addressed as the first step of this procedure

C. Without a reactor trip, plant safety limits will be exceeded which will ultimately result in endangering the health and safety of the public.

D. Without a reactor trip, a transition to EP/1/A/5000/FR-S.1 (Response to Nuclear Power Generation/ATWS) must immediately occur to provide acceptable consequences for the limiting core over-power event.

Distracter Analysis:

A. **Correct:**

B. **Incorrect:**
Plausible: While this is a correct statement in and of itself, it does not provide the basis for the given step.

C. **Incorrect:**
Plausible: This is a possible outcome of not ensuring the reactor is tripped but does not provide the basis for the given step.

D. **Incorrect**:
Plausible: In general this statement is correct but does not provide the basis for the given step.

Level: RO

K/A: EPE: 007 Reactor Trip EK3 Knowledge of the reasons for the following as they apply to a reactor trip: (CFR 41.5 /41.10 / 45.6 / 45.13) EK3.01 Actions contained in EOP for reactor trip. ... 4.0 4.6

Lesson Plan Objective: EP113 Explain the Bases, including any identified knowledges/abilities, for all of the steps, notes, and cautions in EP/1/A/5000/E-0 (Reactor Trip or Safety Injection).

Source: BANK (Point Beach 2002)

Level of knowledge: Memory

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Question 1

References:
1.
2. EBG\E-0

STEP 2: Verify Reactor Trip:

PURPOSE:

To ensure that the reactor has tripped.

APPLICABLE ERG BASIS:

Reactor trip must be verified to ensure that the only heat being added to the NC System is from decay heat and reactor coolant pump heat. The safeguards systems that protect the plant during accidents are designed assuming that only decay heat and NC pump heat are being added to the NC System. If the reactor cannot be tripped, a transition is made to FR-S.1 (Response To Nuclear Power Generation/ATWS), to deal with ATWS conditions.

Immediate actions are those actions which the operator should be able to perform before opening and reading his emergency procedures. In general, immediate actions are limited to the verification of automatic protection features of the plant. Although the immediate actions should be memorized by the operator, they need not be memorized verbatim. The operator should know them well enough to complete the intent of each step, which is to verify that the automatic actions have occurred. The order in which they should be performed should also be consistent with the step sequence requirements, i.e., the order of Steps 2 through 5 are important.

In the ERGs, the purpose of this step, is to ensure that the reactor has tripped so that only decay heat and reactor coolant pump heat are being added to the reactor coolant system. The typical indications used to confirm a reactor trip are control rod position, reactor trip and bypass breaker position, and neutron flux. Since all three are expected to be in their post-trip position, they are checked in the Action/Expected Response column. If any of the three indications are not indicating reactor trip, the operator enters the RNO column and manually trips the reactor. The operator must then make a decision if the reactor has tripped (i.e., only decay heat and NC pump heat is being added to the NC System). If all instruments indicate a reactor trip except one reactor trip breaker, then the reactor is tripped and the intent of the step is met. The operator would proceed to the next step in E-0. If by looking at his instrumentation the operator determines that the reactor has not tripped, he would transfer to FR-S.1, ATWS. This procedure would direct him to manually insert the control rods, trip the turbine, and emergency borate the NC System. The key to the intent of this step, is that the operator interprets that the reactor has tripped, therefore the intent of the step is met (DW-88-033).

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Previous utility members have raised questions concerning CSF usage when exiting to FR-S.1. The following response to DW-90-026 provides the expectation of CSF usage when transitioning to FR-S.1:

- As stated in the Users Guide for the Emergency Response Guidelines, the operator should begin to monitor the status trees when he is directed by the action step after the diagnostics steps in E-0 or he makes any transition to another procedure from E-0.

- The intent of the status trees and FRGs is to provide the operator with direction for prioritizing and selecting actions for accidents beyond the design basis. If the accident remains within the plant design basis, the operator should be able to perform the actions of E-0 which consists of verification of the automatic actions and diagnosis of the appropriate optimal recovery procedure. If an accident beyond the design basis were to occur, the ERGs provide actions prioritized to minimize the consequences of that accident, for example the case of an ATWS. If an ATWS were to occur, it would be appropriate for the operator to begin monitoring the status trees and implementing the FRGs when a transition is made from E-0 to FR-S.1 to address an ATWS event. This is appropriate because the ATWS, being a beyond a design basis event, can create plant conditions which are no longer typical of the design basis conditions that are assumed for the background of the actions in E-0. An ATWS event can cause the steam generators to dry out in a few seconds with or without auxiliary feedwater available while the E-0 action addressing heat sink assumes a certain amount of time is available before bleed and feed actions are necessary if auxiliary feedwater is not operating. That is one example of why the rules of usage direct the initiation of status tree monitoring and FRG implementation once the first transition is made from E-0 even if the operator is directed to return to E-0 after the first FRG he implements.

PLANT SPECIFIC INFORMATION:

A substep in the RNO column is added to start monitoring the Critical Safety Function Status Trees when the transition is made out of the procedure. This is to ensure operating crews consistently monitor the Critical Safety Function Status Trees in accordance with the rules of usage described in the ERG Executive Volume.

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KNOWLEDGE/ABILITY:

The operating crew should conform to the following guidelines in relation to performing the immediate actions of E-0 and FR-S.1 during an ATWS event (PPRB EP/1/A/5000/2A1, 03/19/94):

a. After attempting to manually trip the reactor and determining that the reactor will not trip, the OATC should announce to the crew that an ATWS is in progress.

b. The OATC and the BOP shall then begin to perform the immediate actions of FR-S.1.

c. The procedure reader shall read Steps 1 and 2 of E-0 to verify that the transition was correctly implemented.

d. The procedure reader shall transition to FR-S.1 and begin reading the immediate actions to verify that they were correctly completed.

The Operator should be aware that DRPI indication may not present (such as in the case of Loss of Offsite Power, prior to implementation of Mods to provide battery powered backup). Under this condition, the operating crew shall transition to the RNO and evaluate the status of the reactor as described in "APPLICABLE ERG BASIS" above.

2007 CNS NRC RO Exam Reference List

1) TS 3.1.7

3.1 REACTIVITY CONTROL SYSTEMS

3.1.7 Rod Position Indication

LCO 3.1.7 The Digital Rod Position Indication (DRPI) System and the Demand Position Indication System shall be OPERABLE.

APPLICABILITY: MODES 1 and 2.

ACTIONS

----------NOTE----------
Separate Condition entry is allowed for each inoperable rod position indicator per group and each demand position indicator per bank.

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. One DRPI per group inoperable for one or more groups.	A.1 Verify the position of the rods with inoperable position indicators by using movable incore detectors. OR A.2 Reduce THERMAL POWER to ≤ 50% RTP.	Once per 8 hours 8 hours
B. One or more rods with inoperable position indicators have been moved in excess of 24 steps in one direction since the last determination of the rod's position.	B.1 Verify the position of the rods with inoperable position indicators by using movable incore detectors. OR B.2 Reduce THERMAL POWER to ≤ 50% RTP.	4 hours 8 hours

(continued)

ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
C. One demand position indicator per bank inoperable for one or more banks.	C.1.1 Verify by administrative means all DRPIs for the affected banks are OPERABLE. AND C.1.2 Verify the most withdrawn rod and the least withdrawn rod of the affected banks are ≤ 12 steps apart. OR C.2 Reduce THERMAL POWER to ≤ 50% RTP.	Once per 8 hours Once per 8 hours 8 hours
D. Required Action and associated Completion Time not met.	D.1 Be in MODE 3.	6 hours

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
SR 3.1.7.1	Verify each DRPI agrees within 12 steps of the group demand position for the full indicated range of rod travel.	Once prior to criticality after each removal of the reactor head

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Question 2

Bank Question: 07-02 ***Answer: B***

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1 Pt(s). A malfunction causes NC PORV 1NC-34A to open. Which of the following describes the effect of this event and how it will be automatically mitigated?

A. The PZR Pressure Master output will increase to ~94% and 1NC-34A will be blocked from opening by the PZR Pressure Master.

B. The PZR Pressure Master output will increase to ~94% and 1NC-34A will be blocked from opening by PZR Pressure Channel 4.

C. The PZR Pressure Master output will decrease to ~40% and 1NC-34A will be blocked from opening by the PZR Pressure Master.

D. The PZR Pressure Master output will decrease to ~40% and INC-34A will be blocked from opening by PZR Pressure Channel 4.

Distracter Analysis:

A. **Incorrect:**
Plausible: The master output does increase but the PORV, while actuated by the master, is blocked by channel 4 at 2185 psig.

B. **Correct:**

C. **Incorrect:**
Plausible: The master does control the PORV on opening but does not control the block. The master going down with pressure decreasing is intuitively obvious but incorrect.

D. **Incorrect:**
Plausible: The block is correct but the master going down with pressure decreasing is intuitively obvious but incorrect.

Level: RO

K/A: APE: 008 Pressurizer (PZR) Vapor Space Accident (Relief Valve Stuck Open AK2. Knowledge of the interrelations between the Pressurizer Vapor Space Accident and the following: (CFR 41.7 / 45.7) AK2.03 Controllers and positioners ... 2.5 2.4

Lesson Plan Objective: IPE08 List the nominal value for the alarms and control functions generated by the Pressurizer pressure master controller, assuming the controller is set for 2235 psig

Source: NEW

Level of knowledge: Memory

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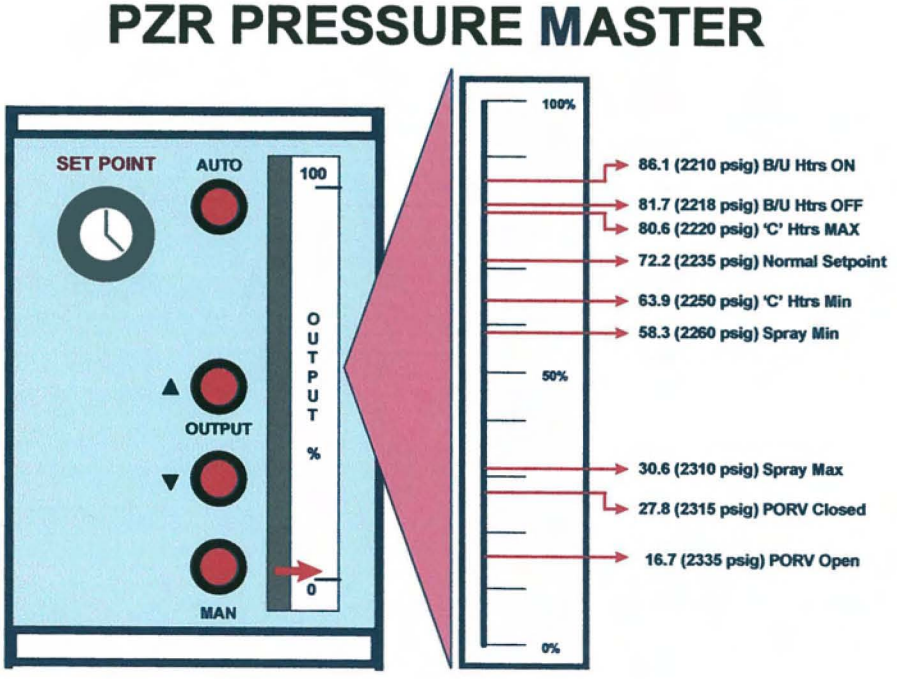
Question 2

References:
1. IPE lesson
2.

2. Channel 2
   - Channel normally selected as B/U Channel via 3 Position Selector Switch
3. Channel 3
   - Can be selected as Controlling Channel
   - Functions as Lo Press Block for PORV 32-36 (2185)
4. Channel 4
   - Can be selected as B/U Channel
   - Functions as Lo Press Block for PORV 34 (2185)
5. Controlling Channel (Channel 1 or 3)
   - Inputs PZR Press master to control the following:
   a) PZR Htrs
   b) PZR Sprays
   c) PORV NC-34 actuation
   d) Hi and Lo Press Deviation Alarms
6. Backup Channel
   a) Sends actuating signal for opening of PORV 32 and 36 (0pen 2335/Close 2315)

C. Pressure Controller (PZR pressure master) (**OBJ. #8**)



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Question 3

Bank Question: 07-03 ***Answer: B***

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1 Pt(s). A small LOCA has occurred on Unit 1. The following plant conditions are noted:

- Reactor is tripped.
- SI has actuated.
- All S/G Levels = 35%
- CA flow to each S/G = 200 gpm
- NC Temperatures:
  - A Tave = 564 deg F
  - B Tave = 565 deg F
  - C Tave = 566 deg F
  - D Tave = 565 deg F
- The Feedwater Isolation status lights (1SI-5) are lit.
- Annunciator 1AD-3 C/6 CF ISOL TRN A is lit.
- Annunciator 1AD-3 D/6 CF ISOL TRN B is lit.
- All other equipment functioned as expected.

What caused the CF Isolation and what is required to reset the CF isolation?

A. CF Isolation was caused by the SI. Reset CF Isolation

B. CF Isolation was caused by the SI. Clear the SI and P-4, then reset CF Isolation.

C. CF Isolation was caused by Lo Tave. Reset CF Isolation.

D. CF Isolation was caused by Lo Tave. Clear the SI and P-4, then reset CF Isolation.

Distracter Analysis:

A. **Incorrect:**
Plausible: CF Isol should have occurred due to the SI , but to reset with an SI must clear both SI and P-4 then reset CF Isolation.

B. **Correct:**

C. **Incorrect:**
Plausible: CF Isol should have occurred due to the SI (not Rx Trip and Lo Tave). To reset with an SI must clear both SI and P-4 then reset CF Isolation. If CF Isolation on Rx Trip Lo Tave then can just reset CF Isol.

D. **Incorrect**:
Plausible: CF Isol should have occurred due to the SI (not Rx Trip and Lo Tave). To reset with an SI must clear both SI and P-4 then reset CF Isolation. If CF Isolation on Rx Trip Lo Tave then can just reset CF Isol.

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Question 3

Level: RO

K/A: EPE: 009 Small Break LOCA EA1 Ability to operate and monitor the following as they apply to a small break LOCA: (CFR 41.7 / 45.5 / 45.6) EA1.13 ESFAS .. . 4.4 4.4

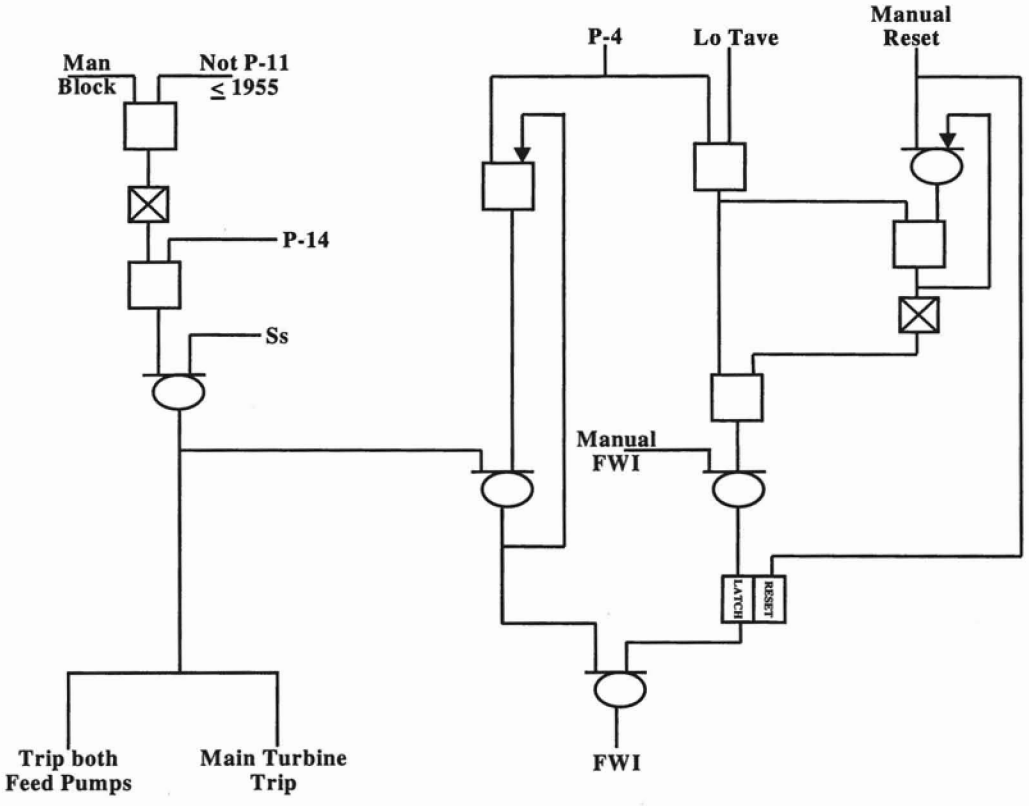
Lesson Plan Objective: ISE 04 List all the Engineered Safeguards Signals with their setpoints, logic and interlocks and ISE 05 Describe how each ESF Signal is reset.

Source: NEW

Level of knowledge: comprehension

References:
1. ISE Lesson.
2.

Feedwater Isolation



F. Feedwater Isolation

1. 4 signals can actuate Feedwater Isolation

   a) Manual

      1) One pushbutton per train: INITIATE and RESET on the same switch. Indication of initiate and reset.

      2) Either pushbutton (Train A or B) will send a feed water isolation signal to close all valves associated with feed water isolation.

      3) Unit 1 Initiate Lights and Unit 2 Initiate Lights will light for both manual and automatic actuation.

   b) S_S Signal

      1) Train A or B S_S will cause an entire Feedwater Isolation.

      2) With an S_S signal present, CF isolation CANNOT BE RESET.

   c) P-14 (Hi-Hi S/G LEVEL): 2/4 S/G Levels on any ONE S/G.

      1) Unit 1 – greater than or equal to 83.9%.

      2) Unit 2 – greater than or equal to 77%

3) With Hi-Hi S/G LEVEL or Ss Signal present, CF ISOLATION CANNOT BE RESET.

4) CF Isolation on P-14 can be blocked using the train related key switch when:

(a) Less than P-11 (1955 psig)

(b) In mode 4, 5 or 6

d) Low Tave coincident with Rx Trip

1) 2/4 Tave channels less than or equal to 564°F AND P-4 (Rx trip)

2) Alarm on AD3 for CF Isolation.

2. An annunciator on AD3 CF ISOL TRN A (B) is actuated by any CF Isolation.

3. Reset (on same switch as Initiate)

a) To reset CF Isolation following an Ss signal or P-14:

1) The S_S signal AND P-14 must be cleared; AND

2) The P-4 signal must be cleared.

b) YOU CAN RESET with the Low Tave and P-4 signal present. These signals (LOW TAVE or P-4) would have to CLEAR and RETURN to initiate another CF Isolation.

4. Indication of CF Isolation is provided by status lights on SI-5 for each S/G.

5. The P-14 signal exists only as long as S/G level is above the setpoint.

a) As soon as S/G level drops below the setpoint the P-14 signal clears.

b) There is no latching bistable for Feedwater Isolation due to P-14 such as exists for 'Manual' and 'Low Tave with P-4'.

c) However, the P-14 signal will initiate a turbine trip and if reactor power is above P-9 (69%) this will cause a reactor trip (P-4). The P-4 signal will 'seal in' the Main Feedwater Isolation. P-9 is Reactor trip on Turbine trip permissive.

d) If less than P-9 but greater than 5% then AP/1 or 2/5500/06 (Loss of Normal Feedwater) will administratively require a reactor trip. The P-4 will then seal in the Main Feed Water Isolation.

e) Individual Tempering Flow to CA Nozzle valves, Containment Isolation valves, Containment Isolation Bypass valves, and CF Bypass to CA Nozzle valves will all reopen if the valve did not reach the fully closed position before the P-14 signal cleared. If the P-14 signal clears after the valves are fully closed, then the valves will remain closed.

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Question 4

Bank Question: 07-04 ***Answer: C***

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1 Pt(s). Given the following:

- A large break LOCA occurred 40 minutes ago.
- All ECCS and ESF equipment functioned as expected.
- All the steps of EP/1/A/5000/ES-1.3 (Transfer to Cold Leg Recirculation) have been completed.
- RCS pressure is 25 psig.
- Containment pressure is 3.2 psig and slowly decreasing.
- Containment radiation is 1.0E+0 R/hr.
- FWST level reads 3%.
- All required systems have been aligned for recirculation.

What is the required status of the following ECCS pumps at the current time?

A. Both trains of ND on in recirculation
NS pumps off

B. One train of ND on in recirculation
One train of ND on in Auxiliary Containment Spray Alignment
NS pumps on

C. Both trains of ND on in recirculation
NS pumps on

D. One train of ND on in recirculation
One train of ND on in Auxiliary Containment Spray Alignment
NS pumps off

Distracter Analysis:

A. Incorrect:
Plausible: ND is correct. The NS pumps will be running with containment pressure greater than 3 PSIG.

B. Incorrect:
Plausible: ND is incorrect, ND containment spray is not aligned until >50 minutes after the event. NS is correct.

C. Correct:

D. Incorrect:
Plausible: ND is incorrect, ND containment spray is not aligned until >50 minutes after the event. The NS pumps will be running with containment pressure greater than 3 PSIG.

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Question 4

Level: RO

K/A: EPE: 011 Large Break LOCA EK2 Knowledge of the interrelations between the following and the following Large Break LOCA: (CFR 41.7 / 45.7) EK2.02 Pumps 2.6* 2.7*

Lesson Plan Objective: EP218 Explain the Bases, including any identified knowledges/abilities, for all of the steps, notes, and cautions in EP/1/A/5000/ES-1.3 (Transfer to Cold Leg Recirculation)

Source: BANK (Kewaunee 2004)

Level of knowledge: comprehension

References:
1.
2. ES-1.3

ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED

8. **Verify criteria for initiation of ND aux containment spray:**

__ a. Containment pressure - GREATER THAN 3 PSIG.

a. Perform the following:

__ 1) **IF AT ANY TIME** containment pressure exceeds 3 PSIG, **THEN** perform Step 8.

__ 2) Observe Caution prior to Step 9 and **GO TO** Step 9.

__ b. Time since reactor trip - GREATER THAN 50 MIN.

b. Perform the following:

__ 1) Designate someone to notify Control Room Supervisor when 50 min from reactor trip has elapsed.

__ 2) **WHEN** the time since reactor trip is greater than 50 min, **THEN** perform Step 8.

__ 3) Observe Caution prior to Step 9 and **GO TO** Step 9.

c. Verify the following valves - CLOSED:

__ • 1NS-43A (ND Pmp 1A To Cont Spray Hdr)

__ • 1NS-38B (ND Pmp 1B To Cont Spray Hdr).

__ c. Observe Caution prior to Step 9 and **GO TO** Step 9.

ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED

1. **Close the following valves:**

   __ • 1NS-20A (NS Pump 1A Suct From FWST)

   __ • 1NS-3B (NS Pump 1B Suct From FWST).

2. **Verify at least one of the following annunciators - LIT:**

   __ • 1AD-20, B/3 "CONT. SUMP LEVEL >3.3 ft"

   OR

   __ • 1AD-21, B/3 "CONT. SUMP LEVEL >3.3 ft".

   Perform the following:

   __ a. **WHEN** at least one "CONT. SUMP LEVEL >3.3 ft" annunciator is LIT, **THEN GO TO** Step 3.

   __ b. Do not continue in this enclosure until at least one annuciator is LIT.

__ 3. **Verify both NS trains - AVAILABLE FOR SERVICE.**

   Perform the following:

   __ a. **IF** NS Train 1A is available, **THEN GO TO** Step 5.

   __ b. **IF** NS Train 1B is available, **THEN GO TO** Step 6.

ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED

4. **Align NS as follows:**

   a. Verify the following valves - OPEN:

   __ • 1NI-185A (ND Pump 1A Cont Sump Suct)
   __ • 1NI-184B (ND Pump 1B Cont Sump Suct).

   a. Perform the following:

   __ 1) **IF** 1NI-185A closed, **THEN GO TO** Step 6.

   __ 2) **IF** 1NI-184B closed, **THEN GO TO** Step 5.

   __ b. Verify 1NS-20A (NS Pump 1A Suct From FWST) - CLOSED.

   __ b. **GO TO** Step 6.

   __ c. Open 1NS-18A (NS Pmp A Suct From Cont Sump).

   __ d. Verify 1NS-3B (NS Pump 1B Suct From FWST) - CLOSED.

   __ d. **GO TO** Step 5.

   __ e. Open 1NS-1B (NS Pmp B Suct From Cont Sump).

   f. Ensure the following valves - OPEN:

   __ • 1NS-29A (NS Spray Hdr 1A Cont Isol)
   __ • 1NS-32A (NS Spray Hdr 1A Cont Isol)
   __ • 1NS-15B (NS Spray Hdr 1B Cont Isol)
   __ • 1NS-12B (NS Spray Hdr 1B Cont Isol).

   __ g. **GO TO** Step 7.

ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED

5. **Align NS Train 1A as follows:**

__ a. Verify 1NI-185A (ND Pump 1A Cont Sump Suct) - OPEN.
__ a. **GO TO** Step 6.

__ b. Verify 1NS-20A (NS Pump 1A Suct From FWST) - CLOSED.
__ b. **GO TO** Step 6.

__ c. Open 1NS-18A (NS Pmp A Suct From Cont Sump).

d. Ensure the following valves - OPEN:

__ • 1NS-29A (NS Spray Hdr 1A Cont Isol)
__ • 1NS-32A (NS Spray Hdr 1A Cont Isol).

__ e. **GO TO** Step 7.

6. **Align NS Train 1B as follows:**

__ a. Verify 1NI-184B (ND Pump 1B Cont Sump Suct) - OPEN.
__ a. **GO TO** Step 5.

__ b. Verify 1NS-3B (NS Pump 1B Suct From FWST) - CLOSED.
__ b. **GO TO** Step 5.

__ c. Open 1NS-1B (NS Pmp B Suct From Cont Sump).

d. Ensure the following valves - OPEN:

__ • 1NS-15B (NS Spray Hdr 1B Cont Isol)
__ • 1NS-12B (NS Spray Hdr 1B Cont Isol).

__ 7. **Verify containment pressure - HAS EXCEEDED 3 PSIG.**
__ **GO TO Step 10.**

ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED
__ 8. **Verify containment pressure - GREATER THAN 1 PSIG.**	**Perform the following:** __ a. Reset NS. __ b. Stop NS pumps. __ c. **GO TO** Step 10.
__ 9. **Ensure NS pump(s) aligned to an open containment sump suction valve - ON.**	
__ 10. **Verify all Unit 1 and Unit 2 RN pumps - ON.**	__ **GO TO Step 12.**

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Question 5

Bank Question: 07-05 ***Answer: B***

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1 Pt(s). With Unit 1 at 25% RTP, the following occurs plant parameters are noted:

Time in hrs.	1340	1342
NCP A Temperatures		
Motor Winding	302	304
Motor Bearing	194	196
Pump Bearing	218	220

Which of the following correctly states the actions and the time the NCP A temperature has exceeded its trip setpoint?

A. 1340 – Manual trip of NCP A and enter AP/1A/5500/004 (Loss of Reactor Coolant Pump). Reactor trip is not required due to being below P-8.

B. 1342 – Manual Reactor trip and manual trip of NCP A and enter EP/1/A/5000/E-0 (Reactor Trip or Safety Injection)

C. 1342 –Manual trip of NCP A and enter AP/1A/5500/004 (Loss of Reactor Coolant Pump). Reactor trip is not required due to being below P-8.

D. 1340 - Manual Reactor trip and manual trip of NCP A and enter EP/1/A/5000/E-0 (Reactor Trip or Safety Injection)

Distracter Analysis:
Per OP/1/A6150/002A (Reactor Coolant Pump Operation)

2.4 The NC Pump shall be stopped if any of the following occur.

NOTE: If in Mode 1 or 2, the Reactor should be tripped manually prior to stopping the NC Pump.

- Any pump bearing exceeds 225°F.
- No. 1 seal outlet temp. reaches 235°F.
- Pump shaft vibration exceeds 20 mils.1
- Any motor bearing exceeds 195°F.
- Motor winding temp. exceeds 311°F.
- Motor frame vibration exceeds 5 mils.
- #1 Seal ΔP decreases to less than 200 psid.

With the unit at 25%, P-7 is active enabling the 2/4 loss of NCP reactor trip but P-8 is not active and the ¼ loss of NCP's trip is not enabled. Thus the loss of one NCP will not cause an automatic reactor trip but admin guidance states if the Unit is in Mode 1 or 2 the reactor should be tripped prior to trip of the NCP. There are no auto NCP trips associated with temperatures.

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Question 5

A. Incorrect:
Plausible: The NC Pump bearing temperature has not yet exceeded its trip set point (195 deg.).

B. Correct:

C. Incorrect:
Plausible: A manual trip of the NC Pump is required but must be performed after a manual reactor trip. P-8, 48% power, is the set-point for an auto reactor trip on 1 loop loss of flow.

D. Incorrect:
Plausible: The NC Pump bearing temperature has not yet exceeded its trip set point (195 deg.) This would be the correct action if the trip set-point had been exceeded.

Level: RO

K/A: APE: 015/017 Reactor Coolant Pump (RCP) Malfunctions AA2. Ability to determine and interpret the following as they apply to the Reactor Coolant Pump Malfunctions (Loss of RC Flow): (CFR: 43.5 / 45.13) AA2.08 When to secure RCPs on high bearing temperature 3.4 3.5

Lesson Plan Objective: NCP12 Evaluate NCP operations including: When immediate trip of the NCP is required)

Source: NEW

Level of knowledge: comprehension

References:
1.OP/1/A/6150/002A
2.

2.4 The NC Pump shall be stopped if any of the following occur.

NOTE: If in Mode 1 or 2, the Reactor should be tripped manually prior to stopping the NC Pump.

- Any pump bearing exceeds 225°F.
- No. 1 seal outlet temp. reaches 235°F.
- Pump shaft vibration exceeds 20 mils.[1]
- Any motor bearing exceeds 195°F.
- Motor winding temp. exceeds 311°F.
- Motor frame vibration exceeds 5 mils.
- #1 Seal ΔP decreases to less than 200 psid.

NOTE: Direct OAC points/indications are **NOT** available for S/G secondary water temperature. If there is CF or SM flow, use associated temperature points from OAC as S/G temperature. If there is no CF/SM flow for a reasonable time (operator judgment), use primary temperature as S/G temperature. If S/Gs are saturated, secondary pressure may be used to get S/G temperature from steam tables. Other indications may also be available.

2.5 A reactor coolant pump shall **NOT** be started with one or more of the NC cold leg temperatures $\leq$ 210°F unless the secondary water temperature of each steam generator is < 50°F above each of the NC cold leg temperatures. (Tech Spec 3.4.6)

2.6 For starting duties of Reactor Coolant Pumps see the OAC Large Motor Restart Monitor (LMR) or The Unit One Revised Data Book, Figure 9 (Permissible Successive Attempts to Start Motors) if the OAC is **NOT** available.

2.7 Simultaneous loss of Thermal Barrier KC and Seal Injection Flow at NC temperatures > 180°F could destroy pump internals. A complete status evaluation and inspection shall be performed prior to restarting affected pumps.

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[1] Pump shaft vibration limit may be increased to 30 mils if the following conditions are met:

- Unit 1 is in Mode 3, 4 or 5,
- Engineering evaluation of operating with increased vibration has been performed, and
- OSM concurs with increasing the limit.

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Question 6

Bank Question: 07-06 ***Answer: A***

---

1 Pt(s). Given the following:

- both units VCT at 50%
- a loss of VCT makeup occurred
- both VCT decrease at the same rate (%/min)

When would each unit, relative to each other, reach the VCT makeup setpoint and the VCT low level alarm?

A. Unit 1 would reach the makeup level first and the VCT low level alarm first.

B. Unit 2 would reach the makeup level first and the VCT low level alarm first.

C. Unit 2 would reach the VCT makeup level first and Unit 1 would reach the low level alarm first

D. Both would reach the makeup level at the same time but Unit 1 would reach the low level alarm first.

Distracter Analysis:
Unit 1 auto makeup =35 %
Unit 2 auto makeup = 32.7%
Unit 1 Low Level alarm = 22.8%
Unit 2 Low Level alarm = 21.3%
Unit 1 Swap to FWST = 4.3%
Unit 2 Swap to FWST = 4%

These differences are because the tanks are not the same size. One tank was damaged during construction and had to be replaced. The size differences do make the tanks have a different gal per % but the question states the levels are decreasing at the same % per minute to account for this difference.

A. **Correct:**

B. **Incorrect:**
Plausible: See above

C. **Incorrect:**
Plausible: See above.

D. **Incorrect**:
Plausible: See above

Level: RO

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Question 6

K/A: APE: 022 Loss of Reactor Coolant Makeup 2.2 Equipment Control 2.2.4 (multi-unit) Ability to explain the variations in control board layouts, systems, instrumentation and procedural actions between units at a facility. (CFR: 45.1 / 45.13) IMPORTANCE RO 2.8 SRO 3.0*

Lesson Plan Objective: NV31 (Describe as-built configuration of level instrumentation and design bases for the Volume Control Tank level, pressure, and temperature limits.)

Source: NEW

Level of knowledge: Memory

References:
1. NV Lesson
2.

c) Provides means of degassing during shutdown. (OBJ. #15) Gases are removed as they come out of solution in the VCT. They are then directed to the WG System.

d) Provides suction head for Charging pumps.

e) Provides level control signals to Rx Makeup System and NV172A flow divert valve to RHT.

f) VCT level channels (Unit 2 setpoints in parenthesis). (OBJ. #16)

Level Channel	Actions and Setpoints
5761	Controls auto makeup 35 % (32.7%) to 52% (49.3%). Modulates NV172 from 75% (70.1%) to 91.4% (85.3%). Input at 4.3% (4%) to swapover to FWST. Need both 5761 and 5760 sensing setpoint to swap over to FWST. Will give hi level alarm at 83.5% (78%) and low level alarm at 22.8% (21.3%) level. Indication on MCB and OAC.
5760	Fully diverts NV172 at 91.4% (85.3%) level. Indicates locally. Input to swapover to FWST (same setpoints as 5761). Gives hi level alarm at 83.5% (78%) and low level alarm at 22.8% (21.3%) level. Indicates on the OAC.
5762 and 5763	Provide indication on ASP-A and ASP-B respectively.

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Question 7

Bank Question: 07-07 ***Answer: D***

---

1 Pt(s). A loss of ND has occurred. Per AP/1/A/5500/019 (Loss of Residual Heat Removal), two operators have been dispatched to throttle open 1FW-27A to gravity feed the NC hot legs.

What is the basis for sending two (2) NLOs?

A. Due to the difficulty of valve operation, local operation of the valve physically requires two (2) individuals per the Catawba Safe Work Practice Manual.

B. Access to 1FW-27A requires use of an extension ladder and per the Catawba Safe Work Practices Manual a second person is required to secure the ladder from movement.

C. The buddy system is required for this task per Site Directive 3.1.2 (Access to Reactor Building and Areas having High Pressure Steam Release Devices)

D. Continuous communication with the control room is required to establish the appropriate flow rate from the FWST to the NC system.

Distracter Analysis:

A. **Incorrect**:
Plausible: Heavy lifting tasks do require 2 individuals if a mechanical device is not used but not manual operation of valves.

B. **Incorrect:**
Plausible: This is a common sense approach to ladder use but an extension ladder is not required for access to 1FW-27A.

C. **Incorrect:**
Plausible: This would be correct if the area of the valve was in the DH, or reactor building.

D. **Correct:** AP/19 specifically requires two NLOs be dispatched with radios.

Level: RO

K/A: APE: 025 Loss of Residual Heat Removal System (RHRS) 2.4.43 Knowledge of emergency communications systems and techniques. (CFR: 45.13) IMPORTANCE RO 2.8 SRO 3.5

Lesson Plan Objective: NONE

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Question 7

Source: NEW

Level of knowledge: Memory

References:
1. AP/19, NSD 700, Work Practice Manual
2.

6. **IF desired to align FWST through ND pump suction nozzles to hot legs for gravity feed, THEN perform the following:**

   a. Ensure at least one set of ND loop suction isolation valves - OPEN:

      • Train A:

      __ • 1ND-2A (ND Pump 1A Suct Frm Loop B)
      __ • 1ND-1B (ND Pump 1A Suct Frm Loop B).

      OR

      • Train B:

      __ • 1ND-37A (ND Pump 1B Suct Frm Loop C)
      __ • 1ND-36B (ND Pump 1B Suct Frm Loop C).

   b. **IF** it is desired to gravity feed using 1FW-27A (ND Pump 1A Suct From FWST), **THEN** dispatch operator to perform the following:

      __ 1) Open breaker 1EMXA-F02B (1A ND Pump Suction From FWST Motor (1FW-27A)) (AB-577, FF-GG, 54, Rm 478).

      2) Establish communications with the Control Room as follows:

         __ a) Dispatch two operators with radios to the 522 elevation.

         __ b) Station one operator at 1FW-27A (ND Pump 1A Suct From FWST) (AB-524, FF-GG, 52-53, Rm 113).

         __ c) Station the second operator at the nearest telephone.

         __ d) Establish telephone communications with the Control Room.

      __ 3) Throttle open 1FW-27A (ND Pump 1A Suct From FWST) (AB-524, FF-GG, 52-53, Rm 113) to provide sufficient flow to maintain required core conditions.

      __ 4) **IF AT ANY TIME** FWST level begins increasing, **THEN** close 1FW-27A (ND Pump 1A Suct From FWST).

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Question 8

Bank Question: 07-08 ***Answer: A***

---

1 Pt(s). Unit 2 has experienced a Loss of KC. The crew is in the process of aligning alternate cooling to the NV Pump. How is the cooling water flow controlled upon the initial alignment?

A. Manually throttled to maintain outlet flow rate within a required band

B. Manually throttled to maintain bearing and oil temperature within a required band

C. Auto flow control which maintains outlet temperature within a required band

D. A self contained regulator maintains outlet flow rate within a required band

---

Distracter Analysis:

A. **Correct:**

B. **Incorrect:**
Plausible: This is the method used when starting the VI compressors

C. **Incorrect:**
Plausible: This is normal for most HX in the KC system.

D. **Incorrect**:
Plausible: This method is used in some systems.

Level: RO

K/A: APE: 026 Loss of Component Cooling Water (CCW) AA1. Ability to operate and / or monitor the following as they apply to the Loss of Component Cooling Water: (CFR 41.7 / 45.5 / 45.6) AA1.06 Control of flow rates to components cooled by the CCWS 2.9 2.9

Lesson Plan Objective: KC14 Discuss the supplementary actions for the loss of KC AP

Source: NEW

Level of knowledge: Memory

References:
1. AP/21
2.

NOTE The following sequence involves components on both units, many with very similar numbers and nomenclature.

1. **Close the following valves:**

__ • 1KC-E31 (YD B/U To 1A NV Pump Mtr Tell-Tale) (AB-545, JJ-56, Rm 200)

__ • 2KC-E31 (YD B/U To 2A NV Pump Mtr Inlet Tell-Tale) (AB-546, HH-58, Rm 200)

CAUTION **Attempting additional valve movement after reaching the mechanical end stop may damage the valve operator of the following valves.**

__ • 1KC-E29 (1A NV Pump Motor Inlet Isol) (AB-551, JJ-56, Rm 200)

__ • 1KC-A53 (1A NV Pump Motor Cooler Outlet Isol) (AB-551, HH-56, Rm 200)

__ • 1KC-A59 (1A NV Pump Oil Coolers Outlet Isol) (AB-550, JJ-KK, 56, Rm 200).

2. **Open the following valves:**

__ a. 1YD-431 (YD Supply To 1A NV Pump Motor) (AB-549, JJ-56, Rm 200)

__ b. 1KC-E30 (YD B/U To 1A NV Pump Mtr Isol) (AB-549, JJ-56, Rm 200)

__ c. 1KC-E32 (1A NV Pump Mtr Clr YD Outlet Isol) (AB-546, HH-56, Rm 200)

__ d. 1KC-E33 (1A NV Pump Oil Clrs YD Outlet Isol) (AB-547, JJ-56, Rm 200).

3. **Throttle YD flow to 1A NV pump as follows (Ladder Needed):**

__ • Unlock and throttle 1KC-A52 (1A NV Pump Motor Cooler Outlet Throttle) (AB-551, HH-56, Rm 200) to obtain 30-35 GPM on 1KCPG8280 "1A NV PUMP MOTOR COOLER KC FLOW" (AB-548, HH, 55-56, Rm 200).

__ • Unlock and throttle 1KC-A58 (1A NV Pump Oil Coolers Outlet Throttle) (AB-551, JJ-56, Rm 200) to obtain 32-35 GPM on 1KCPS8330 "1A NV PUMP OIL COOLERS KC FLOW" (AB-543 HH, 55-56, Rm 200) .

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Question 9

Bank Question: 07-09 ***Answer: A***

---

1 Pt(s). Unit 1 is at 100% RTP. 1NC-27 PZR (Spray Control from Loop A) fails open. All control systems respond as expected. What is the end result of this failure?

A. PZR spray cools the steam bubble faster than it can be generated by the heaters, steam bubble is lost, and pressure DECREASES until 1845 psig

B. PZR spray cools the steam bubble faster than it can be generated by the heaters, steam bubble is lost, and pressure DECREASES until 2185 psig

C. PZR heaters generate the steam bubble faster than it is collapsed by spray, steam bubble remains, and pressure INCREASES until 2218 psig.

D. PZR heaters generate the steam bubble faster than it is collapsed by spray, steam bubble remains, and pressure INCREASES until 2310 psig.

Distracter Analysis:

A. **Correct:** Process is correct; pressure will decrease until SI actuates

B. **Incorrect:**
Plausible: Process is correct but pressure will continue to decrease past the PZR PORV block value.

C. **Incorrect:**
Plausible: Process is incorrect but if correct the heaters would operate to maintain 2218.

D. **Incorrect**:
Plausible: Process is incorrect; heater operation is to 2218 not the 2310 spray valve closure for normal operation.

Level: RO

K/A: APE: 027 Pressurizer Pressure Control System (PZR PCS) Malfunction AA1. Ability to operate and / or monitor the following as they apply to the Pressurizer Pressure Control Malfunctions: (CFR 41.7 / 45.5 / 45.6) AA1.03 Pressure control when on a steam bubble 3.6 3.5

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Question 9

Lesson Plan Objective: IPE09 Describe all alarms, control functions, and interlocks which are generated by pressurizer pressure but not controlled by the master controller, including setpoint and pressure channel

Source: NEW

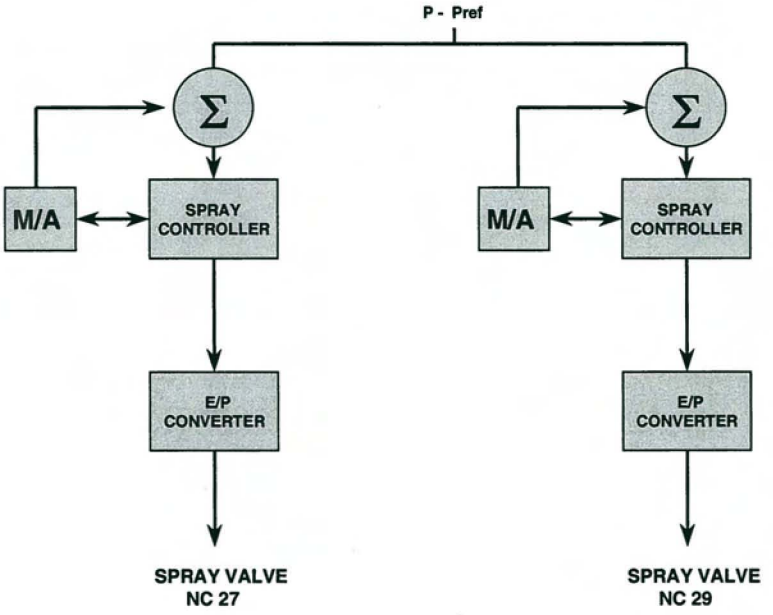
Level of knowledge: comprehension

References:
1. IPE Lesson
2.

3. The Pressurizer itself must be Operable with:
   a) A Water Level less than or equal to 92%. This ensures a bubble exists which preserves the steam space needed for adequate pressure control.
   b) Two (2) groups of Heaters each with a capacity greater than or equal to 150 kW and capable of being powered from an Emergency Power Supply. These are Heaters Groups A and B. Only these two Groups can be powered from a D/G as LXI and LXH are powered from FTA and FTB which can be powered from ETA and ETB during a Station Blackout. Groups C and D are powered from LXC and LXD.

      NOTE: The availability of FTA (B) from ETA (B) affects the operability of A and B Heater groups.

F. Spray Valve Control (**OBJ. #2**)
   1. Controller
      a) Air pressure positions spray valves for desired flow
      b) Valves fail closed on loss of air.
   2. Spray Valves



      a) Automatic
         1) Fully closed 25 psig greater than P_{ref} (2260)
         2) Fully open 75 psig greater than P_{ref} (2310)

3) Prevent reaching PORV lift setpoint following a 10% step load reduction.

b) Manual

1) Bypasses master pressure controller signal

2) Operator positions valves using pushbuttons on M/A station.

c) Controller output signal/position demand signal.

1) Indicated on spray controller

2) Is not valve position.

3) PZR Spray Control valves are expected to indicate open somewhere between 10% and 15 % demand. The actuator setup is such that valves will start to open when the positioner input signal approaches approximately 6.3% demand. The valve's v-ball design is such that another 6.3% demand increase is required to rotate the v-ball and slightly 'open' a flow path. As such, a flow path through the PZR spray control valve will not be established until the positioner input signal reaches approximately 12.6% demand (i.e., somewhere between 10% and 15 % demand).

d) Lights on controller pushbuttons (red, green) indicate actual valve position (open, closed).

e) With any NC pump in operation, opening either NC27 or NC29 will cause a pressure decrease in the reactor coolant system as long as a steam bubble exists in the PZR. The magnitude of the pressure decrease is dependent on the length of time the valve remains open. (PIP C-96-2663)

f) During frequent or large Boration or Dilution events, PZR heaters should be placed in MANUAL and energized. This will result in a pressure increase and corresponding spray flow increase as the spray valves open greater than 2260 psig. This is done to allow better mixing of NC and PZR water to keep the boron concentrations within 50 ppm.

3. Spray valve bypass flow (**OBJ. #3**)

a) Manual throttle valves in parallel with spray valves.

b) .5 gpm flow/spray line

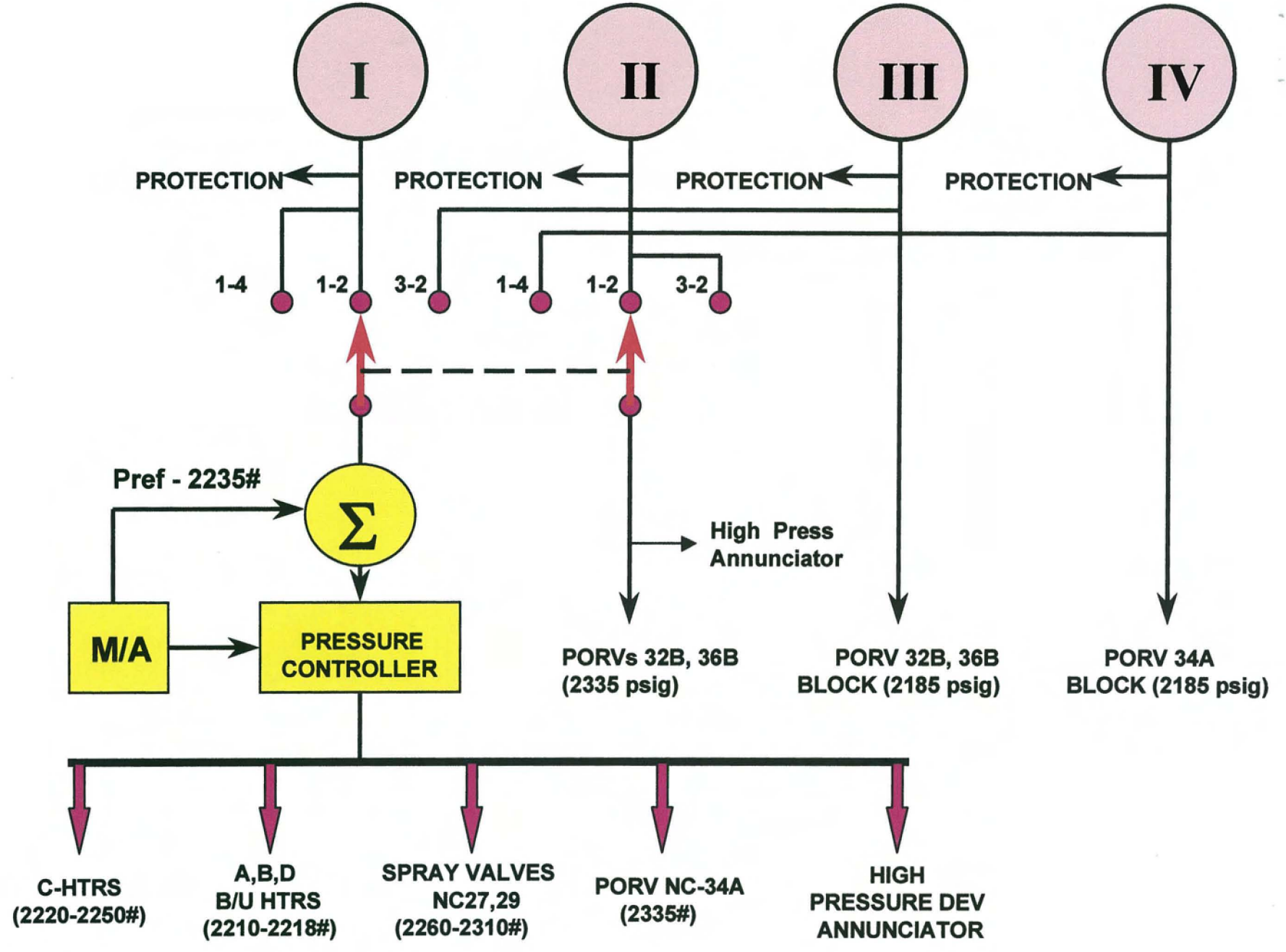
1) Prevent thermal shock

2) Provide mixing between NCS and PZR.

c) Temperature sensor (2) indicates insufficient bypass flow with low temp alarm.

G. Power Operated Relief Valves (PORV's) (**OBJ. #5**)

1. General
   a) Three PORV's
   b) Discharge to PRT
   c) VI (Instrument Air) is the normal supply. In LTOP operation, N_2 is aligned as the backup to PORV's 32B & 34A from CLA's. VI is normally at the higher pressure than the N_2. NC36B only has VI.
2. Interlock bistables block AUTO opening of PORV's if PZR pressure is less than 2185 psig.
   a) NC 32B & 36B from pressure channel 3
   b) NC 34A from pressure channel 4
3. Actuate Signals
   a) Backup channel (Channel 2 or 4) supplies NC32B and NC36B. The backup channel will send an actuation signal to NC32B and NC36B to open at 2335 psig, and then reclose at 2315 psig.
   b) Controlling channel 1 (Channel 1 or 3) supplies NC34A.
      1) The actuation signal comes from the pressurizer master controller through a bistable. NC34A will open at 100 psi greater than Pref and reclose at 80 psi above Pref. For a Pref of 2235 psig, this still corresponds to an open signal of 2335 psig and a re-close signal at 2315 psig.
   c) Three switches (open-auto-close) on MCB for manual control.
   d) Operation also from ASP manually.
4. Open/close indication on MCB


I
II
III
IV
PROTECTION
PROTECTION
PROTECTION
PROTECTION
1-4
1-2
3-2
1-4
1-2
3-2
Pref - 2235#
Σ
High Press
Annunciator
M/A
PRESSURE
CONTROLLER
PORVs 32B, 36B
(2335 psig)
PORV 32B, 36B
BLOCK (2185 psig)
PORV 34A
BLOCK (2185 psig)
C-HTRS
(2220-2250#)
A,B,D
B/U HTRS
(2210-2218#)
SPRAY VALVES
NC27,29
(2260-2310#)
PORV NC-34A
(2335#)
HIGH
PRESSURE DEV
ANNUNCIATOR

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Question 10

Bank Question: 07-10 ***Answer: B***

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1 Pt(s). Unit 2 is at 100%. A valid S/G low level reactor trip signal is received but the reactor does not trip. Per EP/2/A/5000/FR-S.1 (Response to Nuclear Power Generation/ATWS) the RO begins to manually insert the control rods. All equipment is operating as required.

What is the affect on reactivity at this point and what is the definition of the "reactivity"?

A. Reactivity is becoming more negative. The definition of reactivity is the amount the reactor is shutdown assuming all rods are fully inserted except the highest worth rod.

B. Reactivity is becoming more negative. The definition of reactivity is the amount the reactor has departed from criticality.

C. Reactivity is remaining stable. The definition of reactivity is the amount the reactor is shutdown assuming all rods are fully inserted except the highest worth rod.

D. Reactivity is remaining stable. The definition of reactivity is the amount the reactor has departed from criticality.

Distracter Analysis:

A. Incorrect:
Plausible: correct value given but this is the definition of SDM

B. Correct:

C. Incorrect:
Plausible: incorrect value and the definition of SDM

D. Incorrect:
Plausible: incorrect value but correct definition.

Level: RO

K/A: EPE: 029 Anticipated Transient Without Scram (ATWS)
EK1 Knowledge of the operational implications of the following concepts as they apply to the ATWS: (CFR 41.8 / 41.10 / 45.3) EK1.02 Definition of reactivity 2.6 2.8

Lesson Plan Objective: BNTRT0206 Define the following terms: Reactivity

Source: NEW

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Question 10
Level of knowledge: comprehension

References:
1. BNTRT02
2.

3.4 EFFECT ON k_{eff}

Multiplying the value of each term in the six factor formula results in the value of k_{eff}. Observing the shape of the curve in Figure 6, k_{eff} increases rapidly through 1.0, reaches a maximum then decreases slowly past 1.0 again. When a reactor is operated in the region to the left of maximum k_{eff}, a moderator temperature increase will lower k_{eff}, decreasing neutron population and lowering reactor power. A lower reactor power level will cool the fuel and moderator. A new equilibrium will be attained with k_{eff} back at 1.0.

This is considered the stable region of the curve and is called the undermoderated region.

If a reactor is operated to the right of maximum k_{eff}, a moderator temperature increase would increase k_{eff}. Reactor power would increase which would raise moderator temperature further and increase k_{eff} even more.

This is called the overmoderated region. The overmoderated region is less stable and is undesirable for commercial reactors in the United States.

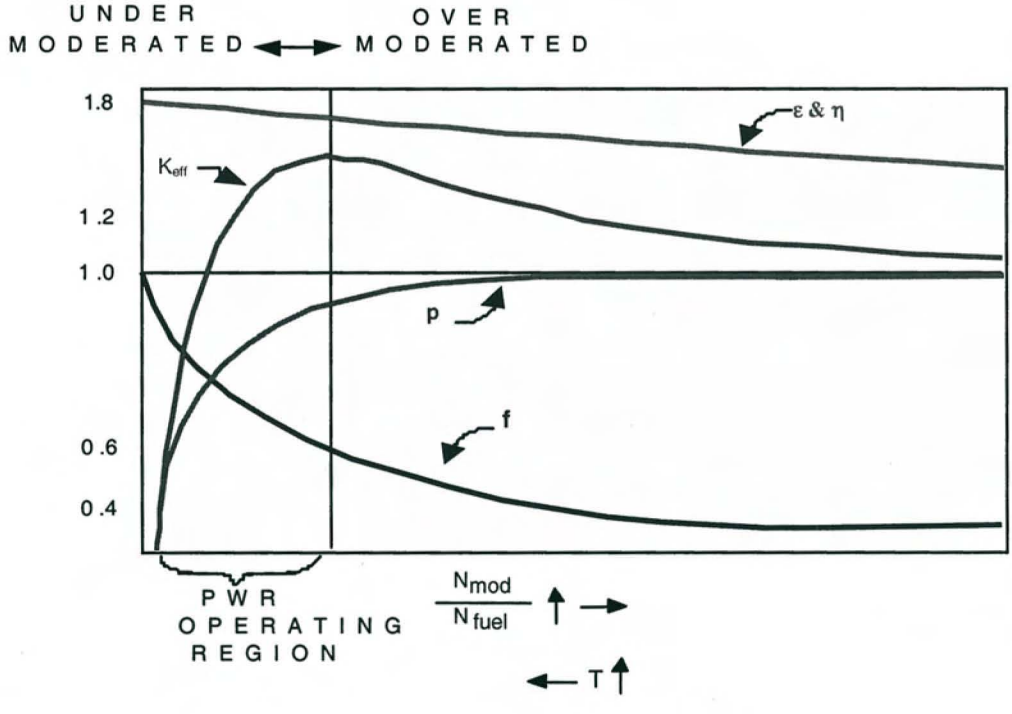

Figure 6 k vs. Moderator-to-Fuel Ratio

Note the values of ε and η are essentially constant as compared to p and f.

4.0 REACTIVITY

Objective 6D

Reactivity is defined as the fractional change in neutron population per generation, or the measure of the departure of a reactor from criticality and is indicated by the symbol ρ. Assume an initial neutron population of N_o. As given by the definition of k_{eff}, the population of the next generation is (N_o) (k_{eff}). The fractional change in neutron population per generation (reactivity) can be shown by the equation given below.

$$\rho = \frac{N_o K_{eff} - N_o}{N_o K_{eff}} = \frac{K_{eff} - 1}{K_{eff}}$$

Equation 14

Objective 8

Example: Calculate the reactivity level of a core with a k_{eff} of 0.985.

$$\rho = \frac{K_{eff} - 1}{K_{eff}} = \frac{0.985 - 1}{0.985} = -0.0152 \Delta k/k$$

Example 1

The following notational changes are used to simplify the discussion of reactivity.

$$\Delta k_{eff} = k_{eff} - 1 \quad \text{and} \quad \rho = \frac{\Delta K_{eff}}{K_{eff}} = \frac{\Delta K}{K}$$

Equation 15

Example: A control rod withdrawal results in the k_{eff} of a reactor changing from 0.97 to 0.975. How much reactivity was added to the core by the control rod withdrawal?

$$\Delta\rho = \rho_2 - \rho_1$$

$$\rho_2 = \frac{K_{eff\,2} - 1}{K_{eff\,2}} = \frac{0.975 - 1}{0.975} = -0.0256 \frac{\Delta K}{K}$$

$$\rho_1 = \frac{K_{eff\,1} - 1}{K_{eff\,1}} = \frac{0.97 - 1}{0.97} = -0.0309 \frac{\Delta K}{K}$$

$$\Delta\rho = \rho 2 - \rho 1 = -0.0256 - (-0.0309) = +0.0053 \frac{\Delta K}{K}$$

Example 2

Objective 9, 10

For values of k_{eff} very close to 1, $\rho \approx \Delta K$. If the reactivity of the reactor is known, then k_{eff} can be determined by:

$$k_{eff} = \frac{1}{(1 - \rho)}$$

Equation 16

Example: A shutdown reactor has a core reactivity of –0.0028 Δk/k. What is the core k_{eff}?

$$k_{eff} = \frac{1}{1 - \rho} = \frac{1}{1 - (-0.0028)} = 0.9972$$

Example 3

Reactivity is a convenient term to use when discussing deviation from criticality. For any power, if the reactor is critical ($k_{eff} = 1$), the reactivity associated with the reactor is zero. For a

supercritical reactor, reactivity is a positive value and for a subcritical reactor, reactivity is a negative value.

Since k_{eff} is a dimensionless quantity, reactivity (ΔK/K) is also dimensionless. It is convenient, however, to talk about reactivity in units of ΔK/K or %ΔK/K. To determine %Δk/k, multiply Δk/k by 100%.

Example: A shutdown reactor has a core reactivity of –0.0038 ΔK/K. What is the core reactivity value in %ΔK/K?

$$-0.0038\ \Delta K/K = -0.38\%\ \Delta K/K$$

Example 4

Another commonly used unit of reactivity is pcm (**p**er **c**ent **m**illi). To obtain pcm, multiply Δk/k by 10^5, or multiply %Δk/k by 10^3.

%k/k	pcm
Multiply k/k by 100	Multiply k/k by 10^5
	Multiply %k/k by 10^3

Table 1 Conversion Factors

Example: Convert 0.0050 Δk/k to %Δk/k and pcm.

0.0050 Δk/k x 100% = 0.5 %Δk/k

0.0050 Δk/k x 100000 = 500 pcm

or 0.5% x 1000 = 500 pcm

Example 5

5.0 EXCESS REACTIVITY AND k_{EXCESS}

Objective 6C

Excess reactivity is the reactivity added to the core over and above that needed to achieve criticality. During startup, the increase in moderator and fuel temperatures adds negative reactivity to the core. Additionally, during reactor operation, the reactivity in the core decreases for the following reasons: 1) fuel burnup, 2) fission product poison buildup 3) resonant absorber buildup (Pu-240). Therefore, the reactor has an excess reactivity initially built in to compensate for these decreases.

The excess multiplication factor is defined as the amount by which the total installed k_{eff} exceeds 1.0, and is expressed mathematically as:

$$k_{excess} = k_{eff} - 1$$

Therefore,

$$\rho_{excess} = \frac{K_{excess}}{K_{eff}}$$

Equation 17

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Question 11

Bank Question: 07-11 ***Answer: C***

---

1 Pt(s). Following a Reactor Trip, the following annunciators on 1FO-1 are lit as indicated below:

- B\1 – S/G A Lo-Lo Level Rx Trip - White
- B\2 – S/G B Lo-Lo Level Rx Trip - White
- B\3 – S/G C Lo-Lo Level Rx Trip - White
- B\4 – S/G D Lo-Lo Level Rx Trip - White
- B\5 – PZR Hi Press Rx Trip - White
- D\6 – Manual SI Rx Trip - White
- F\5 – Turb Trip Causes Rx Trip - Red

Which of the following is the most likely cause of the reactor trip and the procedure which must be used to respond to the trip?

A. Manual safety injection
EP/1/A/5000/E-0 (Reactor Trip or Safety Injection)

B. Manual safety injection
AP/1/A/5500/05 (Reactor Trip or Inadvertent S/I Below P-11)

C. Loss of Main Feedwater
EP/1/A/5000/E-0 (Reactor Trip or Safety Injection)

D. Loss of Main Feedwater
AP/1/A/5500/05 (Reactor Trip or Inadvertent S/I Below P-11)

Distracter Analysis:

A. **Incorrect:**
Plausible: The red Turbine Trip causes Rx Trip alarm indicate 1) the reactor was greater than 69% when tripped 2) the initiating event was a loss of the main turbine. From the information given the only viable turbine trip would have been an AMSAC trip. The manual SI came after the reactor trip thus it is incorrect and since the reactor was greater than P-11 this is the correct procedure to enter.

B. **Incorrect:**
Plausible: Incorrect cause and procedure. See A explanation of plausibility.

C. **Correct:**

D. **Incorrect**:
Plausible: Correct cause but incorrect procedure.

Level: RO

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Question 11
K/A: APE: 054 Loss of Main Feedwater (MFW) AA2. Ability to determine and interpret the following as they apply to the Loss of Main Feedwater (MFW): (CFR: 43.5 / 45.13)
AA2.07 Reactor trip first-out panel indicator 3.4* 3.9

Lesson Plan Objective: IPX10 Describe the function of the "First Out" annunciator panel.

Source: NEW

Level of knowledge: comprehension

References:
1. FO-1
2. IPX Lesson

3. Operation
   a) Spring returned to center (neutral) position
   b) If taken to open/close and then released, spring return could cause contacts to unmake and perform protective functions by passing through the 'Neutral' position.
   c) CF isolation may be prevented by depressing both CF ISOL TRN A and B reset pushbuttons while opening the breakers (T_{ave} less than 564°F)
4. Manual S/I (Train A & B) perform the same actions as the Manual Rx Trip Handles.

G. "First Out" Annunciator Panel (Obj. #10)
   1. Located in Control Room
   2. Function - Will indicate in Red which Rx Protection signal initiated Rx trip.
   3. Separate Reset on MC1, First out will remain red until it is reset.

2.3 Protective Circuits (Obj. #2,3,4,7)

A. DNBR Protection
   1. Protect fuel clad from overheating by
      a) Limiting Rx Power
      b) Ensuring Adequate Coolant Flow
      c) Limiting Rx Coolant Temperature
      d) Ensuring Adequate Coolant Pressure
   2. Overpower Reactor Trips and Interlocks
      a) Source Range
         1) Hi Flux Trip
            (a) 1/2 SR Channels = 10^5 cps
            (b) Blockable greater than P-6
         2) No credit for this in Accident Analysis
      b) Intermediate Range
         1) High Flux Rx Trip
            (a) 1/2 IR Channels amps = 25% RTP
            (b) Blockable greater than P-10

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Question 12

Bank Question: 07-12 ***Answer: C***

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1 Pt(s). Three weeks after a Unit 1 refueling outage, Unit 1 experiences a Loss of All AC Power. While in EP/1/A/5000/ECA-0.0 (Loss of All AC Power), during the rapid depressurization of intact S/G's to 165 psig, all S/G's were reduced to 50 psig before the depressurization was stabilized.

Which ONE of the following plant conditions is the most likely result of this excessive SG depressurization?

A. NC system brittle fracture

B. A return to criticality

C. Natural circulation impeded by accumulator Nitrogen injection

D. At high boron concentrations, boron comes out of solution

Distracter Analysis:

A. Incorrect:
Plausible: This would is a believable concern for this rapid cool-down but not a likely result.

B. Incorrect:
Plausible: This is a valid concern for this rapid a cooldown but not at BOL when the MTC is small.

C. Correct:

D. Incorrect:
Plausible: This may occur but is not the major concern when reducing the SG pressure below 165 psig.

Level: RO

K/A: EPE: 055 Loss of Offsite and Onsite Power (Station Blackout)
EK1 Knowledge of the operational implications of the following concepts as they apply to the Station Blackout : (CFR 41.8 / 41.10 / 45.3) EK1.02 Natural circulation cooling 4.1 4.4

Lesson Plan Objective: EP508 Explain the Bases, including any identified knowledges/abilities, for all of the steps, notes, and cautions in EP/1/A/5000/ECA-0.0 (Loss of All AC Power)

Source: MODIFIED (Beaver Valley 2005)

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Question 12
Level of knowledge: Memory

References:
1.
2. ECA-0.0

ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED

NOTE 1WL-869B (VUCDT Cont Isol) is highest priority valve to close since this penetration could provide direct air path between containment and the aux bldg.

22. **Verify the following Monitor Light Panel Group 5 St lights - LIT:**

a. VUCDT:

__ • L-12 or M-1.

__ a. Dispatch operator to locally close outside containment isolation valve for affected penetration. **REFER TO** Enclosure 16 (Local Isolation of Phase B Isolation Valves).

b. VP, VQ, and VY:

__ • G-1 or G-11
__ • G-2 or G-10
__ • G-3 or G-9
__ • G-4 or G-8
__ • G-5 or G-7
__ • H-2 or H-10
__ • H-3 or H-9
__ • H-4 or H-8
__ • H-5 or H-7
__ • H-11 or I-2
__ • I-3 or I-10
__ • I-6 or I-7.

__ b. Dispatch operator to locally close outside containment isolation valve for affected penetration. **REFER TO** Enclosure 15 (Local Isolation of Phase A Isolation Valves).

CAUTION **Lowering S/G pressures less than 65 PSIG will cause injection of nitrogen from the CLAs into the NC System.**

NOTE Pzr level may be lost and reactor vessel head voiding may occur due to depressurization of S/Gs.

23. **Depressurize intact S/Gs to 165 PSIG as follows:**

__ a. Verify S/G N/R level in at least one intact S/G - GREATER THAN 11% (29% ACC).

a. Perform the following:

__ 1) Maintain maximum CA flow until at least one intact S/G N/R level is greater than 11% (29% ACC).

(RNO continued on next page)

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Question 13

Bank Question: 07-13 ***Answer: D***

---

1 Pt(s). The following plant conditions exist on Unit 1:

- A reactor startup is in progress on Unit 1
- All shutdown banks are withdrawn
- Source range channels N31 and N32 indicate 10E4 CPS
- Intermediate range channels N35 and N36 indicate 5 X10-11 AMPS

The annunciator 1AD-11 G/1 (120 VAC ESS PWR CHANNEL A TROUBLE) has just alarmed and the BOP reports that 1ERPA is deenergized.

Which of the following is a result of 1ERPA deenergizing? What is the next procedure that must be entered?

A. 1EDE is deenergized. Enter AP/1/A/5500/29 (Loss of Vital or Aux Control Power).

B. '"A" Train Safety Injection occurs. Enter EP/1/A/5000/E-0 (Reactor Trip or Safety Injection).

C. Loss of ERPA prevents all auto and manual rod withdrawal. Enter AP/1/A/5500/29 (Loss of Vital or Aux Control Power).

D. N-31 source range instrument fails. Enter EP/1/A/5000/E-0 (Reactor Trip or Safety Injection).

Distracter Analysis:

A. Incorrect:
Plausible: ERPA is a source of power to EDE and AP/29 would normally be entered for a loss of ERPA. Power to EDE is auctioneered and EDE would still have power from VADA. Also the reactor would trip due to source range instrument failure and E/0 must be entered.

B. Incorrect:
Plausible: E-0 would be entered. Rx would trip due to the source range instrument failure. No SI would be actuated..

C. Incorrect:
Plausible: AP/29 would normally be entered for a loss of ERPA. But in this case the Rx would trip due to the source range instrument failure.

D. Correct:

Level: RO

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Question 13
K/A: APE: 057 Loss of Vital AC Electrical Instrument Bus AK3. Knowledge of the reasons for the following responses as they apply to the Loss of Vital AC Instrument Bus: (CFR 41.5,41.10 / 45.6 / 45.13) AK3.01 Actions contained in EOP for loss of vital ac electrical instrument bus . . . 4.1 4.4

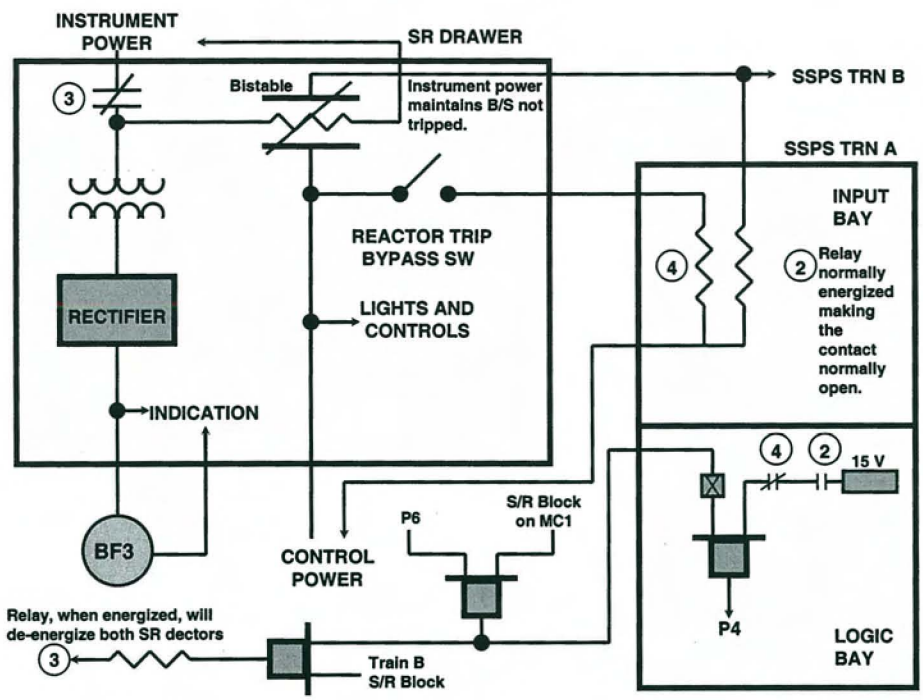
Lesson Plan Objective: ENB09 Describe the plant response to a given detector or instrument failure.

Source: MODIFIED (Ginna 2004)

Level of knowledge: comprehension

References:
1.
2. ARP for AD-11, AP/29, PT for 1/M,

5. Channel "On Test" Lamp - indicates the operation selector switch is in a position other than "NORMAL".
6. Loss of Detector Volt Lamp - indicates high voltage to detector off or low.
7. Level Trip Lamp - indicates neutron level greater than trip setpoint in Source Range (10^5 cps)
8. Level Trip Bypass Lamp - On when Level Trip switch in "BYPASS" for test or calibration.
9. High Flux at Shutdown Lamp - Neutron level greater than 1/2 decade above normal shutdown level (0.5 decade = 3.16)
10. Bistable Trip Spare Lamp - No function.
11. Instrument Power Fuses - Overcurrent protection for power supply circuits. Instrument power supplies the meters, circuit processing components, high voltage and detector power. This is true for the IR and PR drawers/circuits also.



12. Control Power Fuses - Overcurrent protection for control signal circuit transformers. Control power supplies the lights on the drawer and 118 VAC to the bistable relay drivers to the plant relays (High flux at shutdown alarm and SR high level trip). This is true for the IR and PR drawers/circuits also.
    a) A trip signal will be generated when either the instrument or control power fuses are removed. This is true with the exception of when the trips are blocked.

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Question 14

Bank Question: 07-14 ***Answer: D***

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1 Pt(s). Inverter KXIA was shutdown per procedure to allow IAE to replace the DC input breaker.

How do you know that the back up power supply has aligned to 1KXPA, and how will the power be swapped back when 1KXIA is restarted?

A. OAC alarm for KUA Static Switch indicates alternate source aligned: manually.

B. OAC alarm for KUA Static Switch indicates alternate source aligned: automatically

C. 1KXAA indicating light "Alternate Source Supplying Load" is LIT; automatically

D. 1KXAA indicating light "Alternate Source Supplying Load" is LIT; manually

---

Distracter Analysis:

A. **Incorrect**:
Plausible:. KUA is the static switch for KUI but is sometimes mistaken for the KXIA static switch. The swap is automatic unlike vital which has no auto swaps.

B. **Incorrect:**
Plausible: KUA is the static switch for KUI but is sometimes mistaken for the KXIA static switch. The swap is automatic unlike vital which has no auto swaps.

C. **Inorrect:**
Plausible: Correct indication, but the swap during shutdown is done manually, Manual return realignment is required.

D. **Correct:**

Level: RO

K/A: APE: 058 Loss of DC Power AA2. Ability to determine and interpret the following as they apply to the Loss of DC Power: (CFR: 43.5 / 45.13) AA2.01 that a loss of dc power has occurred; verification that substitute power sources have come on line 3.7 4.1

Lesson Plan Objective: EPF06 Explain when an auto transfer occurs on auto static Transfer Switch.

Source: NEW

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Question 14
Level of knowledge: comprehension

References:
1. ARP AD-11, AP/29, Aux Power OP, EPF Lesson
2.

E. Auto Static Transfer Switch (KXAA, KXAB, KUA) (Obj. #2)

1. The auto static transfer switch will automatically swap to the alternate source on low inverter output. (Obj. #6)
2. Manual swap capability is also provided via pushbuttons on the Transfer switch labeled:
   a) Inverter to load - normal position
   b) Alt Source to load - alt position
3. Some of the indications on the transfer switch include:
   a) "Static Sw. in Inverter Position" - amber light
   b) "Static Sw. in Alt. Source Position" - Red light
   c) In Sync Light
4. Once the transfer switch has automatically swapped to alternate source, a 60 second relay is initiated. After 60 seconds, if the transfer was due to a total loss of inverter output voltage, the switch will transfer back to the inverter whenever voltage and frequency have returned to normal.
5. The Static transfer switch can be bypassed using the Manual Transfer Switch.

F. Manual Bypass Switch (Obj. #2)

1. The Manual Bypass Switch Provides a means of bypassing the Auto static transfer switch and the inverter to allow maintenance on these components.
2. The switch has three positions (Obj. #7)
   a) **Normal**
   b) **Inverter to load** - bypasses the auto transfer switch.
   c) **Alternate Source to load** - Bypasses the inverter and the Auto transfer switch. (Called "TOTAL SYSTEM BYPASS") Puts the regulated power supply to KXPA(B).
3. It is a "Make before break" switch.
   a) Transfer should only be made when inverter and manual bypass "IN SYNC" lights are lit.
4. Some of the indications provided on the Manual Bypass Switch include:
   a) AC volts (downstream of manual bypass switch)
   b) AC amps (downstream of manual bypass switch)
   c) "Alt. source Low" - red light will be lit when alternate source voltage is low.

1. Initial Conditions

—— 1.1 Review the Limits and Precautions.

—— 1.2 Verify 1KXIA is in service per Enclosure 4.3 (Inverter Startup).

2. Procedure

—— 2.1 Verify the "IN SYNC" indicator light on 1KXAA is illuminated.

—— 2.2 Depress the "ALTERNATE SOURCE TO LOAD" pushbutton on 1KXAA.

—— 2.3 Verify the following indicator light status on 1KXAA:

☐ "ALTERNATE SOURCE SUPPLYING LOAD" – "ON"

☐ "INVERTER SUPPLYING LOAD" – "OFF"

—— 2.4 Place 1KXIA CB2 (Inverter Output) on 1KXIA in the "OFF" position.

—— 2.5 Place 1KXIA CB1 (Battery Input) on 1KXIA in the "OFF" position.

NOTE:
1. At this point, 1KXIA is shutdown with 1RDA supplying 1KXPA through 1KXAA.
2. Subsequent steps are to return 1KXIA to service and 1KXAA to normal condition.
3. Step 2.7 must be performed immediately after Step 2.6 is completed. Failure to close the "BATTERY INPUT" breaker immediately after the "PRE-CHARGE" pushbutton is released may result in blown inverter input fuses.

—— 2.6 Depress the "PRE-CHARGE PUSHBUTTON DEPRESS UNTIL PRE-CHARGE LIGHT IS LIT" pushbutton on 1KXIA until the "PRE-CHARGE" indicator light has been illuminated for a minimum of 5 seconds.

—— 2.7 Place 1KXIA CB1 (Battery Input) on 1KXIA in the "ON" position.

NOTE:	1KXIA has three meters, each with the label "INVERTER OUTPUT". The correct meter nomenclature is found on the meter face.

—— 2.8 Verify the output of 1KXIA is as follows:

- ☐ "A-C AMPERES" are < 25 (the meter increment between 0 and 50 corresponds to 25 amps).
- ☐ "A-C VOLTS" are between 118 and 125 VAC.
- ☐ "HERTZ" is between 59.4 and 60.3 Hz.

—— 2.9 Place 1KXIA CB2 (Inverter Output) on 1KXIA in the "ON" position.

—— 2.10 Verify the following indicator light status on 1KXIA:

- ☐ "INVERTER OUTPUT LOW VOLTAGE" - "OFF"
- ☐ "IN SYNC" – "ON"

—— 2.11 Verify the "IN SYNC" indicator light on 1KXAA is illuminated.

—— 2.12 Depress the "INVERTER TO LOAD" pushbutton on 1KXAA.

—— 2.13 Verify the following indicator light status on 1KXAA:

- ☐ "INVERTER SUPPLYING LOAD" – "ON"
- ☐ "ALTERNATE SOURCE SUPPLYING LOAD" – "OFF"

—— 2.14 Verify the "NORMAL OPERATION" indicator light on 1KXIA is illuminated.

NOTE:	1KXIA is returned to normal service.

2.15 Do **NOT** file this enclosure in the Control Copy folder of this procedure.

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Question 15

Bank Question: 07-15 ***Answer: D***

---

1 Pt(s). All AC power was lost on Unit 1 and subsequently restored to one 4160 Kv bus. The crew has made a transition to EP/1/A/5000/ECA-0.2 (Loss of All AC Power Recovery With SI Required).

Which ONE of the following describes how safeguards equipment will be re-energized and what is the reason for this action?

A. After one buss has been reenergized, allow the sequencer to automatically load the SI equipment in the proper order. The sequencer will load the plant loads in the order of their priority for restoration of power to safety related equipment.

B. After one buss has been reenergized, the NV Pump is the first pump started and then the NI pump. The high head injection pumps are the first choice for restoration of core cooling and inventory when SI is required.

C. After one buss has been reenergized, ensure proper safeguards equipment lineup using EP/1/A/5000/E-0 (Reactor Trip or Safety Injection). EP1/A/5000/E-0 was written to address the safety related systems in the order of their priority or importance.

D. After one buss has been reenergized, the RN Pump is the first pump started and then the KC pump. This is done to provide cooling to the other safeguards equipment prior to their operation.

Distracter Analysis:

A. **Incorrect**:
Plausible: Normal for emergency conditions. In the condition given sequencer power is removed and cannot actuate.

B. **Incorrect:**
Plausible: Depending on the size of the LOCA , NC pressure may still be above the shutoff head of the lower head pumps. The NV Pumps and then the NI pumps are the highest head pumps and would ensure core cooling and inventory for certain sized LOCAs. But, on restoration of power, RN is restored first and then KC to ensure cooling for all essential pumps.

C. **Incorrect:**
Plausible: This would be normal if power were available.

D. **Correct:**

Level: RO

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Question 15

K/A: APE: 062 Loss of Nuclear Service Water AK3. Knowledge of the reasons for the following responses as they apply to the Loss of Nuclear Service Water: (CFR 41.4, 41.8 / 45.7) AK3.03 Guidance actions contained in EOP for Loss of nuclear service water 4.0 4.2

Lesson Plan Objective: EP509 Explain the Bases, including any identified knowledges/abilities, for all of the steps, notes, and cautions in EP/1/A/5000/ECA-0.2 (Loss of All AC Power Recovery With S/I Required)

Source: Modified (Turkey Point 2003)

Level of knowledge: comprehension

References:
1.
2. ECA-0.0

ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED

33. **Verify RN system operation as follows:**

a. All of the following RN valves - OPEN:

__ • 1RN-1A (RN P/H Pit A Isol From Lake)

__ • 1RN-2B (RN P/H Pit A Isol From Lake)

__ • 1RN-5A (RN P/H Pit B Isol From Lake)

__ • 1RN-6B (RN P/H Pit B Isol From Lake)

__ • 1RN-57A (Station RN Disch To RL Sys)

__ • 1RN-843B (Station RN Disch To RL Sys)

__ • 1RN-54A (Station RN Disch Hdr X-Over)

__ • 1RN-53B (Station RN Disch Hdr X-Over).

__ a. Dispatch operator to ensure affected valve(s) open.

__ b. At least one RN pump - ON.

__ b. Manually start one RN pump.

ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED

CAUTION **Exceeding the capacity of the power source may result in the loss of power to the energized essential bus.**

6. **Manually load the following safeguards equipment on the essential bus:**

__ a. Ensure KC pumps - ON.

__ b. Ensure ND pumps - ON.

__ c. Verify S/I systems - ALIGNED FOR INJECTION MODE.

c. Perform the following:

__ 1) **WHEN** NC pressure is less than 1620 PSIG, **THEN** start NI pumps.

__ 2) **GO TO** Step 7.

__ d. Ensure NI pumps - ON.

7. **Verify proper NV pump operation as follows:**

__ a. Both NV pumps - OFF.

__ a. **GO TO** Step 8.

__ b. Standby makeup pump - OFF.

__ b. **GO TO** Step 7.d.

SEQUENCER LOAD GROUPS

	LOCA	BLACKOUT
LOAD GROUP 2		
* NV Pumps	X	X
LOAD GROUP 3		
* NI Pumps	X	
* CRDM Fans		X
* VV Fans		X
* AIR Locks		X
LOAD GROUP 4		
* ND Pumps	X	
LOAD GROUP 5		
* NS Pumps	X	

SEQUENCER LOAD GROUPS

	LOCA	BLACKOUT
LOAD GROUP 6		
* KC Pumps	X	X
LOAD GROUP 7		
* RN Pumps	X	X
LOAD GROUP 8		
* CA Pumps	X	X
LOAD GROUP 9		
* RY Pumps		X

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Question 16

Bank Question: 07-16 ***Answer: A***

---

1 Pt(s). Which of the following systems is considered to be the most likely location for a LOCA outside containment and is therefore the first system verified to be intact during the performance of EP/1/A/5000/ECA-1.2 (LOCA Outside Containment)?

A. Residual Heat Removal

B. NCP Injection

C. NV Injection

D. Component Cooling

Distracter Analysis:

A. Correct:

B. Incorrect:
Plausible: NCP injection is still in service following an SI but its piping has a high pressure rating and would not be expected to rupture outside containment.

C. Incorrect:
Plausible: NV is in service into the containment for a LOCA but its piping is rated at NC pressure and the pumps should ensure that no leakage exists containment.

D. Incorrect:
Plausible: While the KC system is in service to the containment during the first part of a LOCA, the CCW piping has automatic isolation for a thermal barrier leak and the thermal barrier piping is rated for full RCS pressure.

Level: RO

K/A: Westinghouse E04 LOCA Outside Containment EK1. Knowledge of the operational implications of the following concepts as they apply to the (LOCA Outside Containment) (CFR: 41.8 / 41.10, 45.3) EK1.2 Normal, abnormal and emergency operating procedures associated with (LOCA Outside Containment).
IMPORTANCE RO 3.5 SRO 4.2

Lesson Plan Objective: EP221 Explain the Bases, including any identified knowledges/abilities, for all of the steps, notes, and cautions in EP/1/A/5000/ECA-1.2 (LOCA Outside Containment)

Source: Modified (Point Beach 2006)

Level of knowledge: Memory

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Question 16
References:
1.
2.

ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED

1. (Continued)

__ 3) 1NI-183B (ND Hdr A&B Hot Leg Inj Isol).

3) Perform the following:

__ a) Place the "PWR DISCON FOR 1NI-183B" in "ENABLE".

__ b) Close 1NI-183B.

__ c) Place the "PWR DISCON FOR 1NI-183B" in "DISCON".

__ d) **IF** valve cannot be manually closed, **THEN** dispatch operator to close 1NI-183B (ND Hdr A&B Hot Leg Inj Isol) (AB-571, EE-FF, 52-53, Rm 333A).

__ c. Verify 1NV-857 (Pressurizer Aux Spray Ctrl) - CLOSED.

c. Perform the following:

__ 1) Manually close valve.

__ 2) **IF** 1NV-857 cannot be manually closed, **THEN** dispatch operator to close 1NV-862 (ND To Pzr Spray Isol Otsd Cont) (AB-552, DD-52, Rm 217).

2. **Attempt to identify and isolate break as follows:**

a. Isolate ND header 1A to cold legs as follows:

__ 1) Place the "PWR DISCON FOR 1NI-173A" in "ENABLE".

__ 2) Close 1NI-173A (ND Hdr 1A To Cold Legs C&D).

__ 3) Verify NC pressure - INCREASING.

3) Perform the following:

__ a) Open 1NI-173A.

__ b) Place the "PWR DISCON FOR 1NI-173A" in "DISCON".

__ c) **GO TO** Step 2.b.

ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED

2. (Continued)

__ 4) **GO TO** Step 3.

b. Isolate ND header 1B to cold legs as follows:

__ 1) Place the "PWR DISCON FOR 1NI-178B" in "ENABLE".

__ 2) Close 1NI-178B (ND Hdr 1B To Cold Legs A&B).

__ 3) Verify NC pressure - INCREASING.

3) Perform the following:

__ a) Open 1NI-178B.

__ b) Place the "PWR DISCON FOR 1NI-178B" in "DISCON".

__ c) **GO TO** Step 2.c.

__ 4) **GO TO** Step 3.

ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED

2. (Continued)

c. Isolate NI header to cold legs as follows:

1) Verify following NI pump miniflow valves - OPEN:

__ • 1NI-115A (NI Pump 1A Miniflow Isol)

__ • 1NI-144A (NI Pump 1B Miniflow Isol)

__ • 1NI-147B (NI Pump Miniflow Hdr To FWST Isol).

__ 2) Place the "PWR DISCON FOR 1NI-162A" in "ENABLE".

__ 3) Close 1NI-162A (NI To C-Legs Inj Hdr Isol).

__ 4) Verify NC pressure - INCREASING.

__ 5) Initiate actions as required to complete leak isolation.

__ 1) Stop NI pumps.

4) Perform the following:

__ a) Open 1NI-162A.

__ b) Place the "PWR DISCON FOR 1NI-162A" in "DISCON".

__ c) **IF** the NI pumps were stopped, **THEN** start NI pumps.

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Question 17

Bank Question: 07-17 ***Answer: A***

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1 Pt(s).

- A loss of vacuum has occurred on Unit 2 with vacuum decreasing to 15" HG.
- EP/2/A/5000/FR-H.1 (Loss of Heat Sink) has been implemented.
- Vacuum has been restored.
- No operator actions have been performed on the CFPT since the loss of vacuum.

What is the position of the CFPT recirc valve? What actions must be taken by the crew to manually control the CFPT recirculation valve?

A. The CFPT recirculation valve is open.

Depress the acknowledge pushbutton on the recirc valve controller. The valve may then be manually positioned and any subsequent 4500 gpm or reactor trip signals will have NO affect

B. The CFPT recirculation valve is open;

Depress the acknowledge pushbutton on the recirc valve controller. The valve may then be manually positioned and any subsequent 4500 gpm or reactor trip signals will cause the valves to fail open.

C. The CFPT recirculation valve is throttling in auto to maintain minimum flow of 4500 gpm;

Depress the acknowledge pushbutton on the recirc valve controller. The valve may then be manually positioned and any subsequent 4500 gpm or reactor trip signals will have NO affect

D. The CFPT recirculation valve is throttling in auto to maintain minimum flow of 4500 gpm;

Depress the acknowledge pushbutton on the recirc valve controller. The valves may then be manually positioned and any subsequent 4500 gpm or reactor trip signals will cause the valves to fail open.

Distracter Analysis:

A. **Correct**:

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Question 17

B. **Incorrect:**
Plausible: The Feed Pump tripped on low vacuum and the Reactor is tripped. CFPT recirculation valve opens on decreasing flow of 4500 gpm or on a RX trip. The valve response after the controller is acknowledged is correct for a Feed Pump runback on Rx trip condition.

C. **Incorrect:**
Plausible The Feed Pump tripped on low vacuum and the Reactor is tripped. CFPT recirculation valve opens on decreasing flow of 4500 gpm or on a RX trip. It does not throttle. The valve response after the controller is acknowledged is correct.

D. **Inorrect:** The Feed Pump tripped on low vacuum and the Reactor is tripped. CFPT recirculation valve opens on decreasing flow of 4500 gpm or on a RX trip. It does not throttle. The valve response after the controller is acknowledged is correct for a Feed Pump runback on Rx trip condition.

Level: RO

K/A: Westinghouse E05 Loss of Secondary Heat Sink 2.1 Conduct of Operations 2.1.32 Ability to explain and apply all system limits and precautions. (CFR: 41.10 / 43.2 / 45.12) IMPORTANCE RO 3.4 SRO 3.8

Lesson Plan Objective: CF05 Given appropriate plant conditions, apply Limits and Precautions associated with related station procedures.

Source: NEW

Level of knowledge: comprehension

References:
1. CF OP
2.

2.11 A reactor trip signal will cause the CFPTs to run back to minimum speed. Speed control can be regained by placing the "CFPT RUNBK ON RX TRIP" key switch in the "BYPASS" position.

2.12 The CFPT speed control system (GE MK VI) contains a zero speed trip. At zero speed the CFPTs will trip and **CANNOT** be reset until speed is increased above zero either by windmilling or placing on the turning gear.

2.13 The following limits and precautions apply to the CFPT recirc valves:

- The CF pump recirc valves (1CF-6 and 1CF-13) will receive a fail open signal whenever CF pump suction flow decreases to 4500 gpm or on a reactor trip signal.
- When the CFPT is in the tripped condition, the recirc valves will be positioned full open only once. The valves may then be manually positioned and any subsequent 4500 gpm or reactor trip signals will have no affect until the pump is reset.
- After each automatic valve opening (CF pump suction flow decreases to 4500 gpm or on a reactor trip signal) of the recirc valves (1CF-6 and 1CF-13), the "ACK" pushbutton on the electronic controller needs to be depressed in order to manually reposition the valves.

2.14 To avoid the increased vibration caused by running at critical speeds, the amount of time a CFPT is operated in the 3200-3600 rpm range should be minimized.

2.15 Chemistry should be notified prior to draining any portion of the CM/CF System during an outage so that the hydrazine concentration can be analyzed.

2.16 If Condensate flow through one of the BB Recovery HXs is to be isolated, the flowrate shall be adjusted to 3000-4000 gpm to ensure that maximum flowrate through the remaining HX is **NOT** exceeded and the suction pressure for CBPs is **NOT** reduced below 190 psig prior to isolating the affected BB Recovery HX. Flow rate is adjusted by throttling 1CM-56 (Gland Steam Condenser Outlet)

2.17 When performing initial (Functional Runs) after maintenance of Condensate/Feedwater pumps, SG BB and at least one BB demin should be in service. (PIP 03-03464)

2.18 If sealwater flow is aligned to a feedwater pump before vacuum is established to the corresponding CFPT condenser, sealwater flow may be noted from the pumps tell tale drains and can cause cross-contamination of the LF system.

ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED

11. (Continued)

__ d. Verify at least one CF pump - AVAILABLE TO BE STARTED.

__ d. **IF** both CF pumps are known to be incapable of starting, **THEN GO TO** Step 13.

e. Verify the following feedwater pump recirc valves - FULLY OPEN:

__ • 1CF-6 (CF Pump 1A Recirc Ctrl)
__ • 1CF-13 (CF Pump 1B Recirc Ctrl).

__ e. Manually open valve(s).

__ f. Ensure the CFPT to be started - RESET.

f. Perform the following:

__ 1) Continue attempts to reset a CFPT.

__ 2) **WHEN** CFPT is reset **AND** feed from CF is desired, **THEN RETURN TO** Step 9.

__ 3) **GO TO** Step 13.

__ g. Open 1AS-12 (AS To CFPT Isol).

__ h. Dispatch operator to close 1SP-3 (SC To CFPT 1A & 1B) (TB-640, 1G-24).

i. Open the following valves for the CFPT to be started:

• CFPT 1A:

__ • 1TE-3 (CFPT A LP S/V Above Seat Drn)

__ • 1TE-7 (CFPT A HP S/V Above Seat Drn).

• CFPT 1B:

__ • 1TE-4 (CFPT B LP S/V Above Seat Drn)

__ • 1TE-8 (CFPT B HP S/V Above Seat Drn).

__ j. Place the "CFPT RUNBK ON RX TRIP" in the "BYPASS" position.

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Question 18

Question: 07-18 ***Answer: D***

---

1 Pt(s). Given the following conditions:

- Unit 2 was operating at 100% power.
- An SM line break occurred at 1300.
- EP/2/A/5000/ECA-2.1 (Uncontrolled Depressurization of All Steam Generators) is being performed.
- At 1430 the following conditions exist:

	A	B	C	D
SG WR levels	22	18	21	23
CA flow	50	50	50	50
NC T hots	385°F and increasing	380°F and increasing	384°F and increasing	386°F and increasing

Which of the following describes the required operator action?

A. Implement bleed and feed.

B. Transition to FR-H.1 and increase CA flow to 450 gpm

C. Do not change CA flow until at least one SG NR level is greater than 37%.

D. Increase CA flow to stabilize Thot.

Distracter Analysis:

A. Incorrect:
Plausible: Required action per FR-H.1 when WR levels are < 24%..

B. Incorrect:
Plausible: Entry conditions for FR-H.1 exist, but the procedure will be exited at the first step because CA flow has been purposely reduced.

C. Incorrect:
Plausible: SG level > 37% is the normal level at which CA flow can be reduced.

D. Correct:

Level: RO

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Question 18
K/A: Westinghouse E12 Uncontrolled Depressurization of all Steam Generators EK2. Knowledge of the interrelations between the (Uncontrolled Depressurization of all Steam Generators) and the following: (CFR: 41.7 / 45.7) EK2.1 Components, and functions of control and safety systems, including instrumentation, signals, interlocks, failure modes, and automatic and manual features. IMPORTANCE RO 3.4 SRO 3.7

Lesson Plan Objective: EP306 Explain the Bases, including any identified knowledges/abilities, for all of the steps, notes, and cautions in EP/1/A/5000/ECA-2.1 (Uncontrolled Depressurization of All Steam Generators)

Source: Modified (Harris 2004)

Level of knowledge: comprehension

References:
1.
2. ECA-2.1

ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED

NOTE NC pump trip criteria based on NC subcooling does not apply after S/I termination.

24. **Verify S/I flow not required as follows:**

__ a. NC subcooling based on core exit T/Cs - GREATER THAN 0°F.

a. Perform the following:

__ 1) Manually start S/I pumps and align valves as required to restore NC subcooling.

__ 2) **RETURN TO** Step 4.

__ b. Pzr level - GREATER THAN 11% (20% ACC).

b. Perform the following:

__ 1) Control charging flow to restore Pzr level.

2) **IF** Pzr level cannot be maintained greater than 11% (20% ACC), **THEN**:

__ a) Manually start S/I pumps and align valves as required to restore Pzr level.

__ b) **RETURN TO** Step 4.

__ 25. **Verify all NC T-Hots - STABLE OR DECREASING.**

__ **Throttle feed flow or dump steam to stabilize NC T-Hots.**

__ 26. **Verify N/R level in all S/Gs - LESS THAN 50%.**

__ **Throttle feed flow to maintain N/R level in all S/Gs less than 50%.**

27. **Establish normal letdown as follows:**

__ a. Verify VI pressure - GREATER THAN 35 PSIG.

a. Perform the following:

__ 1) **WHEN** VI pressure is greater than 35 PSIG, **THEN** perform Steps 27.b through 27.o.

__ 2) **GO TO** Step 28.

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Question 19

Bank Question: 07-19 ***Answer: A***

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1 Pt(s). Given the following plant conditions:

- Reactor Power is 20%
- Control Bank D rods are at 55 steps
- ONE Control Bank D rod was dropped and recovered
- The P/A Converter was NOT reset during rod retrieval so the P/A converter display indicates Control Bank D is at 100 steps withdrawn.

After power has been increased to 100% and Control Bank D has been withdrawn to 200 Steps which of the following describes the effect of the incorrect P/A Converter setting?

A. During a runback the ROD INSERTION LO-LO Limit Alarm will occur when Control Bank D actual position is 45 steps below the insertion limit.

B. During a runback the ROD INSERTION LO-LO Limit Alarm will occur when Control Bank D actual position is 45 steps above the insertion limit.

C. During rod insertion overlap will be wrong and Control Bank C control will begin to insert 45 steps too soon.

D. During rod insertion overlap will be wrong and Control Bank C control will begin to insert 45 steps too late.

Distracter Analysis:

A. Correct:

B. Incorrect:
Plausible: Opposite effect from correct answer.

C. Incorrect:
Plausible: Failure to reset the Master Cycler will impact bank overlap..

D. Incorrect:
Plausible: Failure to reset the Master Cycler will impact bank overlap.

Level: RO

K/A: APE: 003 Dropped Control Rod AK3. Knowledge of the reasons for the following responses as they apply to the Dropped Control Rod: (CFR 41.5,41.10 / 45.6 / 45.13) AA1. Ability to operate and / or monitor the following as they apply to the Dropped

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Question 19
Control Rod: (CFR 41.7 / 45.5 / 45.6) AA1.01 Demand position counter and pulse/analog converter 2.9* 2.9

Lesson Plan Objective: IRE02 Describe the basic function of the major components in the Rod Control System including:
2.1 Bank Overlap Unit
2.2 Master Cycler
2.3 P/A Converter

Source: Modified (Summer 2002)

Level of knowledge: comprehension

References:
1.
2. IRE lesson and AP/14

N. Pulse to Analog (P/A) Converter (Obj. #2, 3)

1. The P/A Converter is located in the DC Hold Cabinet and converts the Pulse signals from the Logic Cabinet into Analog signals for use in:
   a) Rod Insertion Limit Computer- used to compare actual rod position to the position calculated by the RIL computer. The RIL computer uses Auct. High Delta T as an indication of power for this calculation.
   b) Rod Insertion limit recorder on MC-9 – supplies actual bank position.
   c) Bank "D" Withdrawal Limit- C-11 – used to compare rod position to C-11 setpoint.
2. The P/A converter counts the steps for each Control Bank. The readout for each bank can be read locally by using the selector switch to select the applicable bank. The reading can be changed by holding the Auto/Man switch to Manual and using pushbuttons to increase or decrease the reading. This is done during repositioning of misaligned rods, periodic rod repositioning, RCCA Movement PT, or rod re-alignment performed after startup.

O. Motor Generator (MG) Sets (Obj. #23)

1. The MG Sets consist of two three phase, 600 volt, 150 HP induction Westinghouse Motors, operating at 60 cycles. Each motor is connected to a generator through a large flywheel.
2. The generator is a three phase synchronous alternator rated at 500 kva, 260 volts $\pm$ 5%, 58.5 hz $\pm$ 5%. The "A" MG set motor is supplied from its units 600v LCC LXC and the "B" MG set is supplied from the 600v LCC LXD from its respective unit. The output of the generator supplies power to the reactor trip breakers, which then supply power to the rod control system.
3. The flywheel is sized so that during a loss of input voltage for one second, the generator output voltage will not decrease 5% below 260 volts to the line. It is also designed so frequency will not decrease below 53.5 hz. while supplying a 100kw load.
4. Operation of the MG sets
   a) Use current copy of OP/1/A/6150/008 for reviewing operation of first set and second MG set startup and parallel operations. This procedure should also be used for shutdown operations of the MG Sets and the adjustment of the directional over-current relays.
   b) The procedure has the operator check for movement of the directional over-current relays. Any movement indicates that the affected MG set is under-excited. Slightly increasing the VOLTAGE ADJUST is necessary for proper operation.

ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED

4. **Initiate emergency boration of NC System as follows:**

__ a. Ensure at least one NV pump - ON.

__ b. Open 2NV-236B (Boric Acid To NV Pumps Suct).

__ c. Ensure both boric acid transfer pump switches - IN THE "ON" POSITION.

__ d. Verify emergency boration flow - GREATER THAN OR EQUAL TO 30 GPM.

d. Align NV pump suction to the FWST as follows:

1) Open the following valves:

__ • 2NV-252A (NV Pumps Suct From FWST)

__ • 2NV-253B (NV Pumps Suct From FWST).

2) Close the following valves:

__ • 2NV-188A (VCT Otlt Isol)
__ • 2NV-189B (VCT Otlt Isol).

ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED

4. (Continued)

e. Verify the following charging line isolation valves - OPEN:

__ • 2NV-312A (Chrg Line Cont Isol)
__ • 2NV-314B (Chrg Line Cont Isol).

e. Perform the following:

1) Align NV pump suction to the FWST as follows:

a) Open the following valves:

__ • 2NV-252A (NV Pumps Suct From FWST)

__ • 2NV-253B (NV Pumps Suct From FWST).

b) Close the following valves:

__ • 2NV-188A (VCT Otlt Isol)
__ • 2NV-189B (VCT Otlt Isol).

2) Ensure the following valves - OPEN:

__ • 2NI-9A (NV Pmp C/L Inj Isol)
__ • 2NI-10B (NV Pmp C/L Inj Isol).

__ f. Verify Pzr pressure - LESS THAN 2335 PSIG.

f. Perform the following:

1) Verify the following valves - OPEN.

__ • All Pzr PORVs
__ • All Pzr PORV isolation valves.

__ 2) **IF** any Pzr PORV(s) **OR** isolation valves closed, **THEN** manually open Pzr PORV(s) and isolation valves as required to reduce Pzr pressure to less than 2135 PSIG.

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Question 20

Bank Question: 07-20 ***Answer: D***

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1 Pt(s). Unit 2 is at 100% RTP when both Feedwater pumps trip. The reactor does not trip. The crew has entered EP/2/A/5000/FR-S.1 (Response to Nuclear Generation/ATWS). During the initiation of Emergency Boration, the following indications are noted:

- Charging Flow = 60 gpm
- Letdown Flow = 75 gpm
- PZR pressure = 2300 psig
- 2A NV Pump is ON
- 2A and 2B BAT Pumps are ON
- 2NV-236B (Boric Acid To NV Pumps Suct) is open
- 2NV-312A (Chrg Line Cont Isol) is open
- 2NV-314B (Chrg Line Cont Isol) is open
- Emergency Boration Flow = 40 gpm.

What action (if any) is required to ensure the boration is accomplished?

A. Swap the suction of the NV pumps to the FWST

B. Swap the suction of the NV pumps to the FWST and align NV SI injection flowpath

C. Open all PZR PORVs and PZR PORV Isolation Valves

D. No action is required.

Distracter Analysis:

A. **Incorrect**:
Plausible: This action is only required if emerg borate flow is less than 30 or if charging line is isol.

B. **Incorrect:**
Plausible: only required if charging line is isol

C. **Incorrect:**
Plausible: only required if press greater than 2335 psig.

D. **Correct:**

Level: RO

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Question 20
K/A: APE: 024 Emergency Boration AA2. Ability to determine and interpret the following as they apply to the Emergency Boration: (CFR: 43.5 / 45.13) AA2.01 Whether boron flow and/or MOVs are malfunctioning, from plant conditions ... 3.8* 4.1

Lesson Plan Objective: FRS05 Given a set of specific plant conditions and required procedures, apply the rules of usage and outstanding PPRBs to identify the correct procedure flowpath and necessary actions

Source: NEW

Level of knowledge: comprehension

References:
1. EP/2/FR-S.1
2.

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Question 21

Bank Question: 07-21 ***Answer: A***

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1 Pt(s). A malfunction in the power supply to S/R N-31 has caused a gradually decreasing voltage supplied to the detector high voltage supply. Annunciator 1AD-2 D/1 (S/R HI Voltage Failure) has alarmed.

What is the effect of this decreasing voltage?

A. The detector output will decrease until the voltage reaches the recombination region.

B. The detector output will decrease until the voltage reaches the Geiger Muller region.

C. The detector output will increase until the voltage reaches the Geiger Muller region.

D. The detector output will increase until the voltage reaches the recombination region.

Distracter Analysis:

A. **Correct:**

B. **Incorrect:**
Plausible: Detector output will continue to decrease but the GM region is high voltage not low.

C. **Incorrect:**
Plausible: Low voltage to compensation chamber of a compensated ion chamber will cause output to increase.

D. **Incorrect**:
Plausible: Low voltage to compensation chamber of a compensated ion chamber will cause output to increase

Level: RO

K/A: APE: 032 Loss of Source Range Nuclear Instrumentation AA2. Ability to determine and interpret the following as they apply to the Loss of Source Range Nuclear Instrumentation: (CFR: 43.5 / 45.13) AA2.09 Effect of improper HV setting 2.5 2.9

Lesson Plan Objective: BNT-CP02R02 State the basic theory of operation of an ion chamber radiation detector.

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Question 21
Source: NEW

Level of knowledge: Memory

References:
1. BNT-CP02R
2.

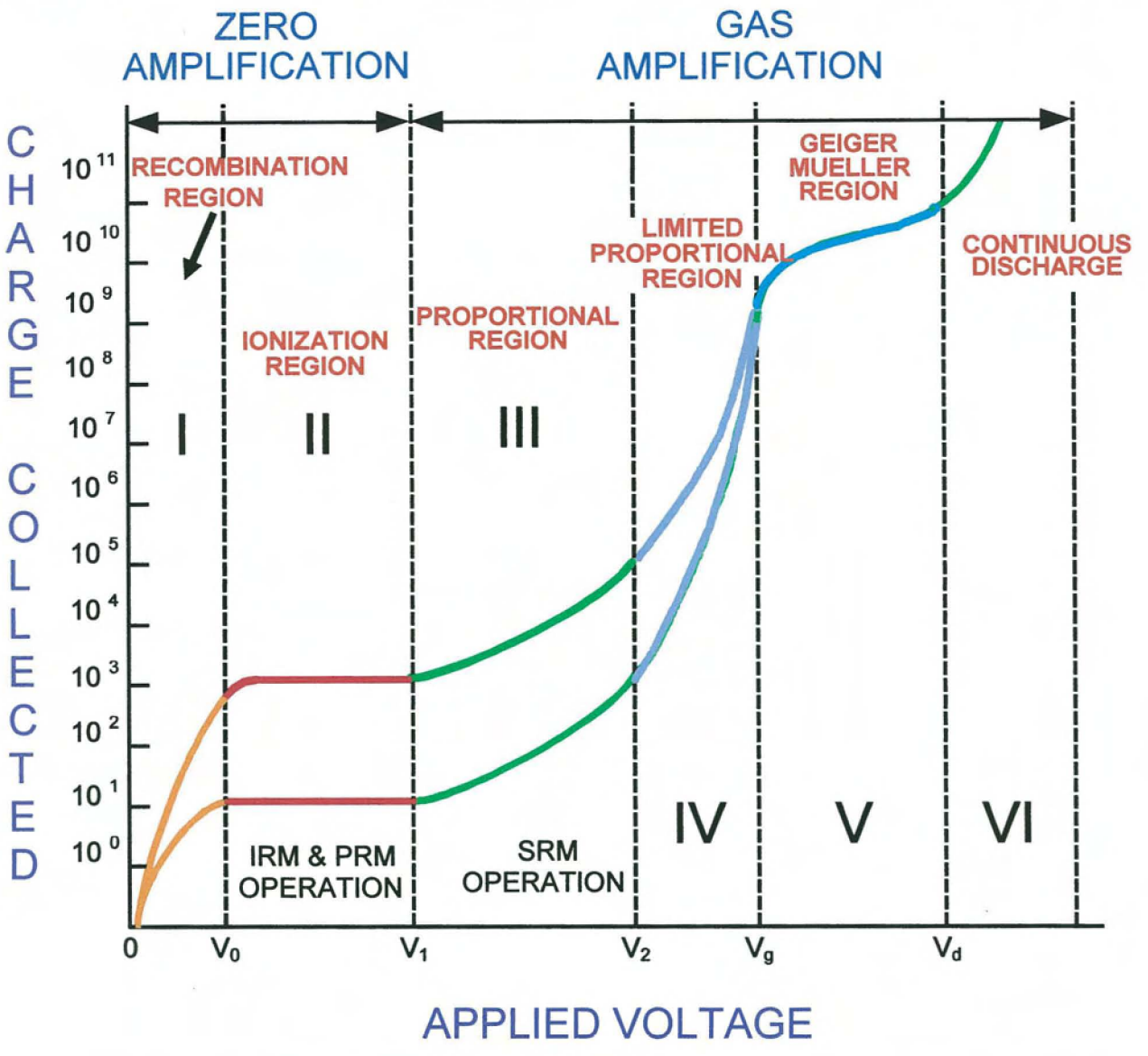

Figure 2 Gas-Filled Detector Characteristic Curve

At voltages less than V_0, the ions move slowly toward the electrodes, and, as a result, they tend to recombine to form neutral atoms or molecules. Consequently, the pulse height will be less than if all the originally formed ion pairs succeeded in reaching the electrodes. Gas filled detectors are NOT operated in this region of response. This region is called the Recombination Region. Region I lies between 0 and V_0 volts. In this region, the number of ion pairs collected per radiation event gradually increases until it reaches a saturation value. At the voltage V_0, the field strength between the detector cathode and anode is sufficient to ensure complete collection of all the ion pairs produced within the detector by the original ionizing event.

Region II is the region extending from V_0 to V_1 volts. There is no appreciable increase in the number of ion pairs collected as the voltage is increased in this region. The field strength is adequate to ensure collection of all ion pairs produced by the initial ionization events (called "primary ions"). The voltage range for this plateau depends on the physical characteristics of the detector and the composition and pressure of the gas. This region is called the Ionization Region, sometimes referred to as the Ion Chamber Region.

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Question 22

Bank Question: 07-22 ***Answer: C***

---

1 Pt(s). A radiation worker will be performing cleanup of a radioactive liquid spill. The area has the following radiological characteristics:

- The worker's present exposure is 1915 mrem for the year
- General area dose rate = 30 mrem/hr
- Airborne contamination concentration = 20.0 DAC

The job will take 2 hours if the worker wears a full-face respirator. It will only take 1 hour if the worker does NOT wear the respirator.

If the RP Manager grants all applicable dose extensions, which one of the following choices for completing this job would maintain the worker's exposure within the station administrative requirements??

A. The worker should NOT wear the respirator because the calculated TEDE dose received will be less than if he wears one.

B. The worker should NOT wear the respirator because the dose received while wearing a respirator will exceed site annual personnel dose limits.

C. The worker should wear the respirator because the calculated TEDE dose received will be less than if he does not wear one.

D. The worker should wear the respirator otherwise he could exceed DAC limits.

Distracter Analysis:
Radiation exposure comparison:
Without respirator
DDE = 30 mrem/hr x 1 hr = 30 mrem
From airborne contamination:
CEDE = 20 DAC 1 hr x 2.5 mrem/DAC-hr = 50 mrem
TEDE = 30 + 50 = 80 mrem from job
Total exposure for year = 1915 + 80 = 1995 mrem

With respirator
DDE = 30 mrem/hr x 2 hr = 60 mrem
CEDE = 0
TEDE = 60 mrem
Total exposure for year = 1915 + 60 = 1975 mrem

(With respirator) (Without respirator)
TEDE = 60 mrem > 80 mrem = use a respirator

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Question 22

A. **Incorrect:**
Plausible: The calculated exposure will be greater if you DO NOT wear the respirator. If the candidate incorrectly computes the exposure - this was the correct answer on a previous exam

B. **Incorrect:**
Plausible: The dose will not exceed the limit.

C. **Correct:**

D. **Incorrect**:
Plausible: DAC limits are not direct ALARA controls. If the candidate does not understand the concept of derived airborne concentrations.

Level: RO

K/A: APE: 059 Accidental Liquid Radwaste Release 2.3 Radiation Control
2.3.2 Knowledge of facility ALARA program. (CFR: 41.12 / 43.4 / 45.9 / 45.10)
IMPORTANCE RO 2.5 SRO 2.9

Lesson Plan Objective: RADHP04 List the mathematical relationship between DAC-hours and ALI, and between ALI and TEDE.

Source: Modified (CNS 2003)

Level of knowledge: comprehension

References:
1. OP-CN-RAD-HP
2.

2.4 Emergency Exposure (Obj. #18)

A. Personnel chosen for emergency exposure will be selected based on the following:

1. Personnel must be Duke Energy Emergency Response Organization Member or Off-site Agency Emergency Worker.
2. Should be a volunteer; but if expected to receive greater than 25 rem, the person must be a volunteer.
3. Personnel shall be advised of the risks, including the effects of different levels of dosage, and both short and long term effects.
4. Should be non pregnant adult.
5. All factors equal, the older workers should be considered first.

B. Exposure Limits

1. To protect valuable property a person may receive up to 10 rem TEDE, 30 rem to the lens of the eye, and 100 rem to the skin and extremities.
2. To save a life or protect a large population a person may receive 25 rem TEDE, 75 rem to the lens of the eye, and 250 rem to the skin and extremities.
3. To save a life or protect a large population on volunteer basis only, a person may receive greater than 25 rem TEDE, greater than 75 rem to the lens of the eye, and greater than 250 rem to the skin and extremities.

2.5 Internal Exposure

A. Annual Limit on Intake (ALI) (Obj. #3)

The amount of airborne radioactive material necessary to receive a CEDE of 5 rem effective dose equivalent or 50 rem to any organ. Each individual is limited to one ALI per year.

B. Derived Air Concentration (DAC) (Obj. #3)

The concentration of radioactive material in air that would result in an intake of one ALI if breathed for 2,000 hours (40 hours/week, 50 weeks/year).

2000 DAC-hours = 1 ALI = 5 rem internal exposure (CEDE) Obj. #4)

1 DAC hr = 2.5 mrem

C. Relating DAC, CEDE, ALI, and TEDE

TEDE is equal to the external dose plus the internal dose (CEDE). Since 5 rem is equivalent to 1 ALI, which is also equivalent to 2,000 DAC hours, 1 DAC hour is equal to 2.5 mrem of external dose for most radionuclides (5,000 mrem/2,000 hours = 2.5 mrem per DAC hour). For nonstochastically limited radionuclides, the hazard is somewhat less than that of 2.5 mrem external dose.

At 25% of DAC or greater, area is posted with sign "Airborne Radioactivity Area". Personnel entering the area are assigned DAC-hrs based on time in the area.

Example of a Simplified TEDE/ALARA Evaluation

Review the following problems:

An individual is assigned the task of repairing a door in a radiological area. The area has a dose rate of 24 mrem/hr and also has some airborne radioactivity. From experience with this door, the individual knows it will take 2 hours and 20 minutes to make the repair with a respirator or 2 hours without a respirator. If the job is done without a respirator, the individual will receive 2 DAC hours' internal exposure.

If the individual wears a respirator what will the total dose be?

Answer: The total dose will be 56 mrem.

(24 mrem/hr)(2.33 hrs) = 56 mrem

If the individual does not wear a respirator, what will the total exposure be?

Answer: The total dose will be 53 mrem.

(24 mrem/hr)(2 hour) + (2 DAC hours)(2.5 mrem/DAC hour) = 53 mrem

Which individual received less dose?

Answer: The individual not wearing the respirator.

D. Methods of Internal Deposition (Obj. #5)

1. Radioactive Material enters the body through:
   a) Inhalation - breathing.
   b) Ingestion - eating, drinking, or chewing.
   c) Absorption - absorbing it through the skin.
   d) Injection/Open wounds - through an open wound, sore, or puncture wound. Notify RP if you have open cuts or sores ***BEFORE*** entering radiologically controlled areas.

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Question 23

Bank Question: 07-23 ***Answer: A***

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1 Pt(s). An Inadequate Core Cooling event has occurred.

- No ECCS pumps are operating.
- FWST level is 3%.

Step 2 of Response to Inadequate Core Cooling (EP/1/A/5000/FR-C.1) RNO is being performed.

What is the reason for ensuring open 1ND-28A (ND Supply To NV & 1A NI Pmps) and 1NI-136B (ND Supply To NI Pump 1B)?

A. To ensure ECCS is in Cold Leg Recirc (CLR) alignment with NV suction aligned to ND discharge.

B. To ensure ECCS remains in Injection Mode while FWST makeup restores FWST level.

C. To ensure a gravity fill flow path in order to utilize the remaining contents of the FWST in the absence of injection pumps.

D. To ensure a miniflow path for ND Pumps in cold leg recirc. until NC pressure is reduced allowing ND injection.

Distracter Analysis:

A. **Correct:**

B. **Incorrect:**
Plausible: Makeup to the FWST is a normal operational practice when level is low or inventory is needed. ECCS is not left in injection mode at 3% FWST level..

C. **Incorrect:**
Plausible: Gravity flow from the FWST is a means of Core Cooling used in the SAMG's but not an option at 3% FWST level in Inadequate Core Cooling..

D. **Incorrect**:
Plausible: In most cases NC pressure would initially be above the ND Pump shutoff head when entering Inadequate Core Cooling. The NC System would be depressurized to allow ND pump injection, but 1ND-28 & 1NI-136B are opened to ensure a cold leg recirc flow path from the ND pumps to the NV Pump suctions.

Level: RO

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Question 23
K/A: EPE: 074 Inadequate Core Cooling EK3 Knowledge of the reasons for the following responses as they apply to the Inadequate Core Cooling: (CFR 41.5 / 41.10 / 45.6 / 45.13) EK3 09 Opening the cross-connect valve from the LPI to the HPI suction 4.4* 4.6*

Lesson Plan Objective: EPFRC03 Explain the Bases for all steps in each of Function Restoration procedures EP/1/A/5000/FR-C Series - Core Cooling

Source: NEW

Level of knowledge: comprehension

References:
1. FR-C.1
2.

ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED

C. Operator Actions

__ 1. **Monitor Enclosure 1 (Foldout Page).**

2. **Verify proper S/I valve alignment as follows:**

__ a. S/I systems - IN INJECTION MODE.

a. Verify S/I valves aligned for Cold Leg Recirc as follows:

1) Ensure the following valves - CLOSED:

__ • 1NV-188A (VCT Otlt Isol)

__ • 1NV-252A (NV Pumps Suct From FWST)

__ • 1NV-189B (VCT Otlt Isol)

__ • 1NV-253B (NV Pumps Suct From FWST)

__ • 1FW-27A (ND Pump 1A Suct From FWST)

__ • 1ND-32A (ND Train 1A Hot Leg Inj Isol)

__ • 1FW-55B (ND Pump 1B Suct From FWST)

__ • 1ND-65B (ND Train 1B Hot Leg Inj Isol)

__ • 1NI-100B (NI Pmps Suct From FWST)

__ • 1NI-115A (NI Pump 1A Miniflow Isol)

__ • 1NI-144A (NI Pump 1B Miniflow Isol)

__ • 1NI-147B (NI Pump Miniflow Hdr To FWST Isol).

(RNO continued on next page)

ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED

2. (Continued)

2) Ensure the following valves - OPEN:

__ • 1NI-185A (ND Pump 1A Cont Sump Suct)

__ • 1NI-173A (ND Hdr 1A To Cold Legs C&D)

__ • 1ND-28A (ND Supply To NV & 1A NI Pmps)

__ • 1NI-184B (ND Pump 1B Cont Sump Suct)

__ • 1NI-178B (ND Hdr 1B To Cold Legs A&B)

__ • 1NI-332A (NI Pump Suct X-Over From ND)

__ • 1NI-333B (NI Pump Suct From ND)

__ • 1NI-334B (NI Pump Suct X-Over From ND)

__ • 1NI-136B (ND Supply To NI Pump 1B)

__ • 1NI-103A (NI Pump 1A Suct)

(RNO continued on next page)

ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED

2. (Continued)

__ • 1NI-118A (NI Pump 1A C-Leg Inj Isol)

__ • 1NI-162A (NI To C-Legs Inj Hdr Isol)

__ • 1NI-135B (NI Pump 1B Suct)

__ • 1NI-150B (NI Pump 1B C-Leg Inj Isol)

__ • 1NI-9A (NV Pmp C/L Inj Isol)

__ • 1NI-10B (NV Pmp C/L Inj Isol).

__ 3) **GO TO** Step 3.

ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED

2. (Continued)

b. Verify all of the following valves - OPEN: — b. Manually open valve(s).

__ • 1NV-252A (NV Pumps Suct From FWST)

__ • 1NV-253B (NV Pumps Suct From FWST)

__ • 1FW-27A (ND Pump 1A Suct From FWST)

__ • 1ND-32A (ND Train 1A Hot Leg Inj Isol)

__ • 1NI-173A (ND Hdr 1A To Cold Legs C&D)

__ • 1FW-55B (ND Pump 1B Suct From FWST)

__ • 1ND-65B (ND Train 1B Hot Leg Inj Isol)

__ • 1NI-178B (ND Hdr 1B To Cold Legs A&B)

__ • 1NI-103A (NI Pump 1A Suct)

__ • 1NI-118A (NI Pump 1A C-Leg Inj Isol)

__ • 1NI-162A (NI To C-Legs Inj Hdr Isol)

__ • 1NI-100B (NI Pmps Suct From FWST)

__ • 1NI-135B (NI Pump 1B Suct)

__ • 1NI-150B (NI Pump 1B C-Leg Inj Isol)

__ • 1NI-9A (NV Pmp C/L Inj Isol)

__ • 1NI-10B (NV Pmp C/L Inj Isol).

c. Verify the following valves - CLOSED: — c. Manually close valve(s).

__ • 1NV-188A (VCT Otlt Isol)
__ • 1NV-189B (VCT Otlt Isol).

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Question 24

Bank Question: 07-24 ***Answer: A***

---

1 Pt(s). Following an automatic Safety Injection signal where all expected automatic actions have occurred, what is required to reset the Safety Injection Signal?

A. One minute has elapsed from the time of the actuation.

B. The Reactor Trip Breakers are re-closed.

C. The initiating condition was high containment pressure.

D. The initiating condition has cleared.

Distracter Analysis:

A. **Correct:**

B. **Incorrect:**
Plausible: This is correct to reinstate auto SI actuation.

C. **Incorrect:**
Plausible: This is correct for an SM Isolation.

D. **Incorrect:**
Plausible: This is correct for several safety signals.

Level: RO

K/A: Westinghouse E01 Rediagnosis EK2. Knowledge of the interrelations between the (Reactor Trip or Safety Injection/Rediagnosis) and the following: (CFR: 41.7 / 45.7) EK2.1 Components, and functions of control and safety systems, including instrumentation, signals, interlocks, failure modes, and automatic and manual features. IMPORTANCE RO 3.3 SRO 3.5

Lesson Plan Objective: ISE05 Describe how each ESF Signal is reset.

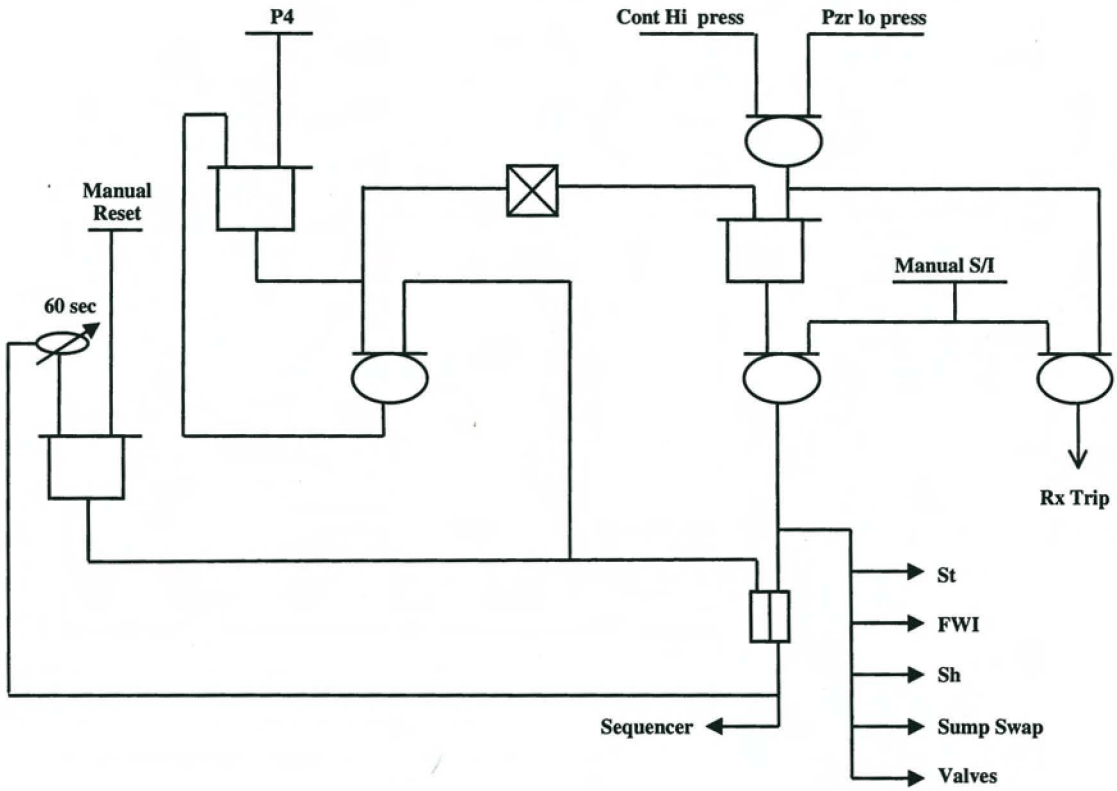
Source: MODIFIED (Diablo Canyon 2002)

Level of knowledge: Memory

References:
1.
2. ISE Lesson

2.4 ESF Signals (OBJ #4 & 5)

Safety Injection



A. Safety Injection (Ss)

1. Three signals actuate S_S.

a) Manual

1) One button for Train A and One button for Train B under Plexiglas on MC11.

2) Each button ONLY ACTUATES its respective train. (See drawing above)

3) After 60 sec timer times out ECCS can be reset. This will block AUTO S/I, if P-4 is present.

4) For a manual S/I, P-4 is not required to allow reset of S/I to gain control of actuated equipment.

5) The Sequencer would also need to be reset to regain control of equipment.

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Question 25

Bank Question: 07-25 ***Answer: B***

---

1 Pt(s). EP/1/A/5000/ES-0.3 (Natural Circulation Cooldown With Steam Void in Vessel) is in progress.

The following conditions exist:

	1200	1205	1210
Letdown flow	75 gpm	75 gpm	75 gpm
Charging flow	85 gpm	75 gpm	75 gpm
Total seal inj flow	32 gpm	32 gpm	32 gpm
Total seal leakoff flow	12 gpm	12 gpm	12 gpm
RVLIS level	88%	87%	88%
Pressurizer pressure	2200	2195	2190
Pressurizer level	30	31	32

Select the answer that, given these conditions, explains the response of pressurizer level?

A. Pressurizer level is increasing because charging and seal injection flows are greater than letdown and seal leak off flows,

B. Pressurizer level is increasing because the void is expanding due to the decrease in pressure.

C. Pressurizer level is increasing faster than expected because charging and seal injection flows are greater than letdown and seal leak off flows, and the void is expanding.

D. Pressurizer level is increasing faster than expected because charging and letdown flows are matched, and the void is expanding.

Distracter Analysis:

A. **Incorrect:**
Plausible: Failure to factor in seal leakoff makes total charging and total letdown to be equil.

B. **Correct:**

C. **Incorrect:**
Plausible: Seal injection is already included in charging flow. A common mistake is to add these two together.

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Question 25

D. **Incorrect**:
Plausible: Total charging flow is less than total letdown flow, but if pressure is decreasing at the correct rate, void growth will cause level to be stable.

EP/1/A/5000/ES-0.2
Dump steam to condenser while maintaining cooldown rate based on NC T-Colds less than 50°F in an hour.

Level: RO

K/A: Westinghouse E10 Natural Circulation with Steam Void in Vessel with/without RVLIS EK1. Knowledge of the operational implications of the following concepts as they apply to the (Natural Circulation with Steam Void in Vessel with/without RVLIS) (CFR: 41.8 / 41.10 / 45.3) EK1.2 Normal, abnormal and emergency operating procedures associated with (Natural Circulation with Steam Void in Vessel with/without RVLIS). IMPORTANCE RO 3.4 SRO 3.6

Lesson Plan Objective: OP-CN-EP-EP1 OBJ# 17: Explain the Bases, including any identified knowledges/abilities, for all of the steps, notes, and cautions in EP/1/A/5000/ES-0.3 (Natural Circulation Cooldown with Steam Void in Vessel (with RVLIS)).

Source: NEW

Knowledge: Comprehensive

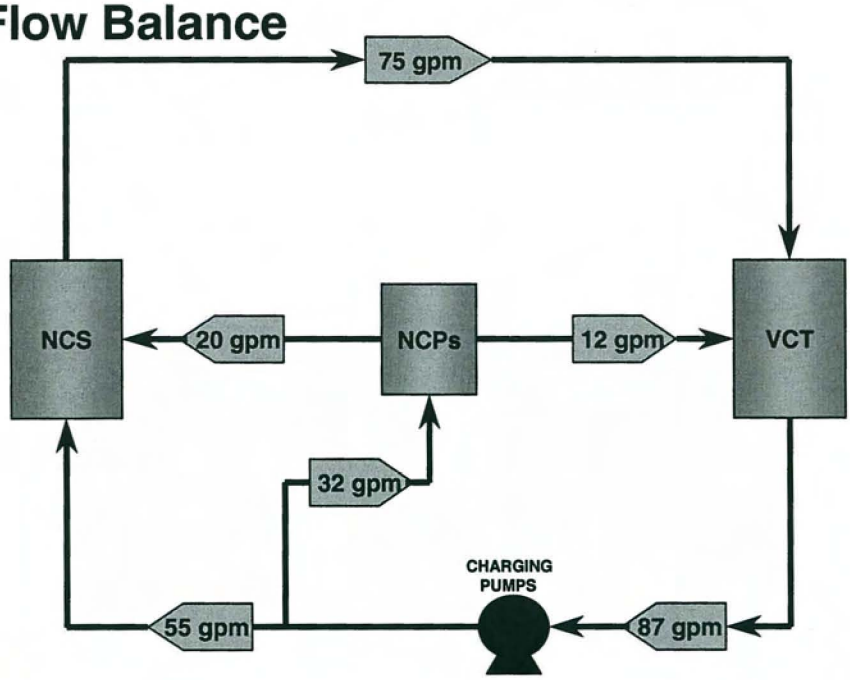
References:
1. EP/1/A/5000/ES-0.2
EP/1/A/5000/ES-0.3
EP/1/A/5000/E-3
EP/1/A/5000/ES-1.2
EP/1/A/5000/ECA-3.2
2. EBG/1/5000/ES-0.3 STEP 5

2. The amount of boric acid stored in the Reactor Makeup Control System always exceeds that amount required to borate the Reactor Coolant System to cold shutdown concentration assuming that the control assembly with the highest reactivity worth is stuck in its fully withdrawn position. This amount of boric acid also exceeds the amount required to bring the reactor to hot shutdown and to compensate for subsequent xenon decay.

G. Emergency Core Cooling - The centrifugal charging pumps in the Chemical and Volume Control System serve as the high-head safety injection pumps in the Emergency Core Cooling System. Other than the centrifugal charging pumps and associated piping and valves, the Chemical and Volume Control System is <u>not</u> required to function during a loss of coolant accident, and is isolated except for the centrifugal charging pumps, safety injection and NC pump seal injection flow paths.

H. System Flow Balance (OBJ. #3)

Flow Balance



1. It is important to have the system in balance during normal steady state conditions to ensure the NCS mass is maintained constant.
2. This is ensured by having the following approximate flow conditions:
   a) 75 gpm letdown flow.
   b) 87 gpm flow from the VCT.
   c) 55 gpm charging flow to the loops.
   d) 32 gpm charging flow to the NCP seals.
      1) 20 gpm down the NCP shaft into the NCS.

STEP 3: Establish Pzr level to accommodate void growth as follows:

PURPOSE:

To remind the operator that he should have a saturated Pzr before he attempts to reduce Pzr level.

To ensure that there is adequate space in the Pzr to allow the displacement of fluid from the primary system due to the formation of a void in the vessel.

APPLICABLE ERG BASIS:

To reduce the Pzr level in a controlled manner, saturated conditions should first be established. If the Pzr is not saturated, decreasing Pzr level (using charging and letdown) will cause the Pzr pressure to decrease faster than if the Pzr were saturated. Though the Pzr pressure still decreases when level is reduced under saturated conditions, the rate of decrease is slower since vapor is created as the pressure drops.

In this procedure as the primary system is cooled and depressurized under natural circulation conditions, a potential for void formation in the upper head region exists. If a void does form, it will displace primary fluid from the vessel into the Pzr as it grows. Therefore, before any further cooldown/depressurization is performed, the Pzr level must be low enough to accommodate this void growth and high enough to cover the Pzr heaters and prevent letdown from isolating. In addition, charging pump speed controls are placed in manual to allow any increase in Pzr level due to void growth.

PLANT SPECIFIC INFORMATION:

KNOWLEDGE/ABILITY:

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Question 26

Bank Question: 07-26 ***Answer: B***

---

1 Pt(s). The following sequence of events has occurred on Unit 1:

- Reactor has been manually tripped due to a secondary system malfunction
- EP/1/A/5000/E-0 (Reactor Trip or Safety Injection) has been performed and a transition made to EP/1/A/5000/ES-0.1 (Reactor Trip Response)
- The STA has identified a YELLOW path on the Heat Sink Status Tree for steam generator pressure
- The crew has entered EP/1/A/5000/FR-H.2 (Response to Steam Generator Overpressure)
- The crew is preparing to dump steam from the affected steam generator
- The CRS reads a step that does not allow releasing steam from a SG with a narrow range level of greater than 93%

Why shouldn't the crew dump steam from the affected SG if NR level is >93%?

A. May cause an uncontrolled radiation release since it is likely that the steam generator is ruptured

B. May result in two phase flow and water hammer, potentially damaging pipes and valves

C. Will be ineffective in lowering SG pressure since the SG water is likely subcooled

D. Will cause a rapid pressure drop in the RCS, potentially resulting in a safety injection

---

Distracter Analysis:

A. Incorrect:
Plausible: A ruptured S/G may have a high level but there are other reasons that level could be high in a S/G.

B. Correct:

C. Incorrect:
Plausible: While true in theory, this is not the reason.

D. Incorrect:
Plausible: This is possible but unlikely following the procedure as written.

Level: RO

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Question 26

K/A: Westinghouse E13 Steam Generator Overpressure EK2.2 Facility*s heat removal systems, including primary coolant, emergency coolant, the decay heat removal systems, and relations between the proper operation of these systems to the operation of the facility. IMPORTANCE RO 3.0 SRO 3.2

Lesson Plan Objective: FRH03 Explain the Bases for all steps in each of Function Restoration procedures EP/1/A/5000/FR-H Series - Heat Sink

Source: BANK (Braidwood 2002)

Level of knowledge: Memory

References:
1.
2. EP/FR-H.2 and EBG

ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED

C. Operator Actions

NOTE Throughout this procedure, "affected" refers to any S/G in which pressure is greater than 1230 PSIG.

__ 1. **Verify at least one S/G pressure - GREATER THAN 1230 PSIG.**	__ **RETURN TO procedure and step in effect.**
__ 2. **Verify Feedwater Isolation status light (1SI-5) for affected S/G(s) - LIT.**	__ **Manually close valves.**
__ 3. **Verify affected S/G(s) N/R level - LESS THAN 92% (82% ACC).**	__ **GO TO EP/1/A/5000/FR-H.3 (Response To Steam Generator High Level).**
4. **Dump steam from the affected S/G(s) PORV as follows:**	
__ a. Manually throttle open affected S/G PORV(s).	__ a. **GO TO** Step 5.
__ b. Verify affected S/G(s) pressure - DECREASING.	__ b. **GO TO** Step 5.
__ c. Verify affected S/G(s) pressure - LESS THAN 1230 PSIG.	__ c. **RETURN TO** Step 3.
__ d. Throttle affected S/G(s) PORV to maintain S/G pressure less than 1230 PSIG.	
__ e. **RETURN TO** procedure and step in effect.	

ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED

C. Operator Actions

1. **IF AT ANY TIME S/G N/R level has increased to greater than 92% (82% ACC), THEN:**

   __ a. Notify station management to perform an evaluation for S/G overfill considerations.

   __ b. Steam should not be released from any S/G with N/R level greater than 92% (82% ACC) prior to overfill evaluation.

NOTE Throughout this procedure, "affected" refers to any S/G in which N/R level is greater than 83%.

__ 2. **Verify at least one S/G N/R level - GREATER THAN 83%.**

__ **RETURN TO procedure and step in effect.**

3. **Verify Feedwater Isolation as follows:**

   __ a. Feedwater pumps - TRIPPED.

   __ b. All Feedwater Isolation status lights (1SI-5) - LIT.

__ a. Manually trip feedwater pump(s).

b. Perform the following:

__ 1) Manually initiate Feedwater Isolation.

__ 2) **IF** proper status light indication is not obtained, **THEN** manually close valves.

STEP DESCRIPTION TABLE FOR EP/1/A/5000/FR-H.3
C. Operator Actions

STEP 1: IF AT ANY TIME S/G N/R level has increased to greater than 92% (82% ACC), THEN:

PURPOSE:

To alert the operator to the potential of overfilling the steam generator to the point where water may have entered the steam lines.

APPLICABLE ERG BASIS:

If the affected S/G level has increased above the narrow range, the operator cannot be sure if the S/G is filled to the steamline. The objective of the status evaluation is to determine if water is in the steamline. Just decreasing affected S/G level into the narrow range does not ensure that water does not remain in the affected S/G steamline. An evaluation of the steamline conditions should occur prior to releasing steam from any S/G with level above 92% [82% for adverse containment] to prevent potential damage to piping, valves, or turbines.

PLANT SPECIFIC INFORMATION:

Unit 1 and Unit 2 difference - Unit 2 value for upper tap is 96% (91% for ACC). |0

KNOWLEDGE/ABILITY:

The operator should have an understanding of potential effects of SG overfill, including:

- Valve inoperability due to effects of water or two phase flow
- Water hammer effects on main steamlines
- Increased dead weight placed on the main steamline and its supports.

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Question 27

Bank Question: 07-27 ***Answer: B***

---

1 Pt(s). During a large LOCA, after the control room is fully staffed, which person or group of persons is (are) required to give permission to an IAE Technician to enter the horseshoe and evaluate the operation of the Containment Sump Level Meter on Main Control Board MC-7?

A. Control Room Supervisor

B. Operations Shift Manager

C. Operations Shift Manager and Reactor Operator

D. Control Room Supervisor and Reactor Operator

Distracter Analysis:

A. **Incorrect:**
Plausible: The CRS is in control of access to the CR during normal ops but The OSM is required to grant access to the CR during abnormal or emergency operations

B. **Correct:**

C. **Incorrect:**
Plausible: The CRS is in control of access to the CR during normal ops but permission to enter the "red zone" must come from an RO if gauge was in "red zone"

D. **Incorrect**:
Plausible: The CRS is in control of access to the CR during normal ops but permission to enter the "red zone" must come from an RO if gauge in "red zone"

Level: RO

K/A: Westinghouse E14 High Containment Pressure 2.1 Conduct of Operations 2.1.9 Ability to direct personnel activities inside the control room. (CFR: 45.5 / 45.12 / 45.13) IMPORTANCE RO 2.5 SRO 4.0

Lesson Plan Objective: NSO523 Describe the requirements and policies for Control Room access control (OMP 2-16, SD 3.1.10,).

Source: NEW

Level of knowledge: Memory

References:
1. SD 3.1.10
2.

4. Responsibilities

4.1. The Operations Shift Manager or designee shall be responsible for:

A. Limiting unnecessary distractions in the Control Room.

B. Controlling access to the Control Room during abnormal/emergency operations.

C. Providing oversight during abnormal/emergency operations to ensure proper crew response.

4.2. The Control Room Supervisor (CRS) shall be responsible for:

A. Maintaining command and control of the Control Room team at all times.

B. Maintaining the Control Room environment quiet and conducive to a professional approach to the job.

C. Ensuring that operators assigned to the Control Room monitor the indications constantly.

D. Controlling access to the Control Room during normal operations.

E. Ensuring that authorization has been granted through communication with the WCC SRO/Unit Supervisor prior to allowing maintenance work to begin on controls or indications under Operations control.

4.3. All Operations personnel shall be responsible for ensuring good communications techniques are employed.

4.4. The Non-licensed Operators shall have responsibility for ensuring that the Control Room is aware of any manipulation of systems that will impact plant operation.

B. The CRS will stay abreast of who is in the Control Room and why they are there.

1. To provide a distraction free turnover and to reduce the number of activities during turnover, no entry into Control Room Surveillance area will be allowed from 0600-0700 or from 1800-1900, except for those individuals listed in Section 5.B.3.

2. Responsibility for limiting access to the area rests with:

a. The CRS during normal operations.

b. The NCO to enter the Red Zone.

c. The Operations Shift Manager (OSM) or designee during abnormal/emergency operations.

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Question 28

Bank Question: 07-28 ***Answer: D***

---

1 Pt(s). Unit 1 was operating at 30% power. Given the following events and conditions:

- 1A NC pump trips
- No operator action has been taken
- All safety systems operate as designed

After 5 minutes have elapsed with the plant still at power, which one of the following parameters will have INCREASED compared to their value before the 1A NCP tripped?

A. Loop hot leg temperature in the A loop.

B. Loop cold leg temperatures in the B, C and D loops.

C. Steam generator pressures in the B, C and D loops.

D. Steam generator steam flows in the B, C and D loops.

Distracter Analysis: The reactor will not trip below P-8.

A. **Incorrect:**
Plausible: Thot will increase as the pump coasts down, but reverse flow will cause Thot to decrease to a value equal to Tcold.

B. **Incorrect**: Unaffected Tcolds will decrease
Plausible: Steam flow in the unaffected loops will increase, heat removal from the RCS will increase, and cold leg temperature will decrease – the candidate may reverse this cause and effect or become confused with the reverse flow in the A loop

C. **Incorrect**: Unaffected S/G pressures will decrease
Plausible: Unaffected steam generators will increase steaming, pressure will decrease – the candidate may reverse this cause and effect.

D. **Correct**: Steam flow in the affected steam generator will decrease, load does not change, the remaining steam generators will increase their steam rates, steam flow in those steam generators will increase.

Level: RO

K/A: 003 Reactor Coolant Pump K5 Knowledge of the operational implications of the following concepts as they apply to the RCPS: (CFR: 41.5 / 45.7) K5.04 Effects of RCP shutdown on secondary parameters, such as steam pressure, steam flow, and feed flow 3.2 3.5

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Question 28
Lesson Plan Objective: NONE

Source: MODIFIED (Catawba 2001)

Level of knowledge: comprehension

References:
1. OP-CN- THF-FF page 15
2.

A/4

1EMF-46A TRAIN A KC HI RAD

SETPOINT: Per HP/0/B/1000/010 (Determination of Radiation Monitor Setpoints)

ORIGIN: 1EMF-46A gamma scintillation detector

PROBABLE CAUSE: Tube leak on one or more heat exchangers interfacing with primary coolant

AUTOMATIC ACTIONS: None

IMMEDIATE ACTIONS: None

SUPPLEMENTARY ACTIONS:

1. Notify Radiation Protection and Chemistry personnel of this alarm.

NOTE: Potential sources of inleakage might be:

- NV Letdown Hx
- NV Excess Letdown Hx
- KF Hxs
- NC Pump Thermal Barriers
- ND Hx

2. Attempt to locate source of leakage into the KC System.
3. Monitor the KC surge tank levels to prevent a contaminated spill at the KC surge tank vent valves, 1KC-122 and 1KC-128, since these valves are open.
4. Refer to AP/1/A/5500/10 (Reactor Coolant Leak).
5. Refer to Tech Spec 3.4.13.

REFERENCES: CNM-1346.05-33

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Question 29

Bank Question: 07-29 ***Answer: B***

---

1 Pt(s). Given the following plants conditions:

- Unit 1 is operating at 100%, steady state power.
- KC surge tank level has increased since the board walk down
- High KC pump inlet temperatures exist
- High KC radiation alarms exist

A leak in which of the following HX would cause the above symptoms?

A. ND heat exchanger.

B. RCP thermal barrier

C. Spent Fuel Pool Cooling heat exchanger.

D. Seal Return heat exchanger

Distracter Analysis:

A. **Incorrect:**
Plausible RHR HX is isolated when at power on the KC side and RHR is not in service. If it where in service and Unisolated, the given conditions are possible.

B. Correct:

C. Incorrect:
Plausible Leakage would be into the KC system but temperature of the KF is very close to that of KC.

D. Incorrect:
Plausible: Leakage at this point would be from KC into seal return.

Level: RO

K/A: SYSTEM: 003 Reactor Coolant Pump System (RCPS) A4 Ability to manually operate and/or monitor in the control room: (CFR: 41.7 / 45.5 to 45.8) A4.08 RCP cooling water supplies 3.2 2.9

Lesson Plan Objective: NCP04 Explain which cooling water supplies cool the NCP components.

Source: MODIFIED (Point Beach 1999)

Level of knowledge: comprehension

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Question 29
References:
1.
2.

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Question 30

Bank Question: 07-30 ***Answer: C***

---

1 Pt(s). The NV Heat Trace system is required to maintain the NV piping greater than ___(1)____ deg F to ensure _____(2)_____.

A. (1) 75
(2) the boron remains in solution in the piping

B. (1) 75
(2) the positive reactivity added by cold water injection is limited.

C. (1) 65
(2) the boron remains in solution in the piping

D. (1) 65
(2) the positive reactivity added by cold water injection is limited

---

Distracter Analysis:

A. **Incorrect:**
Plausible: 75 deg is the minimum temperature of the FWST; correct basis.

B. **Incorrect:**
Plausible: 75 deg is the minimum temperature of the FWST; incorrect basis

C. **Correct:**

D. **Incorrect**:
Plausible: Correct temperature but incorrect basis.

Level: RO

K/A: SYSTEM 004 Chemical and Volume Control System K5 Knowledge of the operational implications of the following concepts as they apply to the CVCS: (CFR: 41.5/45.7) K5.32 Purpose and control of heat tracing (prevent crystallization) 3.1 3.4

Lesson Plan Objective: None

Source: NEW

Level of knowledge: Memory

References:
1. SLC 16.9-8 and AD-8 F/7 ARP
2.

c) Heat trace requirements for boric acid solutions depends mainly on the solution concentration. For Catawba the concentration of boric acid ranges from 10 ppm to 4 wt percent boric acid. Electrical heat tracing is not required on any NV System components which contain 4 wt percent boric acid providing these components are located in a room maintained at 65°F or higher. Redundant room heaters are provided to assure room temperature does not go below 65°F. The 65°F temperature is derived from Boric Acid Tank boron concentration (7700 ppm) solubility temperature of 55°F plus 10°F margin to assure solubility. Boric Acid Tank and Boric Acid Transfer Pump rooms are heated. Thermostat settings typically maintain the areas above 75°F and, therefore, the contents typically above 75°F.

Piping from the Boric Acid Transfer Pump to the Boric Acid Blender and the CCP suction is heated via redundant heat tracing. The amount of piping not heat traced is minimal, and is located downstream of normally closed boron injection path isolation valves NV240 and NV234 where the small lines enter the larger pump suction header. A temperature survey was taken with minimal heat loads in service in the Unit 1 boron injection flowpath areas of the Auxiliary Building during 1EOC4 shutdown. Actual winter conditions were additionally adjusted to simulate 10°F design outdoor air temperature. Survey results indicated that a normal general area temperature of approximately 75°F is maintained by normal heat loads (lighting, etc.) with worst case temperatures no lower than 65°F.

Since dilution of 7700 ppm boron solution at the blender or CCP suction would decrease the minimum solubility, and heat added to the room by CCP operation would aid in maintaining solubility, heat tracing downstream of valves NV240 and NV234 is not required. The proper operation of the heat tracing as displayed on the heat tracing panelboard ensures that boron solubility is properly maintained in all plant modes, including operation, cold shutdown, and refueling.

d) Backup cooling water supply from the YD system for 1A and 2A NV pumps.

1) In order to improve the total core damage frequency, backup cooling was provided to Centrifugal Charging Pump (CCP) A. The Probabilistic Risk Assessment (PRA) for Catawba Nuclear Station states that a "Loss of KC" event and a "Loss of RN" event are significant contributors to an NC pump seal LOCA. In addition, the Severe Accident Analysis Group determined that only one train would need the backup cooling.

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Question 31

Bank Question: 07-31 ***Answer: B***

---

1 Pt(s). With the following Unit status:

- TPBE = 100%
- NC Boron = 250 ppm
- RMWST Boron = 35 ppm
- RMWST Level = 68%
- FWST Boron = 2900 ppm
- FWST Level = 98%
- BAT Boron = 7500 ppm

What should the controller for 1NV-238A (B/A Xfer Pmp To Blender Ctrl) be set for?

A. 0.65

B. 0.75

C. 2.59

D. 3.00

Distracter Analysis:
Per OP/**1**/A/6150/009 Boron Concentration Control Encl 4.1

NOTE: In "AUTO", the blender outlet flow rate defaults to 90 gpm. Calibration tolerances will result in actual flow rate differing slightly from this value. If actual flow rate is **NOT** known, use 90 gpm in the following calculation.
The RMWST boron concentration has an insignificant effect on the calculation at higher outlet concentrations. The RMWST boron concentration term may be considered "0" when the desired concentration is greater than 100 ppm.

2.2 Determine the boric acid flow rate (V**a**) for the desired concentration by the following calculation: (R.M.)

$$Va = \frac{Vb\ (Cb - Cw)}{(Ca - Cw)}$$

Where:
V**b** is the blender outlet flow rate,
C**b** is the desired outlet boron concentration,
C**w** is the RMWST boron concentration and
C**a** is the BAT boron concentration

NOTE: The intent of the following step is to account for known inaccuracies. The Control RoomSupervisor should be involved in determining the amount of correction to apply.

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Question 31

2.3 **IF** previous makeups have demonstrated an inability to achieve the desired boric acid flow rate, determine the amount of correction needed. _____ gpm. (R.M.)

2.4 Determine the setpoint for the boric acid controller as follows: (R.M.)
Setpoint = $\frac{\text{Va + correction from Step 2.3}}{4}$

Correct

90(250 x 0) = 22500/ 7500 = 3/ 4 = 0.75 (3 gpm on a 40 gpm scale)

A. **Incorrect:**
Plausible: If the student uses the RMWST [B] in the calc instead of 0 as required when NC [B] greater than 100.

B. **Correct:**

C. **Incorrect:**
Plausible: Answer A value but failed to divide by 4. 10 turn pot – already taken into account in the calc (40 / 10 = 4)

D. **Incorrect**:
Plausible: Answer B value but failed to divide by 4

Level: RO

K/A: SYSTEM 004 Chemical and Volume Control System A4 Ability to manually operate and/or monitor in the control room: (CFR: 41/7 / 45.5 to 45.8) A4.04 Calculation of boron concentration changes 3.2 3.6

Lesson Plan Objective: NV26 Using the Reactor Operating Data Book as a reference, determine how to maintain a given NCS boron concentration.

Source: NEW

Level of knowledge: comprehension

References:
1. Boron OP.
2.

1. Initial Conditions

☐ 1.1 Review the Limits and Precautions.

☐ 1.2 **IF** in Mode 1 or 2, ensure R3 reactivity management controls established per SOMP 01-02 (Reactivity Management). (R.M.)

☐ 1.3 Verify the NV System is in operation per OP/1/A/6200/001 (Chemical and Volume Control System).

☐ 1.4 Verify the NB System is in operation per OP/1/A/6200/012 (Reactor Makeup Water).

2. Procedure

NOTE: This enclosure will affect reactivity of the core and is therefore designated important to Reactivity Management per the guidelines of NSD 304 (Reactivity Management). (R.M.)

☐ 2.1 Ensure valves are aligned per Enclosure 4.8 (Valve Checklist).

NOTE:
- In "AUTO", the blender outlet flow rate defaults to 90 gpm. Calibration tolerances will result in actual flow rate differing slightly from this value. If actual flow rate is **NOT** known, use 90 gpm in the following calculation.
- The RMWST boron concentration has an insignificant effect on the calculation at higher outlet concentrations. The RMWST boron concentration term may be considered "0" when the desired concentration is greater than 100 ppm.

☐ 2.2 Determine the boric acid flow rate (V_a) for the desired concentration by the following calculation: (R.M.)

$$V_a = \frac{V_b\ (C_b - C_w)}{(C_a - C_w)}$$

where V_b is the blender outlet flow rate,
C_b is the desired outlet boron concentration,
C_w is the RMWST boron concentration and
C_a is the BAT boron concentration

NOTE: The intent of the following step is to account for known inaccuracies. The Control Room Supervisor should be involved in determining the amount of correction to apply.

☐ 2.3 **IF** previous makeups have demonstrated an inability to achieve the desired boric acid flow rate, determine the amount of correction needed. _____ gpm. (R.M.)

☐ 2.4 Determine the setpoint for the boric acid controller as follows: (R.M.)

$$\text{Setpoint} = \frac{V_a + \text{correction from Step 2.3}}{4}$$

☐ 2.5 Adjust the controller for 1NV-238A (B/A Xfer Pmp To Blender Ctrl) to the value determined in Step 2.4. (R.M.)

2.6 Ensure the following valve control switches in "AUTO":

- ☐ 1NV-181A (B/A Blender Otlt To VCT)
- ☐ 1NV-186A (B/A Blender Otlt To VCT Otlt)
- ☐ 1NV-238A (B/A Xfer Pmp To Blender Ctrl)
- ☐ 1NV-242A (RMWST To B/A Blender Ctrl)

2.7 Ensure the following valve controllers in "AUTO":

- ☐ 1NV-242A (RMWST To B/A Blender Ctrl)
- ☐ 1NV-238A (B/A Xfer Pmp To Blender Ctrl)

☐ 2.8 Ensure at least one reactor makeup water pump is in "AUTO" or "ON".

☐ 2.9 Ensure at least one boric acid transfer pump is in "AUTO" or "ON".

☐ 2.10 Place the "NC MAKEUP MODE SELECT" switch in "AUTO".

NOTE: If necessary, automatic makeup can be terminated manually at any time by placing the "NC MAKEUP CONTROL" switch to the "STOP" position.

☐ 2.11 Place the "NC MAKEUP CONTROL" switch to the "START" position. (R.M.)

NOTE: The Boron Concentration Control System is now aligned for automatic makeup.

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Question 32

Bank Question: 07-32 ***Answer: B***

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1 Pt(s). Valve 1ND-001B (ND Pmp 1A Suct Frm Loop B) motor breaker is on which of the following power sources?

A. 1EPD

B. 1EMXD

C. 1EMXS

D. 1ETB

Distracter Analysis:

A. **Incorrect:**
Plausible: This is the power supply to the 1B ND HX outlet valve.

B. **Correct:**

C. **Incorrect:**
Plausible: Power for 1ND-2A (same valve on the opposite train)

D. **Incorrect**:
Plausible: 1B ND Pump supply

Level: RO

K/A: SYSTEM: 005 Residual Heat Removal System (RHRS) K2 Knowledge of bus power supplies to the following: (CFR: 41.7) K2.03 RCS pressure boundary motor-operated valves 2.7* 2.8*

Lesson Plan Objective: None

Source: NEW

Level of knowledge: Memory

References:
1. ND OP
2.

Aligning ND Pump Suction To NC System With NC System Pressurized

_____ 2.3 **IF** cooldown is being directed by an Emergency Procedure **AND** it is desired to align both ND Trains to the NC System at the same time, perform the following:

_____ 2.3.1 Obtain four locks for the suction isolation valve motor breakers.

_____ 2.3.2 Ensure the following are in "MAN": (1MC11)

☐ 1ND-27 (ND Hx 1A Bypass Ctrl)
☐ 1ND-61 (ND Hx 1B Bypass Ctrl)

_____ 2.3.3 Ensure the following are open:

☐ 1ND-27 (ND Hx 1A Bypass Ctrl)
☐ 1ND-61 (ND Hx 1B Bypass Ctrl)

_____ 2.3.4 Verify ND discharge pressure is less than 400 psig as indicated on the following: (1MC11)

☐ 1NDP5090 (ND Pump Disch 1A Press)
☐ 1NDP5080 (ND Pump Disch 1B Press)

_____ 2.3.5 Close the following valves: (1MC11)

☐ 1ND-26 (ND Hx 1A Outlet Ctrl).
☐ 1ND-60 (ND Hx 1B Outlet Ctrl).

2.3.6 Ensure the following breakers in the "ON" position:

_____ _____ • 1EMXD-F01A (1A ND Pump Suction From NC Loop B Motor (1ND1B))
_____ _____ • 1EMXD-F02A (1B ND Pump Suction From NC Loop C Motor (1ND36B))
_____ _____ • 1EMXS-F02A (1B ND Pump Suction From C NC Loop Motor (1ND37A))
_____ _____ • 1EMXS-F03D (1A ND Pump Suction From B NC Loop Motor (1ND2A))
_____ • 1MXK-F06D (1A ND Pump Disch NM Isol Motor (1NM39))
_____ • 1MXK-F04A (1B ND Pump Disch NM Isol Motor (1NM40))

2.3.7 Close the following valves: (1MC11)

_____ _____ • 1FW-27A (ND Pump 1A Suct From FWST)
_____ _____ • 1FW-55B (ND Pump 1B Suct From FWST)

2.3.8 Open the following valves: (1MC11)

_____ _____ • 1ND-2A (ND Pump 1A Suct Frm Loop B)
_____ _____ • 1ND-37A (ND Pump 1B Suct Frm Loop C)

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Question 33

Bank Question: 07-33 ***Answer: B***

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1 Pt(s). Given the following conditions:

- A reactor trip due to a loss of offsite power occurred.
- All equipment operates as designed.
- Pressurizer pressure drops to 1750 psig, then recovers one minute later to 2250 psig
- Offsite power is now available and non safeguard buses have been energized.
- Twenty minutes has elapsed since the reactor trip.
- SI has been terminated per EP/1/A/5000/ES-1.1 (SI Termination).
- EP/1/A/5000/ES-1.1 (SI Termination) directs the start of one NCP.
- No cooldown has been started.
- Natural Circ has not yet been verified.

What is the impact of the above conditions on NCP restart?

A. 1A NCP should be started; ECCS water injected into the cold legs is NOT cold enough to result in a reactor restart.

B. 1B NCP should be started; forced cooling benefits outweigh any probable issues with ECCS water in the cold legs.

C. NCP restart is NOT allowed, the reactivity addition from cold ECCS water in the RCS cold legs could result in reactor restart.

D. NCP restart is NOT allowed, the NC system will overpressurize upon NCP restart when cold ECCS water is heated.

Distracter Analysis:

A. **Incorrect:**
Plausible: A and B NCP provide PZR Spray but B is more effective and should be started first. The water temperature by itself is of a concern for restart but the ECCS water is borated and not a concern at this point.

B. **Correct:**

C. **Incorrect:**
Plausible: ECCS boration has made any restart due to cold NC water improbable.

D. **Incorrect**:
Plausible: The pump can be started. This is the reverse of what is predicted. The pressure should actually decrease due to any voids collapsing.

Level: RO

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Question 33

K/A: SYSTEM: 006 Emergency Core Cooling System (ECCS) K5 Knowledge of the operational implications of the following concepts as they apply to ECCS: (CFR: 41.5 / 45.7) K5.07 Expected temperature levels in various locations of the RCS due to various plant conditions 2.7 3.0

Lesson Plan Objective: EP216 Explain the Bases, including any identified knowledges/abilities, for all of the steps, notes, and cautions in EP/1/A/5000/ES-1.1 (SI Termination)

Source: MODIFIED (Prairie Island 2004)

Level of knowledge: comprehension

References:
1.
2.

STEP 25: Verify 1B NC pump - ON.

PURPOSE:

To establish forced coolant flow, if possible, or to verify natural circulation flow if NC pumps cannot be started.

To alert the operator that NC pump seal damage may have occurred if NC pump cooling had previously been lost. In that case, starting the affected NC pump may further damage the seal and NC pump.

To inform the operator of a preferred order for starting the NC pumps.

APPLICABLE ERG BASIS:

The potential for degradation in NC pump seal performance and seal life increases with increasing temperature above 300°F. Hence, if seal cooling is lost for a significant period of time, seal and/or bearing damage may occur. The potential non-uniform sealing surfaces and seal crud blockage that may exist prior to NC pump start can aggravate bearing and seal damage if the NC pump is started. Following restoration of seal cooling, the NC pump should not be started prior to a complete NC pump status evaluation in order to minimize potential NC pump damage on restart.

Forced coolant flow is the preferred mode of operation to allow for normal NC System cooldown and provide Pzr spray. If no NC pump is running, certain conditions are normally desired prior to starting an NC pump. In addition, NC pumps are normally started in a preferred order to obtain normal Pzr spray flow capability as soon as possible. If NC pumps cannot be started, then natural circulation flow should be verified using Enclosure 4 to ensure adequate NC System heat removal. If natural circulation cannot be verified, steam dump should be increased to remove heat from the primary system and re-establish natural circulation.

To limit the pressure decrease upon NC pump restart, saturated conditions should first be established in the Pzr. If the Pzr is not saturated, starting an NC pump will cause the Pzr level and pressure to decrease faster than if the Pzr were saturated. The Pzr pressure and level will still decrease when an NC pump is started under saturated conditions, but the rate of decrease is slower since vapor is created as the pressure drops.

If all seal cooling has been lost long enough that the maximum NC pump seal parameters identified in the NC pump Vendor Manual have ben exceeded, seal injection and KC thermal barrier cooling could have unintended consequences that result in additional pump damage or the failure of plant safety systems. Seal cooling should instead be restored by cooling the NC system which will reduce the temperature of the water flowing through the pump seals.

Continued On Next Page.

Continued From Previous Page.

For the reference plant there are Pzr connections to one NC System hot leg via the surge line and to two NC System cold legs via the spray lines. Single pump operation in the loop that provides the best spray is preferred to obtain normal Pzr spray capability. If the NC pump in the loop with Pzr surge line can be started, then it alone should be sufficient to provide normal Pzr spray. If that NC pump is unavailable, it will likely be necessary to start more than on NC pump to provide normal Pzr spray. | 16

PLANT SPECIFIC INFORMATION:

NV auxiliary spray may have been initiated earlier in this procedure to control Pzr pressure if all NC pumps were stopped. When NCPs are started in this step, normal Pzr spray is restored and NV aux spray is stopped. If after starting available NC pumps, normal Pzr spray is not available, the procedure will restore NV aux spray as long as normal letdown is available. If normal and aux spray is unavailable, then one Pzr PORV is used to stabilize Pzr pressure. | 16

KNOWLEDGE/ABILITY:

If NC pump seal cooling is lost for only a few minutes, the inventory of cold water in the seal area should prevent excessive seal heat up. For longer periods of time, seal and bearing temperatures may increase greater than 300°F. If excessive temperatures develop, the affected NC pump should not be restarted prior to a complete NC pump evaluation. | 16

NC pumps should not be started prior to a status evaluation unless an extreme (red) or severe (orange) CSF challenge is diagnosed. Under such a CSF challenge the "rules of usage" apply and an NC pump should be started if so instructed in the associated FRG. Under a CSF challenge, potential NC pump damage is an acceptable consequence if NC pump start is required to address a CSF challenge (e.g., to mitigate an inadequate core cooling condition). This is consistent with the intent of these FRGs which attempt to first establish support conditions to start an NC pump, but then start the NC pump whether or not the support conditions are established. | 16

Pressurizer level and subcooling requirements for starting an NC pump with a void in the upper head are designed to accommodate a collapse of the void. Starting an NC pump will preclude the use of a Pzr PORV during subsequent recovery, however, the operator should anticipate a decrease in Pzr level and NC subcooling when the NC pump is started with upper head voiding. Charging flow should be increased as necessary to maintain Pzr level on span and adequate subcooling. If may also be necessary to isolate letdown in order to maintain Pzr level. If Pzr level of NC subcooling is lost, SI pump operation will be required per the SI Reinitiation criteria on the Foldout Page. | 16

If a Pzr spray valve is failed open, NC pumps previously stopped to prevent NC system depressurization should not be restarted. | 16

This step is a continuous action step. | 16

STEP 7: Verify adequate shutdown margin as follows:

PURPOSE:

To ensure all control rods are inserted for adequate shutdown margin.

APPLICABLE ERG BASIS:

A subcritical core is verified if all rods are at the bottom according to the rod bottom lights and the rod position indicators. If these indications reveal 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.

PLANT SPECIFIC INFORMATION:

Additional information to deal with absence of DRPI indications was added in response to problems encountered during the Unit 2 Loss of Offsite Power event of 2/6/96. A step to verify DRPI Available was added, and provided with an RNO to direct additional boration to compensate for the possibility of undetected rod insertion failures.

The RNO substeps for emergency boration were enhanced to recognize the possibility NV-236B may not open from the control room.

The step to verify T-Colds above a minimum value was added to ensure adequate shutdown margin is maintained in the event of an excessive cooldown following the trip. This modification is supported by the resolution to PIR-0-M88-0183, File CN-839.05, CN-1552.02; this requires that a cycle specific T-Cold be added to the Reactor Trip Response procedure to ensure that the operators will immediately borate the NC System if temperature drops below that required for adequate shutdown margin. Tech Specs require boration within 15 minutes if shutdown margin is insufficient (CN-1552.02). This only applies to trips without safety injection, since S/I supplies borated water during those events.

The value used for the temperature at which shutdown margin may be lost is the most conservative value between the two units calculated each refueling cycle. This is done to promote consistency between units and familiarity with the procedure. The temperature is transmitted by the Nuclear Design and Reactor Support Group via an Engineering Instruction (Letter from Scott B. Thomas, Engineer, January 18, 1995).

For future core reloads, a generic stuck rod worth of 145 PPM can be assumed, provided the wording of Step 7b RNO does not change from its current wording as stated in the following (Letter from Scott B. Thomas, Engineer, January 18, 1995):

a. If two or more rods are not fully inserted, then:

   1) Emergency borate 145 PPM for each rod not fully inserted as follows:

KNOWLEDGE/ABILITY:

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Question 34

Bank Question: 07-34 ***Answer: D***

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1 Pt(s). Assuming the PORV Block Valves are open. Which ONE of the following describes the adverse affects, if any, of NO operator action with a leaking Pressurizer PORV?

A. There are NO adverse affects. The PRT is designed to handle continuous in-leakage.

B. The cyclic temperature stresses in combination with inner wall erosion on the PORV tailpipe may lead to premature piping failure

C. Mechanical breakdown of the PORV seating surface may cause the PORV to fail when needed for overpressure protection.

D. The PRT rupture disc may break with subsequent elevated radiation, temperature and pressure indications in containment.

Distracter Analysis:

A. **Incorrect:**
Plausible: This is a common misconception among operators.

B. **Incorrect:**
Plausible: There is cyclic temperature stress if the PORV continues to leak and the pipe erosion from a leak is negligible when compared with flow from 3 PORV and or Safeties.

C. **Incorrect:**
Plausible: The issue with seat "failure" or cutting is under pressure not over pressure.

D. **Correct:**

Level: RO

K/A: SYSTEM: 007 Pressurizer Relief Tank/Quench Tank System (PRTS) A1 Ability to predict and/or monitor changes in parameters (to prevent exceeding design limits) associated with operating the PRTS controls including: (CFR: 41.5 / 45.5) A1.01 Maintaining quench tank water level within limits 2.9 3.1

Lesson Plan Objective: NC03 Be able to describe and understand the NC System interfaces with Pzr, PRT, NV, NI, and ND

Source: BANK (Indian Point 2004)

Level of knowledge: comprehension

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Question 34
References:
1. NC Lesson
2.

2) Signal from accelerometer is converted to a voltage which is processed in a cabinet located in the 560' Electrical Penetration Room to provide an output that represents relative valve position and initiate signals to control room.

(a) Output is displayed on local panel as 10 LEDs corresponding to relative valve position.

(b) Preset alarm setpoint causes annunciator on MC14 and illuminates a Group 2 monitor light panel status light.

(c) A "Flow/No Flow" light on MC10 will also indicate "Flow" when the alarm setpoint is reached.

19. Pressurizer Relief Tank (PRT) (Obj. #3)

a) Designed to condense and cool Pzr discharge steam equal to 100% of the volume above the full-power pressurizer water level setpoint. Not designed for continuous discharge.

b) Normally ~75% level with 3-5 psig N_2 over pressure.

c) Steam discharges to tank through sparger and drained to NCDT.

d) Can be cooled by

1) Spray from RMWST; cool from 200°F to 110°F in one hour.

2) NCDT HX

e) Rupture disc: Relieves at 100 psig

1) Relief capacity equal to the combined capacity of the three-pressurizer safety valves.

2) The PRT design pressure (and the rupture disc settings) is twice the calculated pressure resulting from the maximum safety valve discharge described above.

f) Vent sight glass has been upgraded to 2500 psia and 300°F.

g) Inputs:

1) Pzr PORV's

2) Pzr Safety Valves

3) Reactor Vessel Head Vent

4) ND Suction Relief Valves

5) NV Letdown Relief Valves

6) NV NCP Seal Return Relief

7) Pzr Vent

B. Instrumentation and Control

1. Temperature

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Question 35

Bank Question: 07-35 ***Answer: B***

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1 Pt(s). PRT level has been raised to 95% per the OP to purge the gas space to WG. What is a major concern during this condition?

A. Water could be introduced into the WG header.

B. Pressurizer PORV actuation would result in a rapid rise in PRT pressure.

C. PRT spray nozzles are covered and would be incapable of cooling the PRT.

D. PRT rupture discs could rupture if level is increased to 100%

Distracter Analysis:
L&P from OP/1/A/6150/004 (Pressurizer Relief Tank)
2.7 When PRT level exceeds 90%, PRT pressure may increase rapidly.

A. **Incorrect:**
Plausible: Water could be introduced into the WG header but the system is designed for water introduction.

B. **Correct:**

C. **Incorrect:**
Plausible: PZR has spray nozzles are in the top of the tank which do provide cooling but PRT has a sparger which is constantly under water.

D. **Incorrect**:
Plausible: Pressure would rise to near the shutoff head of the reactor makeup pumps, but the pumps discharge pressure is less than 100 psi..

Level: RO

K/A: SYSTEM: 007 Pressurizer Relief Tank/Quench Tank System (PRTS) 2.1.32 Ability to explain and apply all system limits and precautions. (CFR: 41.10 / 43.2 / 45.12) IMPORTANCE RO 3.4 SRO 3.8

Lesson Plan Objective: NC15 Given appropriate plant conditions, apply limits and precautions associated with related station procedures.

Source: NEW

Level of knowledge: comprehension

References:
1. PRT OP
2.

Pressurizer Relief Tank

1. Purpose

To provide instruction for the operation of the Pressurizer Relief Tank (PRT).

2. Limits and Precautions

2.1 The maximum temperature in the PRT should **NOT** exceed 10°F above lower containment ambient temperature.

2.2 The nominal PRT rupture disc release pressure is 100 psig. If PRT pressure exceeds 50 psig, a PIP should be initiated to evaluate the rupture disc integrity.

2.3 When the PRT is in operation, the Oxygen (O_2) content of the PRT gas space shall be maintained less than 4.5% by volume.

2.4 A Nitrogen (N_2) gas blanket should be maintained at all times to exclude air and prevent the formation of Hydrogen-Oxygen (H_2-O_2) mixtures.

2.5 After manual operation, maintenance or packing adjustment of any safety-related valve, it shall be cycled electrically to ensure reliable automatic operation.

2.6 When manually operating any motor operated valve, minimize the torque applied to the handwheel.

2.7 When PRT level exceeds 90%, PRT pressure may increase rapidly.

2.8 During outages when the PORVs are open to vent the PZR to the PRT, changing PRT level and/or pressure can cause indicated NC System level to change.

3. Procedure

Refer to Section 4 (Enclosures).

1. Initial Conditions

_____ 1.1 Review the Limits and Precautions.

_____ 1.2 **IF** level is to be increased, verify Reactor Makeup Water is available per OP/1/A/6200/012 (Reactor Makeup Water).

_____ 1.3 **IF** level is to be decreased, verify draining the deep end of the refueling cavity per OP/1/A/6200/013 (Filling, Draining, and Purification of Refueling Cavity) is **NOT** in progress.

_____ 1.4 **IF** level is to be decreased, verify the NCDT is in operation per OP/1/A/6500/014 (Operations Controlled Liquid Waste Systems).

_____ 1.5 **IF** level is to be decreased, verify one of the following:

- An N_2 overpressure is being supplied to the PRT.
- The PRT is vented through 1NC-101 (N_2 To PRT Test Vent).

2. Procedures

_____ 2.1 Ensure valves are aligned per Enclosure 4.7 (Valve Checklist).

_____ 2.2 Ensure valves are independently verified per Enclosure 4.8 (Independent Verification Valve Checklist).

_____ 2.3 **IF** level in the PRT is to be raised, complete the following steps:

2.3.1 Open the following valves to align the RMWST to the PRT:

_____ • 1NC-58A (PRT Spray Supply Isol)
_____ • 1NC-56B (RMW Pump Disch Cont Isol)

_____ 2.3.2 Start a Reactor Makeup Water pump:

- "RX M/U WTR PUMP 1A"
  OR
- "RX M/U WTR PUMP 1B"

_____ 2.3.3 **IF** at any time while raising PRT level PRT pressure increases to 6 psig, as indicated on 1NCP-5130 (PRT Press, complete the following steps:

_____ 2.3.3.1 Stop the reactor makeup water pump.

2.3.3.2 Close the following valves:

_____ • 1NC-58A (PRT Spray Supply Isol)
_____ • 1NC-56B (RMW Pump Disch Cont Isol)

_____ 2.3.3.3 Vent the PRT per Enclosure 4.5 (Venting the Pressurizer Relief Tank).

_____ 2.3.3.4 **WHEN** PRT pressure has been reduced to 3 psig, return to Step 2.3.1.

_____ 2.3.4 **WHEN** the desired level is reached, stop the reactor makeup water pump.

2.3.5 Close the following valves:

_____ • 1NC-58A (PRT Spray Supply Isol)
_____ • 1NC-56B (RMW Pump Disch Cont Isol)

_____ 2.3.6 Align the reactor makeup water pump used in this section as required per OP/1/A/6150/009 (Boron Concentration Control).

_____ 2.4 **IF** level in the PRT is to be lowered, complete the following steps:

_____ 2.4.1 Notify Radwaste Chemistry that the PRT level will be lowered.
Person notified _____

_____ 2.4.2 Open 1NC-107 (PRT To NCDT Pmps Suct).

_____ 2.4.3 **WHEN** the desired level is reached, close 1NC-107 (PRT To NCDT Pmps Suct).

2.5 Do **NOT** file this enclosure in the Control Copy folder of this procedure.

10. Reactor Makeup Water Pumps
    a) Two (2) per unit.
    b) Capacity - 150 gpm based on:
        1) Ability to cool PRT from 200°F to 120°F in one hour following safety valve discharge.
        2) Included in flow/head requirement.
            (a) Sufficient to overcome PRT internal pressure (50 psig during relief valve discharge).
            (b) Additional 10.7 psi required for drop across spray nozzles and line losses.
    c) Each pump capable of delivering 115 gpm to BA blender.
    d) Recirculation line back to RMWST.
    e) Power Supplies (OBJ. #17).
        1) Reactor Makeup Water Pump 1A 600V MCC MXW.
        2) Reactor Makeup Water Pump 1B 600V MCC MXX.
    f) Trip on BDMS alarm (OBJ. #22).
11. Blended Flow
    a) Mixture of pure water and boric acid.
    b) Concentration dependent on setting on BA flow controller. Normally set to match NCS boron concentration.
    c) Boric acid flow (NVFT-5450).
        1) Turbine meter (0-40 gpm).
        2) Less accurate at lower flows (Example: at 14 gpm, flow rate is accurate to $\pm$4gpm (28.5% error). At 35 gpm, the flow rate is accurate to $\pm$2 gpm (5.7% error).
        3) More accurate the longer duration of boric acid flow (Example: 14 gpm for 1.75 minutes is accurate to $\pm$7 gallons (28.5% error). 35 gpm for 200 minutes is accurate to $\pm$ 200 gpm (2.85% error).
    d) Boric Acid Blender (TOTAL) Discharge Flow (NVFT-5460).
        1) Orifice plate element feeding a square root extractor type transmitter.
        2) Less accurate at lower flow rates (Example: at 14 gpm, the flow rate is accurate to $\pm$50 gpm (357% error).
        3) More accurate the longer the duration of boric acid flow (Example: at 35 gpm for 200 seconds the accuracy is $\pm$340 gpm (4.85% error).

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Question 36

Bank Question: 07-36 ***Answer: B***

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1 Pt(s). Unit 1 is at 100% power. 1A1 KC Pump is in service. Annunciator 1AD-9 F/5 (KC Train A Single Pump Runout) is received.

At what flow is this alarm received and how will KC Pump 1A2 be started to mitigate this condition?

A. 5700 gpm; automatically at 40 psig discharge header pressure

B. 5700 gpm; manually by the operator

C. 10,800 gpm; automatically at 40 psig discharge header pressure

D. 10,800 gpm; manually by the operator

Distracter Analysis:

A. **Incorrect:**
Plausible: correct value but this is the auto start for the KR pumps (KC of the secondary systems)

B. **Correct:**

C. **Incorrect:**
Plausible: This is the value for the 2 pump runout in the KC system and the auto start for the KR pumps.

D. **Incorrect**:
Plausible: 2 pump runout alarm value but correct start.

Level: RO

K/A: SYSTEM: 008 Component Cooling Water System (CCWS) K4 Knowledge of CCWS design feature(s) and/or interlock(s) which provide for the following: (CFR: 41.7) K4.09 The "standby" feature for the CCW pumps 2.7 2.9

Lesson Plan Objective: KC17 Recognize and apply the necessary actions applicable to all KC System Annunciators.

Source: NEW

Level of knowledge: Memory

References:
1. KC lesson
2.

Panel 1AD-9

F/5

KC TRAIN A SINGLE PUMP RUNOUT

SETPOINT: 5700 gpm increasing and KC Pump 1A1 or 1A2 running

ORIGIN: 1KCFT-5530

PROBABLE CAUSE:
1. **NOT** enough flow restriction in the KC pump flow path.
2. Pipe rupture.
3. Loss of power at power panelboard 1EKPI Breaker #29.

AUTOMATIC ACTIONS: None

IMMEDIATE ACTIONS:
1. Close 1KC-C37A (Trn 1A Miniflow Isol).
2. **IF** closing miniflow valve does **NOT** clear alarm, start an additional A Train KC pump per OP/1/A/6400/005 (Component Cooling System).
3. **IF** an additional A Train KC pump is **NOT** available, **OR** > 10,800 gpm flow is required, i.e. two trains of ND are in service, start additional KC pumps as required to achieve required flow per OP/1/A/6400/005 (Component Cooling System).
4. Verify 1EKPI Breaker #29 is "ON" (AB-577, EE-54, in 1EMXI).

SUPPLEMENTARY ACTIONS:
1. Monitor flow and discharge pressure.
2. **IF** pipe rupture is found, isolate if possible or secure running pumps.
3. Refer to AP/1/A/5500/021 (Loss of Component Cooling).
4. Refer to Tech Spec 3.7.7.

REFERENCES:
1. CNEE-0142-01.58
2. CNEE-0142-01.35
3. CNEE-0142-01.60
4. NSM CN-11372

KC TRAIN A TWO PUMP RUNOUT

F/7

SETPOINT: 10,800 gpm increasing

ORIGIN: 1KCFT-5530

PROBABLE CAUSE:

1. **NOT** enough flow restriction in the KC Pump flow path.
2. Pipe rupture.
3. Both ND Heat Exchanger Inlet Isolation valves, 1KC-56A and 1KC-81B are open, KC cross-connects 1KC-1A, 1KC-2B, 1KC-50A, 1KC-53B, 1KC-3A, 1KC-18B, 1KC-230A, and 1KC-228B are open, and only one train of KC is in operation.
4. Loss of power at power panelboard 1EKPI Breaker #29.

AUTOMATIC ACTIONS: None

IMMEDIATE ACTIONS:

1. Ensure pumps miniflow valves are closed.
2. **IF NOT** required to be in service, isolate ND Heat Exchanger(s).
3. **IF** both ND Heat Exchangers are required to be in service, start additional B Train KC Pump(s) as required per OP/1/A/6400/005 (Component Cooling System).
4. **IF** both ND Heat Exchangers are required to be in service **AND** B Train KC Pumps will **NOT** start, close KC cross-connects:
   - 1KC-2B (Aux Bldg Non-Ess Ret Hdr Isol)
   - 1KC-53B (Aux Bldg Non-Ess Hdr Isol)
   - 1KC-18B (Rx Bldg Non-Ess Ret Hdr Isol)
   - 1KC-228B (Rx Bldg Non-Ess Hdr Isol)
5. Verify 1EKPI Breaker #29 is "ON" (AB-577, EE-54, in 1EMXI).

SUPPLEMENTARY ACTIONS:

1. Monitor flow and discharge pressure.
2. **IF** pipe rupture is found, isolate if possible or secure A Train KC Pumps.
3. Refer to AP/1/A/5500/021 (Loss of Component Cooling).
4. Refer to Tech Spec 3.7.7.

REFERENCES:

1. CNEE-0142-01.58
2. CNEE-0142-01.35
3. CNEE-0142-01.60
4. NSM CN-11372

Catawba Nuclear Station
2007 NRC Exam
Reactor Operator

Question 37

Bank Question: 07-37 ***Answer: B***

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1 Pt(s). Upon entry into AP/1/A/5500/021 (Loss of Component Cooling) due to a loss of all KC, what two methods of cooling the NCP seals are used by the AP?

A. Standby Makeup Pump and NV Pump 1B

B. Standby Makeup Pump and NV Pump 1A

C. RN to the Thermal Barrier HX and NV Pump 1B

D. RN to the Thermal Barrier HX and NV Pump 1A

Distracter Analysis:

A. **Incorrect:**
Plausible: Wrong train NV pump for alternate cooling.

B. **Correct:**:

C. **Incorrect:**
Plausible: RN is backup for NCP Motor stator cooling but not for seal cooling and wrong train NV pump for alternate cooling

D. **Incorrect**:
Plausible: RN is backup for NCP Motor stator cooling

Level: RO

K/A: SYSTEM: 008 Component Cooling Water System (CCWS) 2.4 Emergency Procedures /Plan 2.4.11 Knowledge of abnormal condition procedures. (CFR: 41.10 / 43.5 / 45.13) IMPORTANCE RO 3.4 SRO 3.6

Lesson Plan Objective: KC14 Discuss the supplementary actions for the loss of KC AP.

Source: NEW

Level of knowledge: Memory

References:
1. AP/21
2.

ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED

C. Operator Actions

CAUTION **Failure to restore NC pump seal cooling via thermal barrier cooling or NV seal injection within 10 minutes will cause damage to the NC pump seals resulting in NC inventory loss.**

__ 1. **Monitor Enclosure 1 (Foldout Page).**

__ 2. **Verify at least one KC pump - ON.**

Perform the following:

__ a. Start at least one KC pump.

b. **IF** no KC pump can be started, **THEN** perform the following:

__ 1) **IF** S/I has actuated on either unit, **THEN GO TO** Step 4.

CAUTION **YD can only supply one Unit's NV pump at a time.**

__ 2) Determine which unit will receive alternate NV pump cooling from YD.

__ 3) **IF** Unit 2 selected to receive YD cooling to 2A NV pump, **THEN GO TO** Step 4.

(RNO continued on next page)

ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED

2. (Continued)

NOTE
- NV pumps may be started without regard to cooling water alignment.
- Operating NV Pump will reach high temperature conditions in approximately 15 minutes with no cooling water.

__ 4) Dispatch operator to align YD cooling to NV pump 1A. **REFER TO** Enclosure 4 (Alternate Cooling To NV Pump 1A).

__ 5) Maximize NV pump run time. **REFER TO** Enclosure 7 (Maximize NV Pump Run Time).

__ 6) **IF AT ANY TIME** an S/I occurs on either unit, **THEN** notify dispatched operator to realign NV Pump 1A cooling to normal. **REFER TO** Enclosure 4 (Alternate Cooling To NV Pump 1A).

__ 7) **GO TO** Step 4.

__ 3. **IF AT ANY TIME all KC pumps are lost, THEN RETURN TO STEP 2.**

1. **SSF Manning Criteria:**

CAUTION **Failure to restore NC pump seal cooling via thermal barrier cooling or NV seal injection within ten minutes will cause damage to the NC pump seals resulting in NC System inventory loss.**

IF AT ANY TIME KC **AND** NV seal cooling for any NC pump is lost, **THEN** perform the following:

__ a. Notify Security Officer at SSF (Ext. 5251 or 5212) to perform Enclosure 3 (Establishing NC Makeup/Seal Injection From The SSF) of AP/1/A/5500/021 (Loss Of Component Cooling).

b. **IF** 1EMXS is de-energized, **THEN** perform the following:

__ 1) Dispatch operator to align 1EMXS to alternate power supply. **REFER TO** Enclosure 2 (Align Alternate Power Supply To 1EMXS).

__ 2) Notify Security Officer at SSF (Ext. 5251 or 5212) an operator has been dispatched to align alternate power supply to 1EMXS.

__ c. Dispatch operator to the SSF to locally establish seal injection. **REFER TO** Enclosure 3 (Establishing NC Makeup/Seal Injection From The SSF).

2. **NC Pump Trip Criteria:**

- **IF** any of the following NC pump trip criteria is met:

__ • KC flow unavailable to NC pumps - GREATER THAN 10 MINUTES

OR

__ • #1 Seal outlet temperature - GREATER THAN 235°F

OR

__ • Lower bearing temperature - GREATER THAN 225°F

OR

__ • Motor bearing temperature - GREATER THAN 195°F

__ **THEN GO TO** Enclosure 8 (Rx Trip Sequence).