U.S. NUCLEAR REGULATORY COMMISSION

REGION III

Docket Nos. 50-315; 50-316 License Nos. DPR-58

Licensee: American Electric Power Service Corporation
1 Riverside Plaza
Columbus, OH 43216

Facility Name: Donald C. Cook Nuclear Power Plant

Examination Administered At: Donald C. Cook Nuclear Power Plant

Examination Conducted: June 19, 20 and 21, 1984

Examiners: T D Reidinger — Oct 10, 1984
T. D. Reidinger — Date

J I McMullen for — Oct 10, 1984
D. Schreiber — Date

Approved By: J. I. McMillen — Oct 10, 1984
J. I. McMillen, Chief — Date
Operator Licensing Section

Examination Summary

Examination administered on June 19, 20 and 21, 1984.
Requalification written examinations were administered to two RO and seven SRO licensed operators. Oral examinations were administered to two RO and two SRO licensed personnel.
Results: Two RO and two SRO licensed personnel passed the written examinations and all four persons passed the oral examination.

REPORT DETAILS

1. Examiners

T. Reidinger
D. Schreiber

2. Examination Review Meeting

Section 1 of the RO exam and Section 5 of the SRO exam was supplied by the facility. Comments on the questions and answer key were considered minor in nature. No questions were deleted and changes were incorporated in the answer key as necessary.

3. Exit Meeting

Facility representatives from operations and plant management, the NRC Resident Inspector, and the examiners met on June 22, 1984. The examiners noted no specific generic weaknesses. The examiner did not indicate any passes or failures of any of the candidates. The examiner suspended evaluations of the candidates pending a written statement or explanation from Plant Management addressing the examiner's concerns relating to the failure of all the candidates to operate the plant in accordance with prescribed operating procedures. This issue will be addressed in a separate correspondence with the utility.

4. Subsequent Actions

On June 25 in a conference call between the Region III staff and the D. C. Cook plant staff, the NRC concerns regarding the use of procedures by the operating personnel and the impact of this method of operation were discussed. In a letter to J. G. Keppler (July 13, 1984), D. C. Cook appraised the Region of the results of their investigation of the staffs concerns and the corrective action to be taken. Region III answered this letter on August 31, 1984 and notified D. C. Cook that subsequent inspections would take these matters into consideration.

On August 21, 1984 D. C. Cook Plant Manager, W. G. Smith was informed of the results of the written requalification examinations and that six licensed personnel failed the examination and should be removed from licensed duties and placed in an accelerated requalification training program and would not be permitted to perform licensed duties until each of them had passed an NRC approved written examination. Further discussions between the D. C. Cook plant staff and Region III personnel it was agreed that the grading of one candidate would be upgraded to a pass and he could be returned to licensed duties. Subsequently the NRC reviewed the requalification exam and monitored the administration of the exam on September 13, 1984. One person failed this examination. The D. C. Cook Training Department will inform the Region III of the action to be taken with this person. All other persons were returned to licensed duties.

In addition, the requalification program, was discussed during an enforcement conference on September 7, 1984. Additional conversations between the NRC staff and D. C. Cook staff have taken place and it was agreed that D. C. Cook training department would submit proposed actions for correcting deficiencies, if any, in the requalification program for NRC review and approval.

U.S. NUCLEAR REGULATORY COMMISSION

REACTOR OPERATOR LICENSE EXAMINATION

Master Key

Facility: D. C. Cook

Reactor Type: Westinghouse

Date Administered: 6/19/84

Examiner: R E Schreiber

Candidate: _____

INSTRUCTIONS TO CANDIDATE:

Use separate paper for the answers. Write answers on one side only. Staple question sheet on top of the answer sheet. Points for each question are indicated in parenthesis after the question. The passing grade requires at least 70% in each category and a final grade of at least 80%. Examination papers will be picked up six (6) hours after the examination starts.

Category Value	% of Total	Candidate's Score	% of Cat. Value	Category
25	25			1. Principles of Nuclear Power Plant Operation, Thermodynamics, Heat Transfer and Fluid Flow.
25	25			2. Plant Design Including Safety and Emergency Systems
25	25			3. Instruments and Controls
25	25			4. Procedures: Normal, Abnormal, Emergency, and Radiological Control
100				TOTALS

Final Grade _____ %

All work done on this examination is my own; I have neither given nor received aid.

Contains resolution of facility comments

_____
Candidate's Signature

1.0 Principles of Nuclear Power Plant Operation, Thermodynamics, Heat Transfer, and Fluid Flow. (25.0)

1.1 Both B-10 and U-235 are likely to fission and release energy when they absorb a thermal neutron, but we cannot build a reactor with boron for fuel. Why not? (1.0)

Answer: B-10 fission does not yield neutrons to sustain a chain reaction, like U-235.

Ref: Rx theo review text, I-1.45 and I-2.4

1.2 Match the parameters in Column A with the formula or remark in Column B. (2.0)

A	B
a. Effective value, delayed neutron fraction, BOL	(1) 26.06T
b. Pu-239	(2) 0.007
c. SUR	(3) Has units of sec^{-1}
d. $\overline{\beta}_{eff,EOL}$	(4) 0.005
	(5) The small β_{eff} is increasingly felt over core life.
	(6) Strongly affects Doppler
	(7) $\frac{26\overline{\lambda}\rho}{\overline{\beta}_{eff}-\rho}$

Answer: a. (2)
b. (5)
c. (7)
d. (4)

Ref: I-3.9 through 3.16

1.3 Explain how a Secondary Neutron Source operates. (2.0)

Answer: Antimony becomes activated, the subsequent beta-minus decay emits a high energy gamma which acts on the Beryllium to eject a neutron.

Response: accept sub. answer offered by Staff

Ref: I-4.4

1.4a. What is the purpose of the Inverse Multiplication (1/M) plot that may be made at Cook-I or II during a reload core shuffle? (1.0)

1.4b. Describe, or show in a sketch, the difference between a 1/M plot taken during <u>fuel shuffle</u>, and a 1/M plot taken during <u>control rod withdrawal</u> of banks A, B and C. (2.0)

Answer: a. Insure to the operators that the reactor is not approaching criticality.

b. Figures attached are typical (1/M is also fairly level for reload shuffle). Difference is rod withdrawal plot is much more linear; criticality is reached in rod withdrawal, but not in fuel shuffle. Because reload fuel is exchanged 1 for 1, there is no trend in 1/M.

1.4b Plant Staff Statement: Actual plant experience does not exhibit large drops in 1/M during shuffle.

Response: accept

Ref: I-4

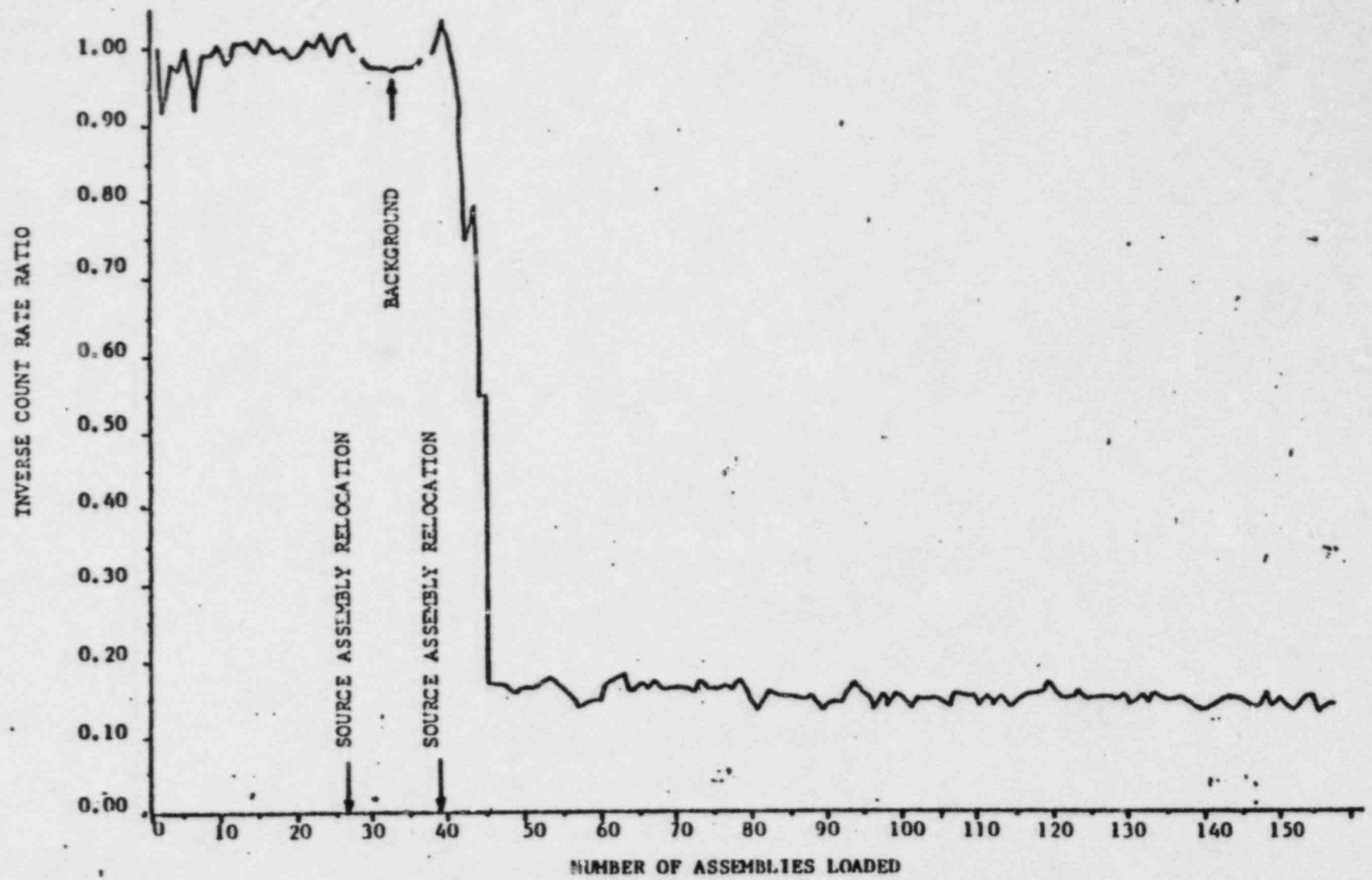
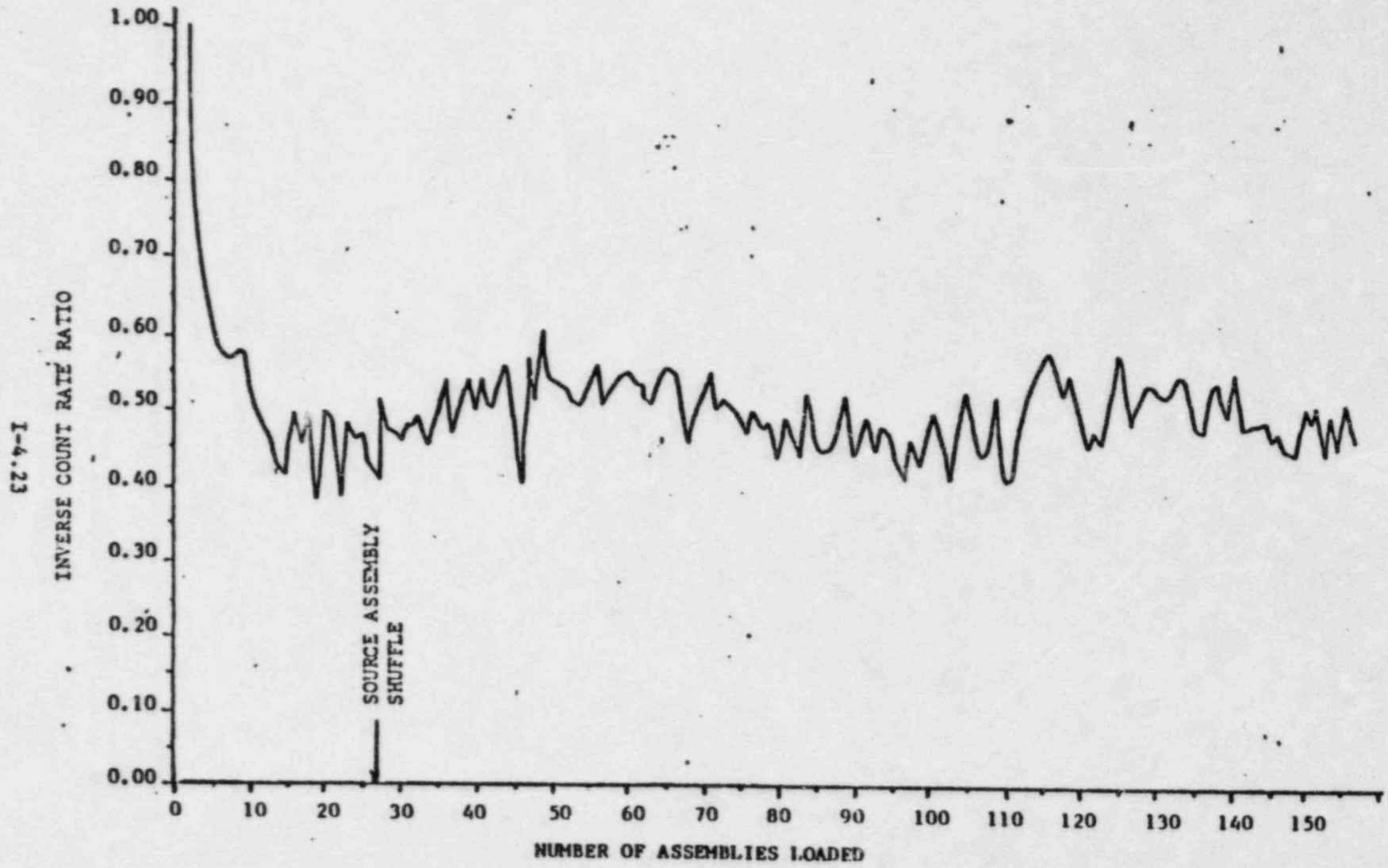


Figure 11. Inverse Count Rate Ratio Core Loading Channel N-31



I-4.23

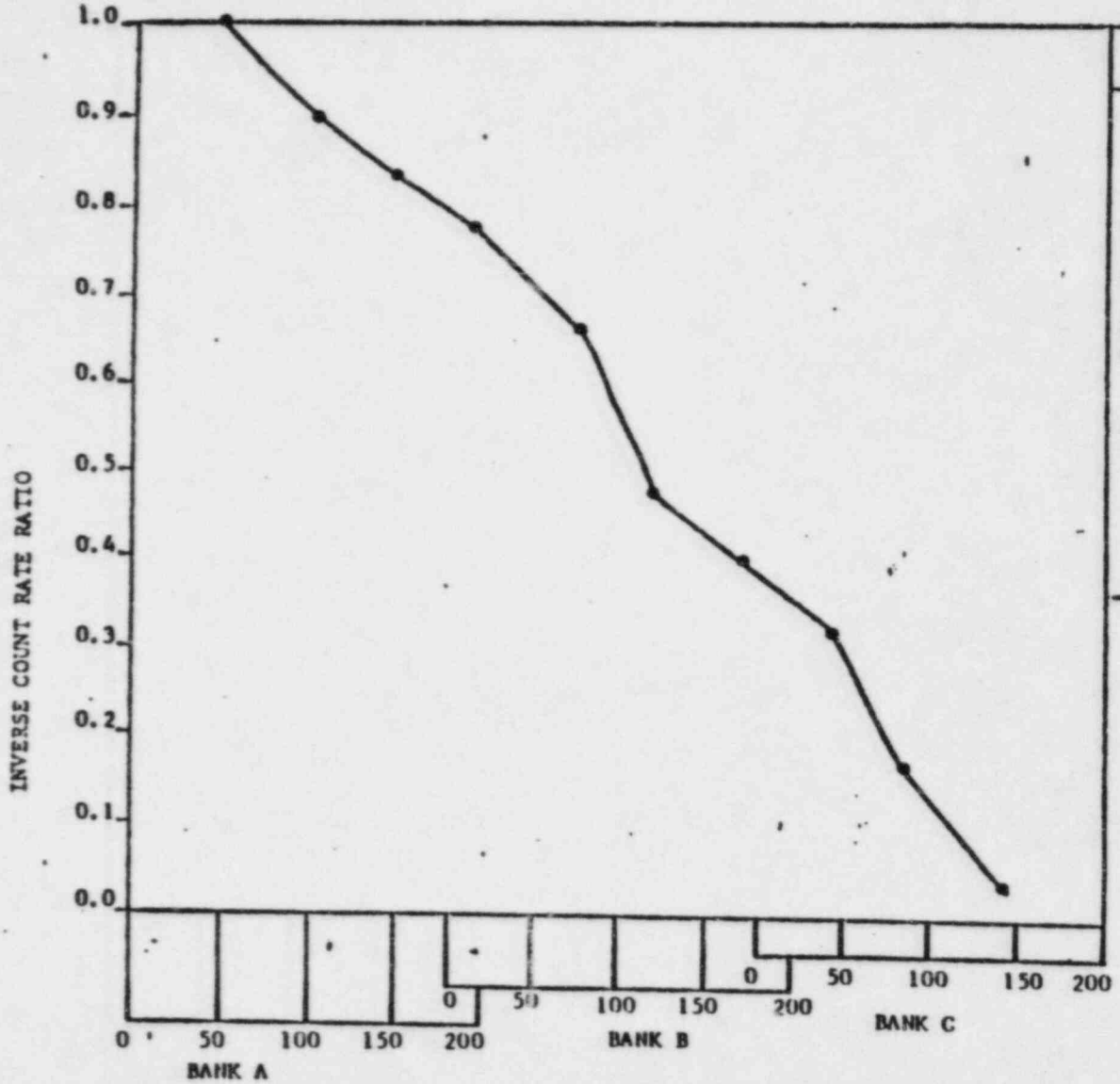
Answer: 1.46

Figure 12. Inverse Count Rate Ratio Core Loading Channel N-32

ECP: BANK C AT 160 STEPS

ACTUAL CRITICAL HEIGHT:

BANK C AT 168 STEPS



1	ROD HEIGHT	AVERAGE C (cps)	1/m
0	A 50	10	1.0
1	A 100	11	.91
2	A 150	12	.83
3	B 22	13	.77
4	B 72	15	.67
5	B 122	20.5	.49
6	B 172	25	.40
7	C 44	30	.33
8	C 94	70	.14
9	C 144	325	.03

Figure 13. 1/m Plot Approach To Critical Using Control Rods

Answer 1.46

1.5a. During reactor heatup from cold shutdown to hot standby, what <u>two</u> coefficients are contributing to the Isothermal Temperature Coefficient? (1.0)

1.5b. Does the value of Total Power <u>Coefficient</u> change more in going from 0 to 100% power, or in going from BOL to EOL? (It is <u>not</u> necessary to quote actual numbers to support your answer.) (1.0)

Answer: a. MTC and Fuel Temp. Coef.
b. BOL to EOL

Ref: I-5.22 and figure I-5.22

1.6 Match the Approximate Thumb Rules in Column A with the numerical values in Column B. (3.0)

A.	B.
a. Boron worth, -____pcm/ppm	(1) 1
b. Total Shutdown Bank Worth,_____%ΔK/K	(2) 2
	(3) 3
c. Boric Acid Addition Change,_____gals/ppm	(4) 4
d. Average Differential Control Rod Worth, - _____pcm/step	(5) 5
	(6) 10
e. Total Control Bank Worth,_____%ΔK/K	(7) 17
	(8) 28
f. Power dependent peak Xe (above eq. Xe), 100% pwr, -___00 pcm	(9) 31
	(10) 52

Answers:
a. 10 pcm/ppm (6)
b. 5%ΔK/K (5)
c. 3 gal/ppm (3)
d. 5 pcm/step (5)
e. 4%ΔK/K (4)
f. 3100 pcm (9)

Ref: Thumb Rule Sheet, part of Rx theo.

1.7a. What are <u>two</u> purposes of Burnable Poison rods? (1.0)

1.7b. True or false. Equilibrium Sm level is independent of power level. (0.5)

1.7c. True or false. Sm takes twice as long as Xe to decay to negligible levels after a trip. (0.5)

Answers: a. Flatten radial flux, reduce the required concentration of boric acid in coolant (MTC not positive).
b. T
c. F

Ref: I-3.9 through 3.16

1.8 Identify the fluid at the following locations in the plant as subcooled, saturated, or superheated. (1.5)

a. Reactor coolant leaving the core.
b. Vapor in the pressurizer.
c. Liquid in the condenser hotwell.
d. Vapor leaving the MSR.
e. Feedwater entering the Steam Generator.
f. Vapor leaving the HP turbine.

Answers:
a. Sub
b. Sat
c. Sub
d. Super
e. Sub
f. Sat

Ref: Thermo Studyguide, para 1.1
PGS-1-22
PGS-2A-29
PGS-9-8
Steam tables

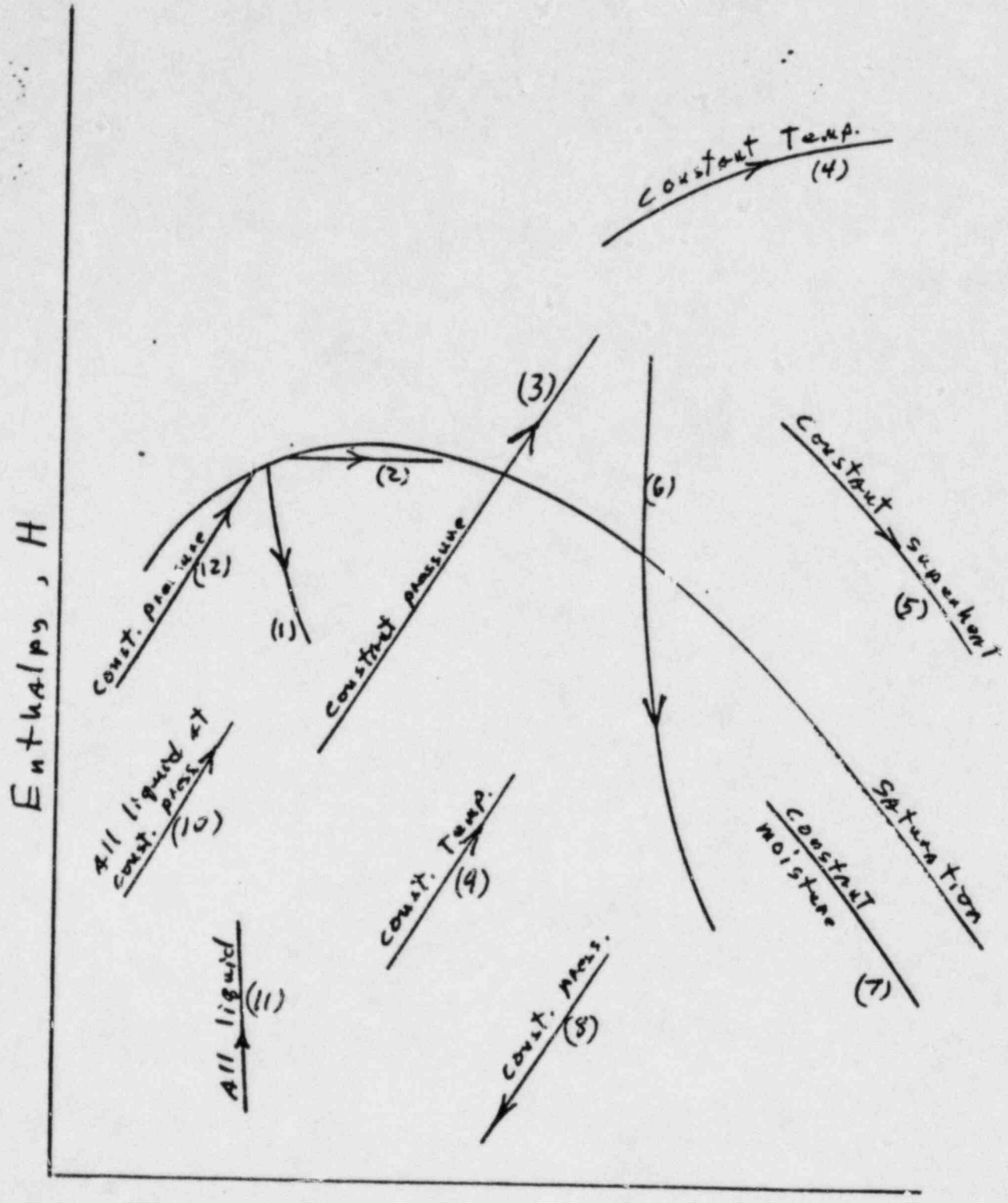
1.9 The attached sketch of the Mollier diagram contains directed line segments representing how fluid properties change in major pieces of secondary plant equipment. Match the line label with the equipment listed in the table below. (2.0)

a. HP turbine
b. MSR
c. LP turbine
d. Condenser
e. Steam Generator
f. Throttle valve
g. Feedwater heater
h. Feedpump

Answers: a. (1)
b. (3)
c. (6)
d. (8)
e. (12)
f. (2)
g. (10)
h. (11)

Ref: a. PGS-4A-5,6
b. PGS-1
c. PGS-4A-5,6
d. PGS-9
e. PGS-1
f. PGS-10
g. PGS-10
Thermo Studyguide, pg. 10, gives Rankine Cycle on T-S diagram.

Figure 1.9



Note: lines (10) and (11) are not under the saturation curve, but are in the far lower left corner of the H-S diagram

1.10a. Define NPSH or express as a formula. (1.0)

1.10b. How does <u>available</u> NPSH differ from the required or limit value of NPSH? (1.0)

Answers: a. $NPSH = P_{static} + P_{dynamic} - P_{saturation}$
(Net Positive Suction Head)

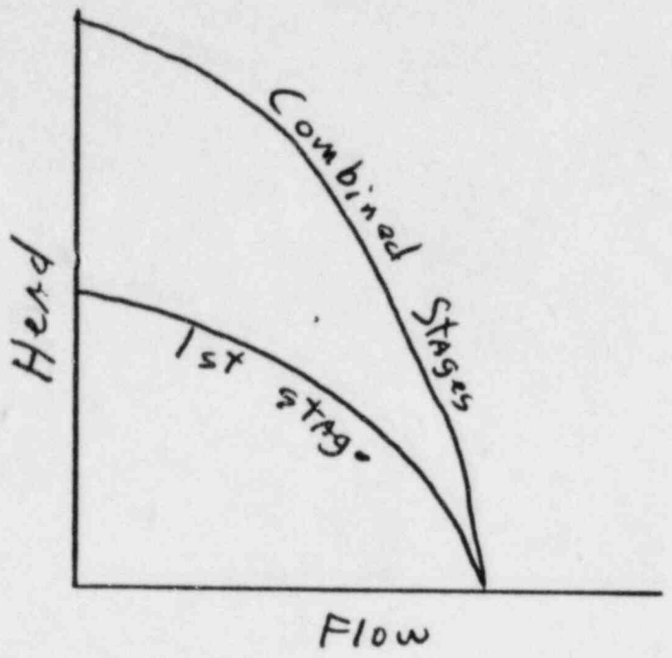
b. The NPSH limit is that minimum value of NPSH at the pump inlet needed to avoid cavitation on the impeller.

Ref: Thermo Studyguide, para 4.4, 4.6

1.11 Sketch a head vs. flow curve for a <u>two-stage</u> centrifugal pump. Show how the head curve for the two stages combine to give the overall pump characteristic. (2.0)

Answer:

Ref: Thermo Studyguide, Section 4



1.12a. The Departure from Nucleate Boiling Ratio (DNBR) is defined as $\frac{\text{heat flux}}{\text{heat flux}}$. (0.4)

1.12b. What is the range of typical values for DNBR in the hottest channel at full power? (0.4)

1.12c. If reactor coolant flow decreases, does DNBR increase or decrease? (0.2)

Answers: a. Critical heat flux/ local heat flux
b. 2-3
c. Decrease

Ref: Thermo Studyguide, para 5.10, 5.11

1.13 Consider the equation for Steam Generator heat transfer:
$Q = UA(T_{avg} - T_{steam})$.

a. Which term (U, A, T_{avg}, T_{steam}) is most strongly affected by tube plugging? (0.25)

b. Which of the 4 terms is directly affected by sludge buildup? (0.25)

Answer: a. A
b. U

Ref: Thermo Studyguide, Section 7

1.14 Which statement best characterizes Natural Circulation? (1.0)

a. The heat source must be above the heat sink.
b. The loop must be open to the atmosphere.
c. A pump is required to get it started.
d. The driving force is a difference in density.
e. Heat transfer is more efficient if steam or gas is mixed with the water.

Answer: d.

Ref: Thermo Studyguide, para 8.1

2.0 Plant Design, Including Safety and Emergency Systems (25.0)

2.1 Two relationships which the operator must manually control during normal operation of the Reactor Coolant System are: (2.0)

a. The relationship between coolant Tavg and pressurizer level must be maintained.
b. System pressure must be adjusted whenever power level is changed.
c. Pressurizer spray flow should be operated while changing boron concentration.
d. Reactor coolant pump (RCP) seal injection flow rate must be maintained, in addition to RCP protection afforded by the thermal barrier heat exchanger.
e. Power level in the primary and secondary systems must be continually balanced.

Answer: c, d

Ref: NS-2-76

2.2 True or false. The Reactor Coolant Design Pressure drop, psi, across the reactor vessel is greater than the total of the pressure drops across all other components in a loop. (Ignore the head developed by the RCP.) (0.5)

_____

Answer: True

Ref: NS-2-77

2.3 Explain the difference between Limiting Safety System Settings and Limiting Conditions for Operations. Examples may be used to illustrate each, but numbers are not required. (3.0)

Answers:

5.1.3 Limiting Safety System Settings

"Limiting Safety System Settings" are settings for automatic protective devices. The activation of protective systems prevents Safety Limits from being exceeded. The reactor protection system is designed to trip the reactor when a limiting safety system setting is reached. The reactor protection system primarily prevents damage in the reactor core. It also protects the reactor coolant system from over-pressure.

5.1.4 Limiting Conditions for Operatons

Limiting conditions for operations are the lowest acceptable functional capability or performance levels of equipment required to assure safe operation of the reactor plant. In other words, if a limiting condition for operation cannot be met, the reactor plant cannot be operated since continuing to do so is considered unsafe and thus not in the best interest of the public.

Scoring: 0.5 for the substance of each underlined phrase.

Ref: NS-2-87, 88

2.4a. Why is hydrogen peroxide added to the Reactor Coolant System (RCS) just prior to refueling. (0.5)

2.4b. What <u>two</u> chemicals are used for oxygen control in the RCS, one at high temperature, the other at low temperature? (0.5)

2.4c. What material is used to control <u>pH</u> in the primary system? (0.5)

2.4d. What are the <u>two</u> purposes of the mixed bed demineralizer? (0.5)

Answers: a. Produce a CRUD burst and allow RCS cleanup prior to head removal. This reduces personnel exposure during refueling.
Ref: Exam bank question, section on plant chemistry

b. Hydrogen (hi temp), hydrazine (low temp)
Ref: NS-6-12, 13

c. Li OH
Ref: NS-6-13

d. (1) Remove ionic corrosion products and certain fission products
(2) Act as mechanical filters for particulates
Ref: NS-6-14

2.4c Plant Staff Statement: May receive lithium for answer.

Response: moot

2.4d Plant Staff Statement: Sometimes used for pH control, i.e., difference between mixed bed resin may be used to remove lithium. Unborated mixed bed may be used for deborating system. Ref. OHP 4021.004.001 Precaution 4.2. Note: mixed bed resin is purchased in H+OH- form. Until the cation portion is lithiated, it is used for pH control. Until the anion portion is borated, it can be used for deborating.

Response: accept as addition to answer

2.5 A week after beginning of cycle, the plant is operating near full power with bank D at 160 steps and boron at 900 ppm. It is desired to "borate the rods out" to 200 steps. Estimate how many gallons of 12% boric acid will be necessary. Use the attached curves and show all work. (4.0)

Answer:

Using figure 3.5,

1260 pcm @ 200 steps, BOC
1095 pcm @ 160 steps, BOC
165 pcm change to be taken up by increasing boron concentration.

Using figure 4.2,

Differential reactivity worth for boron is 9.75 pcm/ppm B at 900 ppm B, HFP, Eq.Xe, Boc.
165 pcm = 16.9 ppm B to be added.
9.75 pcm/ppm B

Using figure 7.5,

At 16.9 ppm (say, 17) boration, and just under the line for 1000 ppm B initial boron, read approximately 55 gallons of 12% boric acid.

Ref: Technical data book, Plants I & II, tabs 3, 4, 7

Scoring: will accept answers in range of 50-60 gal.

For problem 2.5

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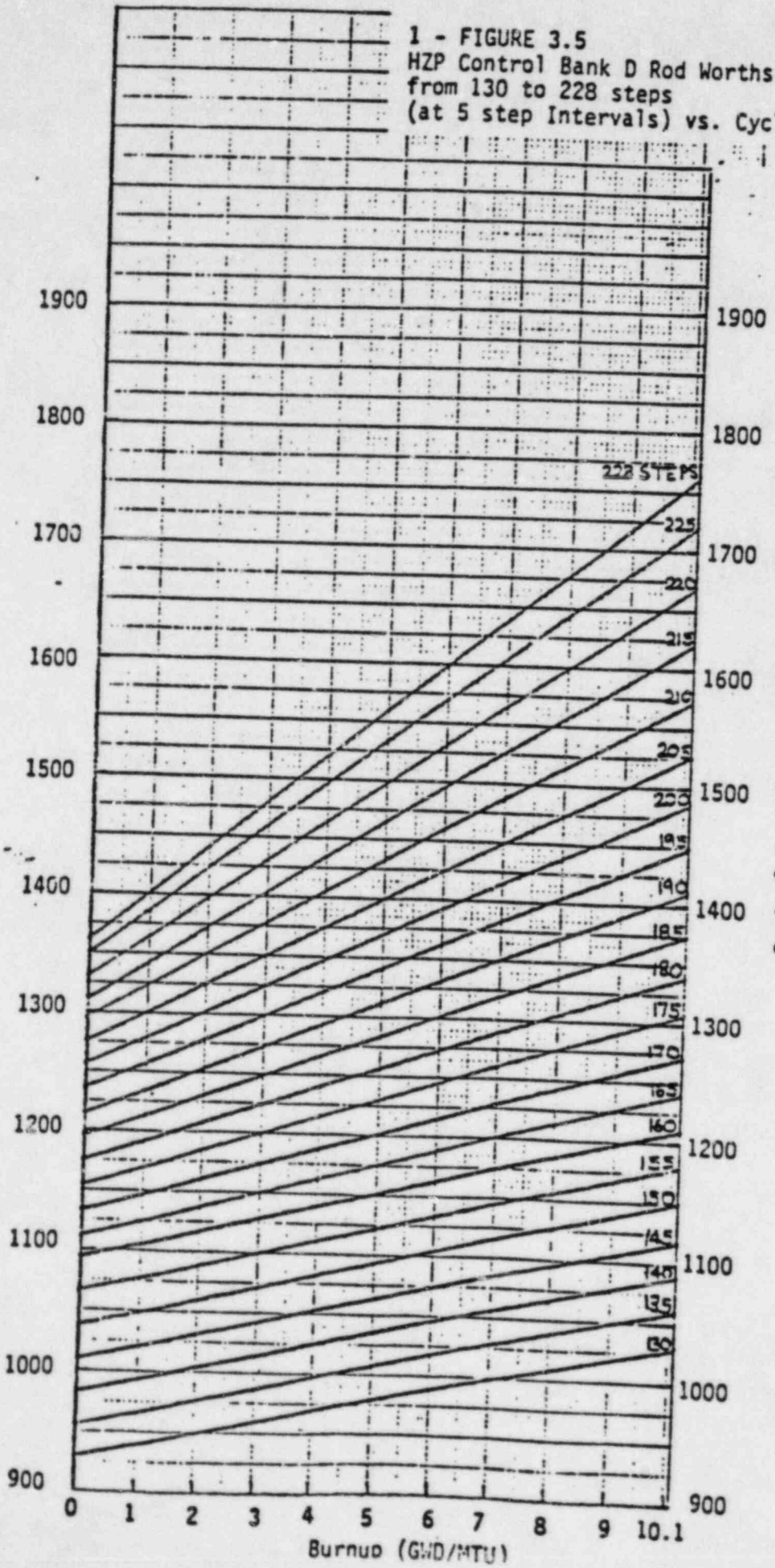
1 - FIGURE 3.5
HZP Control Bank D Rod Worths
from 130 to 228 steps
(at 5 step Intervals) vs. Cycle 7 Burnup



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For problem 2.5

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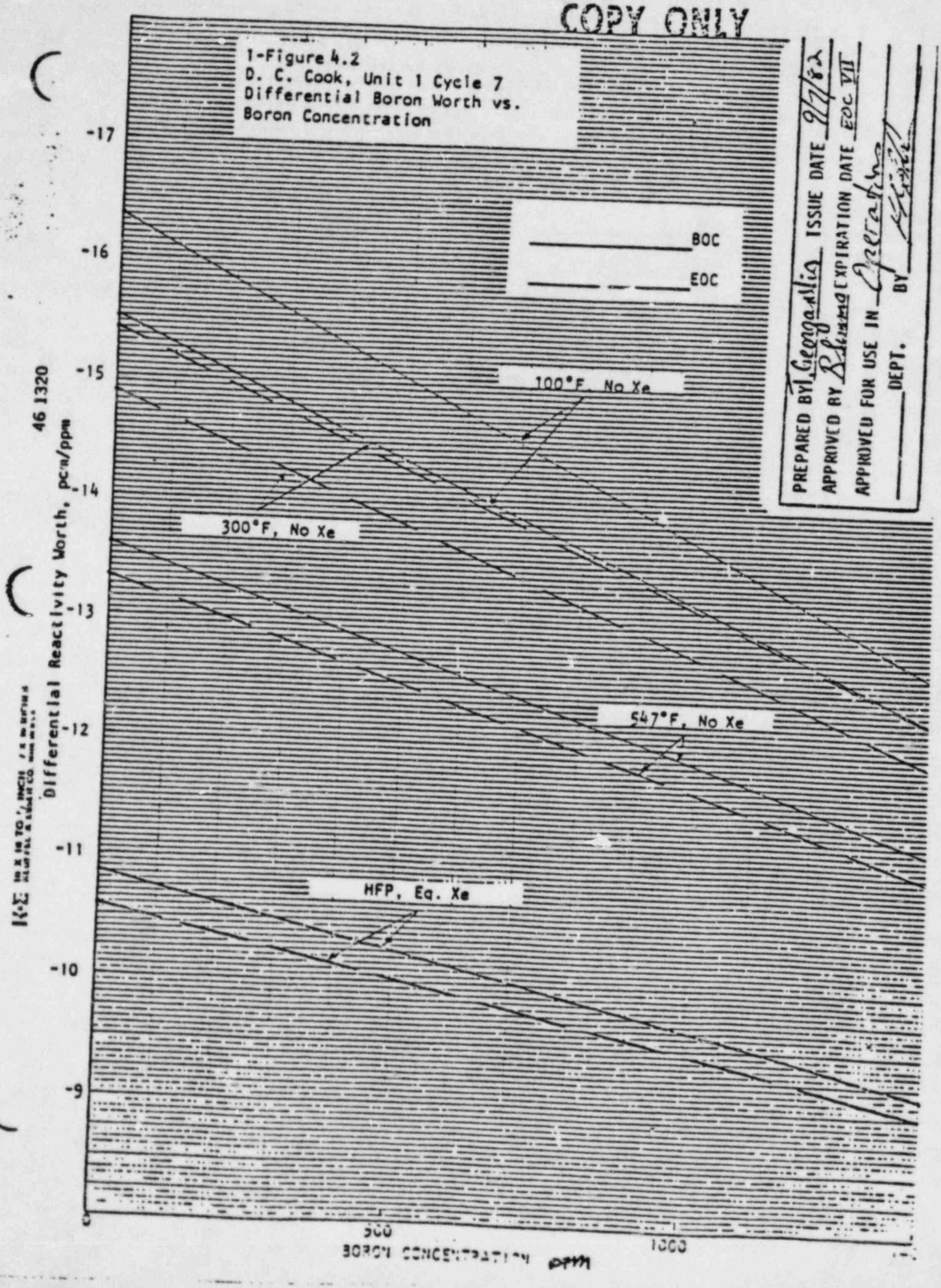
1-Figure 4.2
D. C. Cook, Unit 1 Cycle 7
Differential Boron Worth vs.
Boron Concentration



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For problem 2.5

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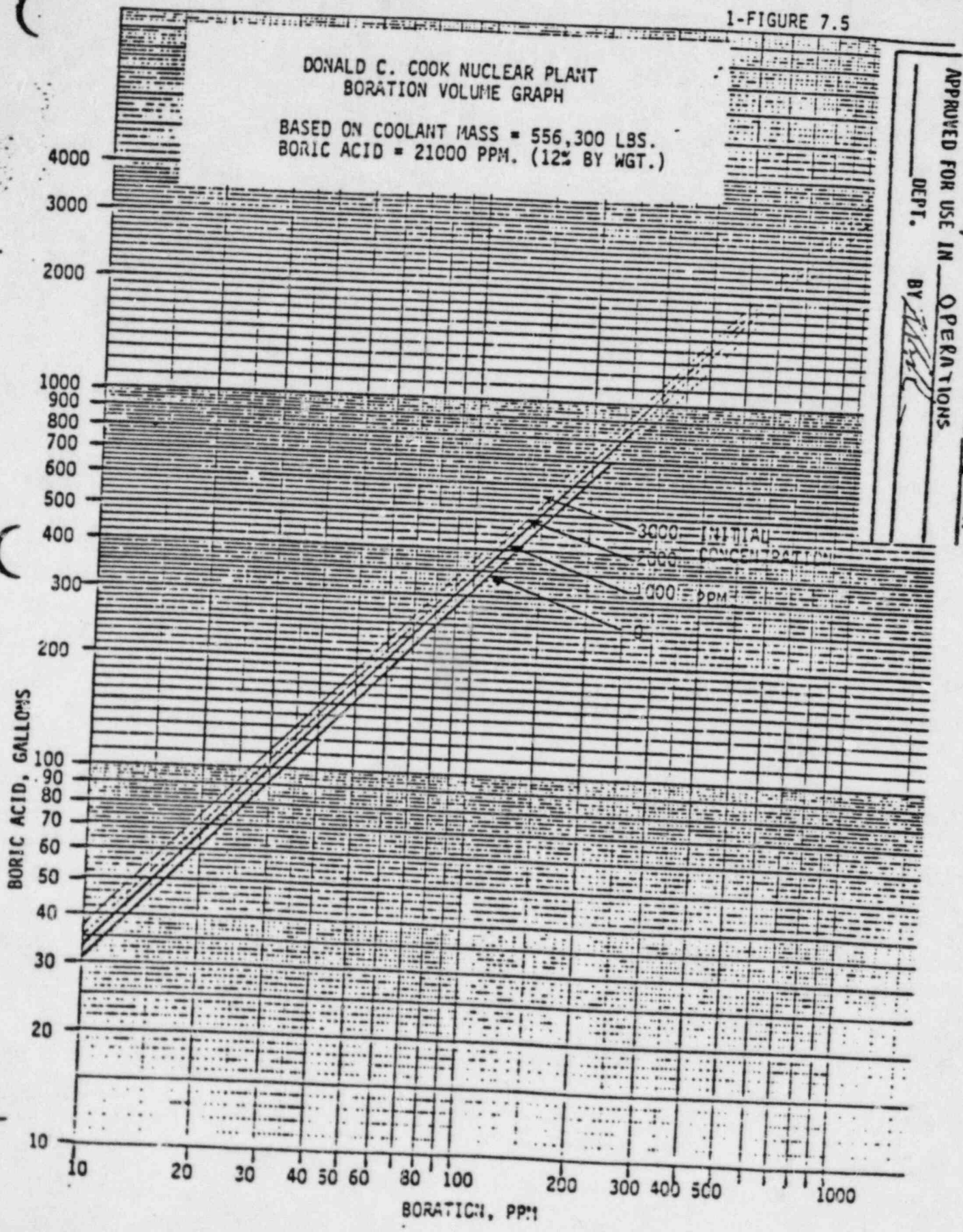
1-FIGURE 7.5



2.6 Match the Charging and Letdown component in Column A with a statement that applies to it in column B (There may be more than one statement per component). (4.5)

A.	B.
a. Regenerative heat exchanger.	(1) Uses component cooling water.
b. Non-regenerative heat exchanger	(2) Handles recirculation flow from centrifugal charging pumps.
c. Seal water heat exchanger	(3) Serves to reduce thermal stress at charging line penetrations to RCS.
d. Excess letdown heat exchanger	(4) omitted
	(5) Prevents flashing of fluid when pressure is reduced.
	(6) Prevents damage to demineralizer resins.

Answers: a. 3,5
b. 1,6,5
c. 1,2
d. 1(5)

2.6d Plant Staff Statement: Excess letdown heat exchanger used only during loss of normal letdown, not normally used during startup.

Response: accept; answer d.4 omitted, answer d.5 may be substituted (neither required nor wrong)

Ref: NS-6-29 through 43 and Figure NS-6-2

Scoring: 0.5 each correct statement from column B. 0.5 off for each wrong statement. Min. score zero for each part: a,b,c,d.

2.7a. Describe the method (flow path control) by which the RCS cooldown rate is controlled by the Residual Heat Removal system. (2.0)

2.7b. During solid plant operation, how does the RHR system regulate RCS pressure? (0.5)

Answer:
a. Part of the flow from the RCS passes through the RHR heat exchangers and part flows through a bypass line. Bojth flows are mixed and returned to the RCS (a small part is diverted to the CVCS for cleanup). The mixed fluid temperature is controlled by varying the flow split.
b. Regulate the amount of flow that is diverted to the CVCS.

Ref: NS-8-6

Scoring: The answer must contain the substance of the underlined phrases.

2.8a. What is the purpose of changing over from cold leg recirculation after a LOCA to the hot leg recirculation phase?

(1.0)

2.8b. Under what conditions might RHR spray be required in containment? (1.0)

Answers: a. This is to minimize the buildup of boric acid in the upper portion of the core. [Evaporation (boiling) can cause an insulating film of acid crystals to form, allowing the cladding to heat up. In addition to risking fuel destruction and hydrogen buildup, this would be a violation of the ECCS criteria on post-accident core cooling.] Note: the material in brackets may be offered, but is not a required part of the answer.

Ref: NS-12-55

b. During ECCS recirculation, if the containment spray pumps seem inadequate to reduce containment pressure below 8 psig, the flow from one RHR HX may be partially or wholly diverted to the containment sprays.

2.8b Staff Plant Statement: Check RHR spray procedure for PWR spray operation. More acceptable answer from OHP-4022 .009.001 2.1.

Response: reject, required answer adequate

Ref: NS-12-55,56

2.9 True or false. The containment vessel resists external loads from storms and earthquakes, as well as serving as a biological shield and pressure container. (0.5)

_____

Answer: true

Ref: NS-13-4,5

2.10 Give 3 functions of the sodium tetraborate ice held in the conderser baskets. (1.5)

Answer:
1. LOCA or steam break pressure suppression in containment.
2. Coolant, on recirculation after LOCA.
3. Boron prevents dilution of RCS during recirculation after LOCA.
4. The sodium (alkaline solution) combines with fission product iodine, making it easier to cleanup after LOCA.

Ref: NS-14-4,5

2.11a. Two sources of hydrogen in containment after a LOCA are _____ and _____. (0.5)

2.11b. Two methods of preventing an explosive buildup of hydrogen in containment after a LOCA are _____ and _____. (0.5)

Answers: a. 1. Hydrogen dissolved in RCS coolant.
2. Hydrogen from corrosion of metal in containment by NaOH spray (Zn, Al).
3. Hydrogen from Zr-H O reaction.
4. Hydrogen from radiolytic decomposition of water
b. 1. Hydrogen recombiner
2. Glow plugs

2.11b Plant Staff Statement: Glow plug may be referred to as DIS. Distributed Ignition System.

Response: accept

Additional Staff comment: "CEQ fan prevent build up of H_2 in dead areas may consider this a correct answer. AS-8, pg. 14, 1.2.86."

Response: moot

Ref: NS-15-7,8,9

2.12 What is the purpose of the lower baffle in the Component Cooling Water Surge tank? (0.5)

Answer: If one safeguards train of CCW ruptures, the other train remains intact.

Ref: AS-1-18,19,22 and figure AS-1-2.

2.13 Mark each true or false. The Auxilliary Feedwater System will auto start upon receipt of the following signals:

a. Turbine trip
b. SI
c. Reactor trip
d. Main feedpump trip
e. Reactor coolant pump trip

Answers: a. false
b. true
c. false
d. true
e. false

2.13d Plant Staff Statement: Must be both main feed pumps. T.S. Table 3.3.4 sec. 6.

Response: accept

Ref: AS-11-4

3.0 Instruments and Controls (25.0)

3.1 In the simplified diagram for Stean Generator (S/G) Level auto control, identify the components in boxes, or explain what function is performed. (3.0)

3.1 Answers:

A Density correction

B $\sqrt{\Delta P}$, convert signal to flow of steam

C $\sqrt{\Delta P}$, convert signal to flow of feedwater

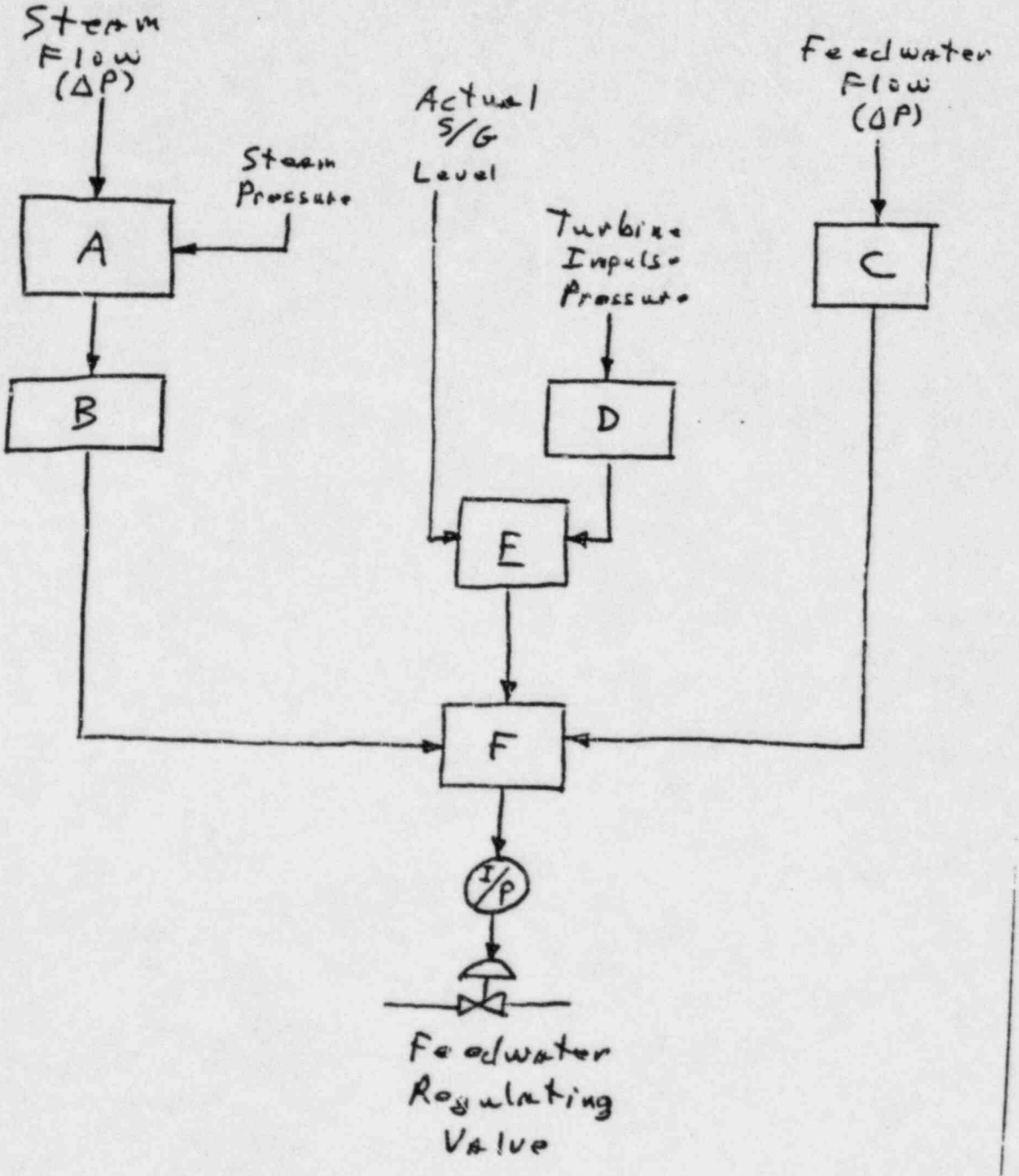
D Level program, function of power

E Level controller, compares actual and program level, has lag feature to dampen out transient shrink and swell

F Feedwater controller, responds mainly to mismatch of steam and feedwater flows.

Ref: PGS-11-4 through 9 and figure PGS-11-1 or PGS-11-13 through 17.

Figure 3.1


Steam Flow (ΔP)
Steam Pressure
Actual S/G Level
Turbine Impulse Pressure
Feedwater Flow (ΔP)
A
B
C
D
E
F
I/P
Feedwater Regulating Valve

3.2 Match the parameter in column A with the function if performs in the Steam Dump Control circuitry, column B. (2.0)

A.	B.
a. Tavg (auct)	(1) Provides interlock signal to prevent opening arming valves and actuates an alarm in the control room if Tavg is less than 541 F.
b. Tref	
c. T no-load	(2) Provides interlock/permissive signal to prevent the arming valves from opening unless condenser vacuum is greater than 10.6 in Hg.
d. Lo-lo Tavg	
e. Condenser pressure	(3) Provides input to load rejection arming bistables for opening selected arming valves if a load rejection is sensed.
f. Turbine impulse pressure	
g. Steam header pressure	(4) Provides inputs to the input selector and the steam dump valve trip signal selector.
h. Availability of Circulating Water Pump	(5) Provides input to the load rejection summing amplifier.
	(6) Provides input to the load rejection and turbine trip summing amplifiers.
	(7) Provides set point for the turbinetrip summing amplifier.
	(8) Provides input to steam pressure summing amplifier.
	(9) Provides interlock/permissive signal to prevent opening arming valves unless at least one circulating water pump is operating.
	(10) Provides set point for the steam pressure summing amplifier.

3.2 Answers:
a. 6
b. 5
c. 7
d. 1
e. 2
f. 3
g. 8
h. 9

Scoring: 0.25 each

Ref: PGS-12-33

3.3 In the main generator control circuitry, what is the function of the Regulator Automatic Voltage Adjustment Potentiometer? Explain the effect of this voltage adjustment on plant output.
(2.0)

Answer: The function of the regulator automatic voltage adjustment potentiometer is to adjust the voltage applied to the main generator's field. The potentiometer is used in conjunction with the generator reactive power meter (Megavar meter). Recall that variation of the generator's desired terminal voltage varies the reactive loading of the generator. [The voltage is raised when the potentiometer is turned clockwise and lowered when turned counterclockwise. Bojth the manual regulator adjustment switch and the automatic potentiometer are used in conjunction with the regulator null meter. Use of this meter enables the operator to ensure the set point of the manual and automatic regulators are balanced prior to shifting from one regulator to the other.]

Scoring: 1.0 for the substance of each underlined phrase. The material in brackets may appear in the answer, but is not required.

Ref: PGS-13A-58,59

3.4 Give 3 plant operating, or accident, situations that require the Breaker Synchronizing Selector switch, for each 4160 volt normal bus, to be in the Auto position. (3.0)

Answers: 1. Paralleling normal to reserve power during shutdown.
2. Reserve to normal during startup.
3. Return to normal lineup following a blackout.

Ref: PGS-14-24

3.5 What two interlocks are provided in the 600 volt system to prevent paralleling while the diesel generators are supplying power? Identify by number, either Unit I or II. (2.0)

Answers: tie breakers 11AC (21AC) and 11BD (21BD).

Ref: PGS-15-41 (shown on figure PGS-15-1)

3.6a. True or false. A Steam Generator (S/G) tube leak awill first be detected by the Sampling Blowdown Radiation Monitor, and a short time later by the monitor on the Condenser Off-Gas Discharge. (0.5)

3.6b. Why is it important that blowdown flow, from a S/G with a leaking tube, be manually re-established (after auto-isolation) as soon as possible? (2.0)

Answers: a. False
b. Minimize buildup of radioactivity (1.0) and prevent excessive concentration of dissolved solids (1.0) in affected S/G. [The former is an aid to maintenance and the latter is to reduce corrosion potential.]

Scoring: 1.0 for each reason indicated. Material in brackets may be in answer, but is not required.

Ref: PGS-1-46
Ref: PGS-1-47

3.7a. Why are steam supplies to the Moisture Separator Reheaters (MSRs) isolated following a reactor trip? (0.5)

3.7b. Where do you have indication that this has taken place (which panel)? (0.5)

3.7c. Which valves must you manually operate from the control room panel if auto isolation fails? (0.5)

Answers: a. To reduce the Reactor Coolant System cooldown rate.
b. MSR main steam valve isolation is indicated on the Heater panel
c. MMO-401, MMO-402 Unit I, or MRV-411, MRV-412, MMO-431, MMO-432

3.7b & 3.7c Plant Staff Statement: accepted additions to answer

Ref: PGS-2A-9, 91/92, Table PGS-2A-I (pg PGS-2A-47), PGS-2B-93/94

3.8a. What two means do you have for detecting RCS coolant leakage into the Component Cooling Water system? (1.0)

3.8b. Which valve (name or number) will close to contain any radioactivity? (0.5)

Answers: a. Surge tank level, radiation monitors at CCW pump discharge.
b. Surge tank vent valve, CRV-412

3.8a Plant Staff Statement: accept (minor change)

Ref: AS-1-43

3.9a. In the attached figure, circle the valve(s) you must close to isolate the flow of Essential Service Water to Diesel Generator AB. (0.5)

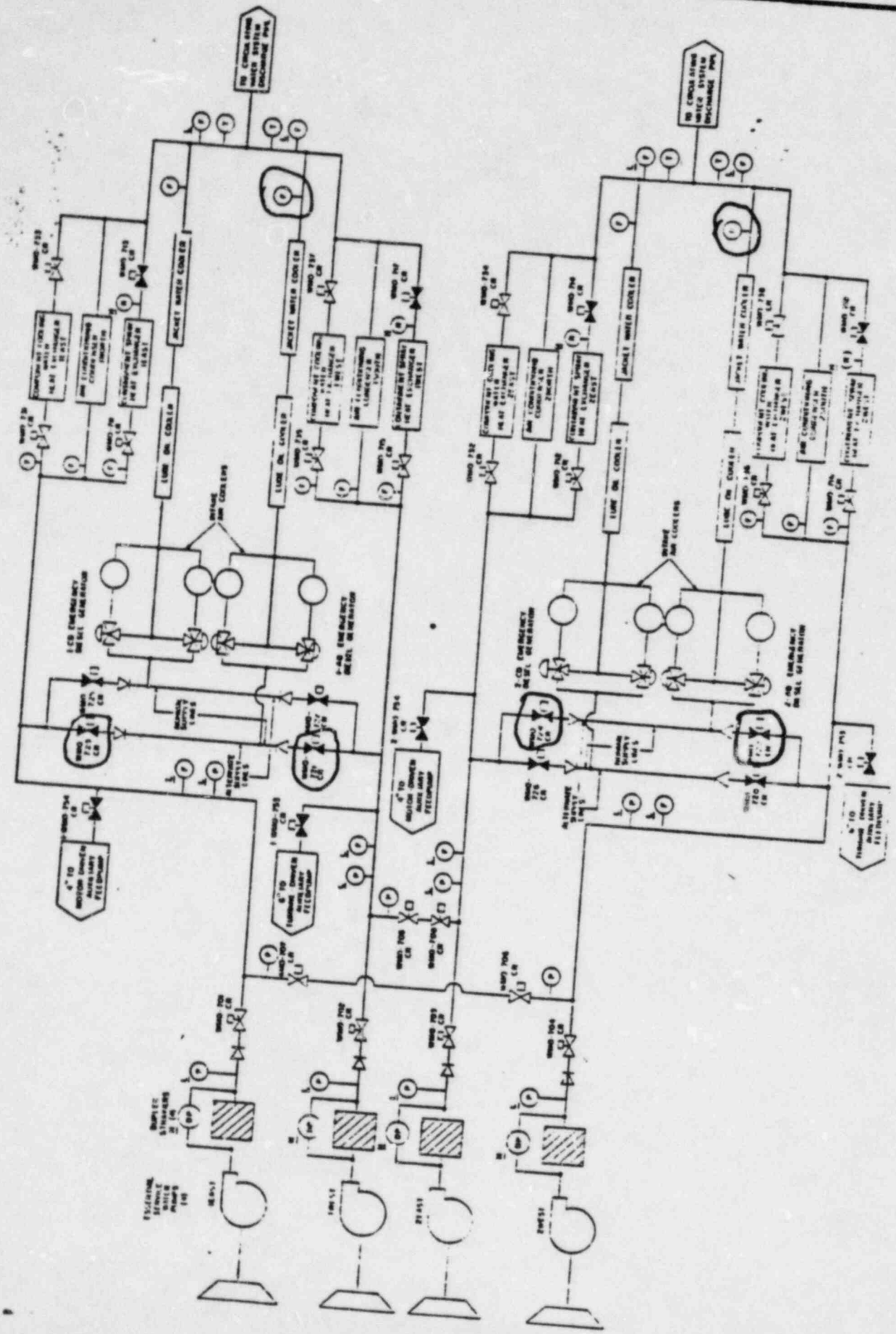
3.9b. Circle the flow meter(s) you would check to verify the isolation. (0.5)

Answer: (attached)

3.9a & 3.9b Plant Staff Statement: accept; changes made in figure

Ref: Figure AS-2-2

3.9 Amend



ESSENTIAL SERVICE WATER SYSTEM DIAGRAM

FIGURE 9.2.2

3.10 For each of the Emergency Diesel Generator HEA lockout trips listed below, indicate whether the trip functions only during normal (surveillance) testing or will function during eithe abnormal (SI, blackout) or normal testing. (2.0)

a. High Intake Manifold Air Pressure
b. Low lube oil pressure
c. Generator phase differential
d. Overspeed
e. Overcurrent
f. Low fuel oil pressure
g. Carbon dioxide actuation
h. Manual pushbutton

Answers: a. normal
b. normal
c. either
d. either
e. normal
f. normal
g. normal
h. either

Ref: AS-10-60

3.11 The motor-driven auxiliary feedpumps will start on a "black- (2.0)
out sequence", and the turbine-driven auxfeedpump will
start on a "loss of power signal". Explain the difference
tween these start signals.

Answer: Blackout sequence (loss of station electrical power, pump sequenced on after EDG energizes safeguards bus). Loss of power signal (2 undervoltage signals from RCP bus, anticipates loss of station power, blackout).

Ref: AS-11-7

3.12 Which Eberline rad monitors have automatic trip or other auto action in response to a high level alarm? List by name or number of the monitor or channel. (2.0)

Answers: Containment airborne monitors, low range noble gas and particulate channels, containment general area monitor (1401, 1405, 1301, 1305, 1101, 1201), unit vent stack monitor low range noble gas (1505), and mid-range noble gas (1507). All unit 2 numbers for comparable channels wuld be prefaced by a 2 rather than a 1.

Response: accepted; answers for either units acceptable

Ref: Exam bank question #4, Radiation Monitoring System

3.13 True or false. Incore flux thimbles are symmetrically placed in the core to facilitate peaking factor calculations. (0.5)

_____

Answer: false

Ref: Figure NS-10-3

4.0 Procedures - Normal, Abnormal, Emergency and Radiological Control. (25.0)

4.1 List the 7 automatic actions that should occur after a substantial loss of primary or secondary coolant. (1.75)

Answer: Rx trip, turbine trip, feedwater isolation, phase A CTMT isolation, AFW pump start and valves open, ECC pumps all start, Service and CCS pumps started

Ref: 1-OHP 4023.001.002 , pg 3, Rev 2, 9/15/81

4.2 What manual action(s) must you take if one (of 4) Reactor Coolant Pumps trips at 40% reactor power? (1.0)

Answer: Trip reactor immediately

Ref: 1-OHP 4023.001.010 , pg 2, Rev 1, 2/15/77

4.3a. What instrument readings are indicative of inadequate core cooling following a small break loss of coolant accident? (1.0)

4.3b. What 2 cooling systems may not be functioning as intended, given the above conditions? (1.0)

4.3c. What 3 containment systems do you manually initiate, given the above conditions? (1.5)

Answers: a. Hot leg RTDs are pegged, 5 or more incore TCs off scale above 700 F.
b. ECC, AFW
c. Hydrogen skimmer fans on, valves open. Turn on CTMT sprays. Turn on distributed ignition system, after turning ice condenser air handler fans off.

4.3a Plant Staff Statement: May find candidates state a different temp. range based on using P-250 TC map.

Response: accept as additional part of answer

4.3c Plant Staff Statement: Candidates may give hydrogen recombiner which is also a manual action.

Response: accept as additional part of answer

Ref: 1-OHP 4023.001.015 , para 3.2 and 4.2

4.4 Following a high coolant activity alarm at the ALERT level, what CVCS alignment do you verify and what letdown change do you make? (1.0)

Answer: Verify mixed bed demin lineup. Increase letdown flow to 120 gpm.

Ref: 1-OHP 4023.002.001 , para 4.2.2, Rev 1, 7/6/77

4.5 State the facility (administrative) exposure limits indicated below.

a. _____ mR per quarter, whole body (0.5)
b. _____ mR/Qt WB, max (0.5)
c. What types of radiation monitors must a person carry when entering a radiation controlled area? (0.5)

Answers: a. 1000
b. 2250
c. Self-reading dosimeter and TLD

Ref: PMP 6010.RAD.001 , pg 36 and 61, Rev 6

4.6a. If you discover an emergency situation while out in the plant, what 4 pieces of information will you communicate to the control room? (1.0)

4.6b. If qualified, would you be allowed to

(1) administer first aid? (0.25)
(2) extinguish small fires? (0.25)
(3) isolate a spilling line? (0.25)

Answer each of these 3 yes or no.

Answers: a. Name, location, situation, injured personnel
b. yes,yes,yes

Ref: PMP 2081 EPP.013 , pg 1, Rev 1 6/24/82

4.7 After a load rejection that has not caused a reactor trip, what 4 immediate manual actions must be taken? (2.0)

Answer:

1. Verify steam dump controls have functioned to limit Tavg and pressurizer pressure transients. If not, trip the reactor.
2. Monitor reactor power to ensure the rods are moving inward to reduce power level. If not, take manual control and reduce reactor power.
3. Adjust turbine speed to maintain frequency at 60 Hz.
4. Monitor Tavg to ensure the Steam Dump System is performing properly; take manual control if required.

Ref: 1-OHP 4022.001.002 , para 4.2.2

4.8 Mark each true or false. Loss of the following equipment will cause the reactor to be automatically tripped, or will require it to be manually tripped. Assume the reactor is at full power. (1.25)

a. One condenser circulating water pump.
b. One main feed pump.
c. One dropped control rod.
d. Two heater drain pumps.
e. One Reactor Coolant Pump.

Answers: a. false
b. false
c. false
d. true
e. true

Ref: a. 1-OHP 4022.057.001
b. " .055.001
c. " .012.004
d. " .060.001
e. " .002.001

4.9a. What are the <u>two</u> conditions under which Containment Integrity, as defined in PMI-2100, need <u>not</u> be maintained? (1.0)

4.9b. Is containment access allowed while the reactor is critical? (0.5)

Answers: a. Mode 5 or 6
b. yes

Ref: a. and b., PMI-2100, pgs 2,3 Rev 4 3/23/79

4.10a. Are you,as RO, permitted to issue a caution (yellow) tag for equipment under your control? (0.5)

4.10b. Can you authorize removal of a caution tag from equipment under your control? (0.5)

Answer: a. yes
b. no

Ref: PMI-2110, para 3.6, Rev 8

4.11 What are the 7 Shift turnover items that both the oncoming Console Operator and Panel Operator (both ROs) must accomplish? (3.5)

Answer:
1. Review CR log
2. Review non-conforming equipment log
3. Review Control logs for jumpers, grounds, lifted wires, blocked relays, blocked alarms
4. Review surveillance schedule
5. Control panel walkdown
6. Review standing orders, operating memos or instructions
7. Discuss conditions with off-going operator

4.11 Plant Staff Statement: Item 6 - the answer should reflect the reference word-for-word. Standing orders are not required to be reviewed every day--only those issued during his/her absence.

Response: The candidate response, and our first hand observation is that "Review Status Board" is a regular part of the turnover process, but is <u>not</u> listed in the procedure. Where given in the answer, we consider it a part of panel walkdown. The staff comment on review of standing orders, etc., is rejected. Our position is that the requirement is to always check and see if any <u>new</u> orders, etc. have been issued since the RO was last on shift. In terms of candidate response on this exam, the issue is moot.

Ref: OHI-4012, para D, Rev 0

4.12 In addition to boron concentration and control rod position, there are 4 other sources of reactivity change that must be considered in a Estimate of Critical Conditions Procedure. List them. (2.0)

Answer: Power defect (MTC and Doppler), Xe, Sm, Pu

Ref: 1-OHP-4021.001.011, paras 8.3,.4,.5,.6, Rev 6

4.13 In the normal procedure for reactor coolant system degassing, the precautions state that the Volume Control tank pressure must be maintained between 15 and 50 psig. Explain why. (2.0)

Answer: Pressure below 15 psig may result in damage to RCP seals.
Pressure above 50 psig increases chances of accidental release.

Ref: 1-OHP 4021.003.005, para 4, Rev 7.

4.14 What range of speeds, rpm, on the Main Turbine are likely to contain the critical speeds at which prolonged operation is not permitted? (1.0)

Answer: 1000-1400 rpm

Ref: 1-OHP 4021.050.001, pg 7, Rev 5, 1/26/82

Scoring: In step 6.10, same ref, the range 800rpm to 1500 rpm is also given as the range to check for critical speeds and other phenomena. Will also accept this range.

4.15 True or false. If Saturation Margin Low alarms, one means of verifying alarm is to check the saturation margin readout on the plant process computer. (0.25)

_____

Answer: true

Ref: 1-OHP 4024.107.099, Rev 2, 4/29/82

MASTER

X1484
X1386

U.S. NUCLEAR REGULATORY COMMISSION
SENIOR REACTOR OPERATOR LICENSE EXAMINATION

FACILITY: D. C. Cook Requalification
REACTOR TYPE: Westinghouse
DATE ADMINISTERED: June 18, 1984
EXAMINER: T. Reidinger
APPLICANT:

INSTRUCTIONS TO APPLICANT:

Use separate paper for the answers. Write answers on one side only. Staple question sheet on top of the answer sheets. Points for each question are indicated in parentheses after the question. The passing grade requires at least 70% in each category and a final grade of at least 80%.

Category Value	% Of Total	Applicant's Score	% Of Category Value	Category
____	____	____	____	6. Plant Systems Design, Control, and Instrumentation
____	____	____	____	7. Procedures - Normal, Abnormal, Emergency, and Radiological Control
____	____	____	____	8. Administrative Procedures, Conditions, and Limitations
____	____	____	____	TOTALS

Final Grade _____%

All work done on this exam is my own, I have neither given nor received aid.

_____
Applicant's Signature

5. THEORY OF NUCLEAR POWER PLANT OPERATION, FLUIDS, AND THERMODYNAMICS (25.0 POINTS)

Q.

(2.00) 5.1 During the initial core designing, one engineer proposes to eliminate the poison rods and only use soluble poison in their place. Another engineer is against the idea. Which engineer do you agree with? Explain your answer.

Q.

(2.40) 5.2 During a routine startup, the reactor is subcritical with a stable count rate of 100 cps on N31/N32 and the Shutdown Banks fully withdrawn. The operator withdraws Bank A to 100 steps and notes a count rate of 150 cps after he stops rod motion.

a. If the operator performed no rod motion for five minutes would the count rate increase, decrease, or remain the same? Explain.

b. Would the change in count rate be different if the reactor was slightly subcritical (K - .995) as compared with a greatly subcritical (K = .95)? Assume the same amount of rod withdrawal and explain your answer.

c. Suppose Bank A is maintained at 100 steps for <u>two</u> hours. What would you expect count rate to do over that period? Assume no temperature/poison change and explain your answer.

SRO5

5. Theory of Nuclear Power Plant Operation, Fluids, and Thermodynamics

Q.

(1.60) 5.3 Why is the thermal utilization factor of such great importance to reactor operation? Explain your answer.

Q.

(1.80) 5.4 Using general system and pump characteristic curves, show how a centrifugal charging pump flow rate will be affected by the following:

a. Throttling down the flow control valve.
b. VCT pressure increase.
c. RCS pressure increase.

Q.

(2.00) 5.5 Select the answer that best completes the following statement: "Boron differential worth (PCM/PPM) becomes less negative

a. As the RCS temperature increases."

b. As the nuclear fuel is depleted."

c. As the control rods are withdrawn."

d. As the reactor power decreases."

5. Theory of Nuclear Power Plant Operation, Fluids, and Thermodynamics

Q.

(2.00) 5.6 Describe reflux flow.

Q.

(3.00) 5.7 Attached is a graph of saturation pressure versus saturation temperature (Figure 5.7). Starting from the point on the curve where the hot leg operates at full power, sketch and explain what will happen to this point (with arrows) for the following small break LOCA's:

a. Makeup flow equals break flow at 1000 psia; no auxiliary feedwater available; break flow and makeup flow insufficient to remove decay heat.

b. Makeup flow equals break flow at 1700 psia; adequate heat sink available.

SRO5

5. Theory of Nuclear Power Plant Operation, Fluids, and Thermodynamics

Q.

(1.60) 5.8

a. Explain why DNB is undesirable.

b. Which heat transfer mode dominates once DNB has occurred?

Q.

(2.90) 5.9

a. What would be the major radioactive isotopes released to the reactor coolant system for a rod rupture accident?

b. How could you determine if fuel melting occurred?

Q.

(2.50) 5.10

Unit 1 has been operating at 50% power for about a week. Reactor power is increased to 100% and held at this power level for 72 hours. At this time, a reactor trip occurs. Draw the corresponding Xenon concentration variation for this power history. Explain these variations and give approximate values.

Q.

(2.00) 5.11

What four plant parameters would you check to verify that natural circulation was established? Provide a <u>brief</u> explanation of parameter trends or indications.

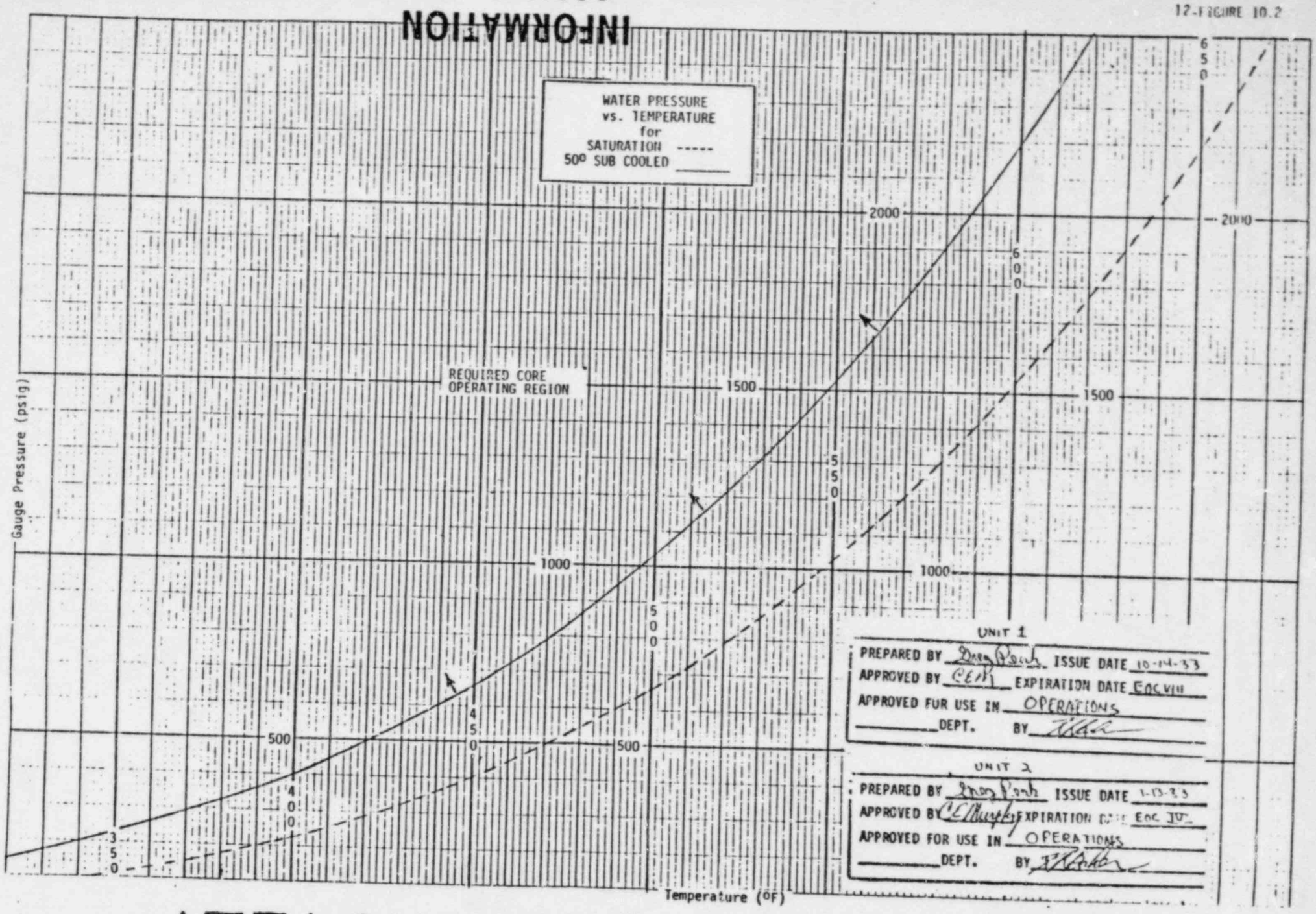
Q.

(2.00) 5.12

Draw a typical integral rod worth curve for our plant with rod withdrawal of banks A, B, C, and D in overlap and another integral rod worth curve for withdrawal of banks A, B, C, and D without overlap. Explain the reasons for the differences.

INFORMATION

12-FIGURE 10.2



ATTACHMENT 5.7

6. PLANT SYSTEMS DESIGN, CONTROL, AND INSTRUMENTATION

6.1 Technical Specifications associate a day fuel oil tank with the emergency diesels. Does the day fuel oil tank allow for 24 hours of diesel operation at full load? (Assume fuel oil transfer pump is off.) Yes/No, Explain your answer. (1.0)

6.2 The plant is at 100% power and the diesel is 100% loaded for surveillance testing. The I&C mechanic accidentally initiates a spurious SI signal. How does the diesel respond to this condition? (1.0)

6.3 Of all the safety devices for the diesel which is the only one functional when all diesel generator DC control power is lost? (1.0)

6.4 List the failed position of the following valves (Open, Shut, As Is) Choose one.

a. QRV-301 backpressure regulator valve in letdown line (0.5)

b. QRV-111 letdown isolation valve (0.5)

c. QMO-410 emergency boration line valve (0.5)

d. Main Steam ~~Safety~~ PCR Valves (loss of control air) (0.5)

6.5 List all the Chemical and Volume control Valves that are automatically positioned on containment isolation phase A. (2.0)

6.6 List 4 out of 6 relief valves that discharge to the PRT (pressurizer relief tank) with the exception of all relief valves from the pressurizer system. (2.0)

6.7 Lit all major primary plant safety loads that are not sequenced on the diesel during a blackout? (2.0)

6.8 List all the valves that are repositioned upon receipt of a safety injection signal in the CVC System? (2.0)

6.9 There are 3 pressurizer level channels in the pressurizer level control circuit. Only 2 channels at a time are used to control the functioning of level control circuits. When you as RO select level channel 1 by the switch, what 2 level channels are used for control circuitry? (2.0)

6.10 The containment spray system is necessary to prevent containment overpressurization during the initial blowdown phase of a design basis LOCA. True/False (1.0)

6.11 What pump supplies operating oil to Reset latch the main turbine prior to startup? (1.0)

6.12 Early this year D.C. Cook was notified that Main Feedwater System back leakage during power operations into the Auxiliary Feedwater System would render AFW pumps inoperable for accident conditions.

Describe how back leakage to the AFW system would affect the AFW pumps? (2.0)

6.13 Can the positive and negative cyclone separators be operated at the same time? (Yes/No) (1.0)

6.14 When will the 600 volt bus tie breaker 11AC or 11BD close automatically and what interlock must be satisfied before these bus tie breakers will close? (2.0)

6.15 Describe the operation of the main turbine feed pump emergency leak off flow. (Include flow paths.) (2.0)

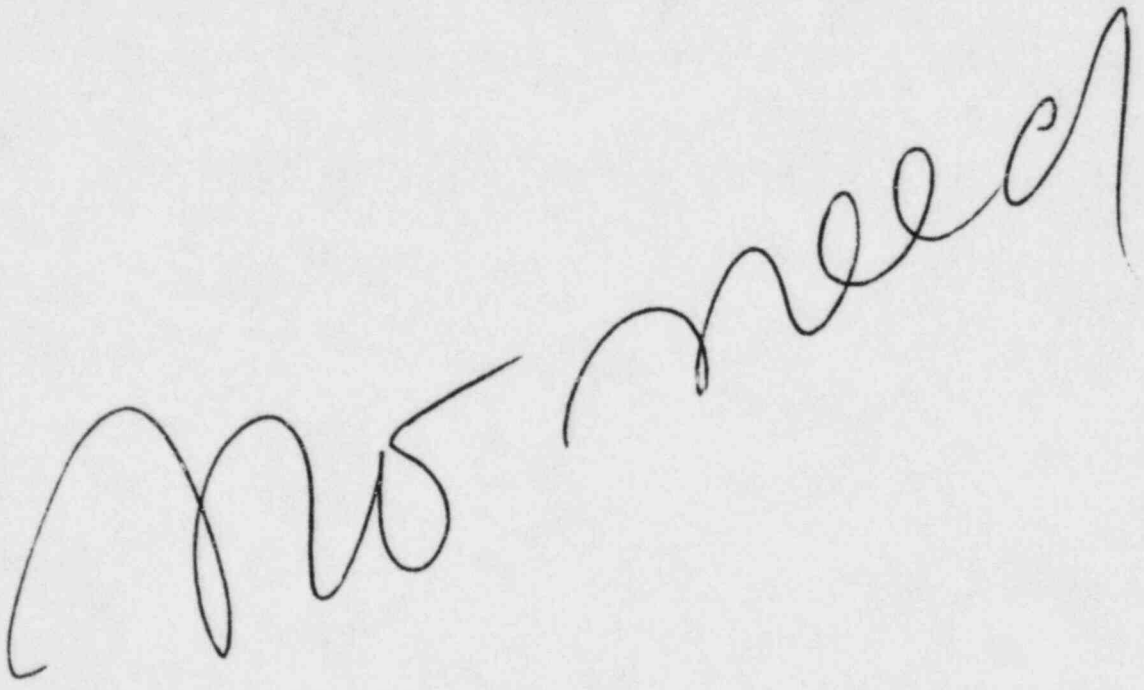
6.16 Give 4 indications in the control room if all three orifice isolation valves for the letdown system were inadvertantly opened. Consider only CVCs indications (assume no operator action). (1.0)

STOP!

END OF SECTION (6)

CHECK ALL QUESTIONS ARE ANSWERED.

NOW PROCEED TO SECTION (7).



7. PROCEDURES - NORMAL, ABNORMAL, EMERGENCY, AND RADIOLOGICAL CONTROL

7.1 The OHP for plant cooldown includes the following statement. Briefly explain the reason for the statement.

Raise VCT temperature to 120°-140°F and maintain at this temperature. (1.0)

7.2 Assume the computer was not available during a small Loss of Coolant Accident. What 4 (four) conditions or symptoms would verify or prove to you that adequate core cooling existed per procedure? (2.0)

7.3 The OHP for loss of all station AC power includes the following statement. Briefly explain the reason for the statement per this procedure!

Isolate RCP seals by placing the following valves in closed position, seal leakoffs, seal return, seal injection supply, thermal barrier return. (1.0)

7.4 The chemist reports that all four steam generators on your unit have slow steadily increasing conductivity levels. The unit is at full power.

a. What are three possible sources for this contamination? (1.5)

b. Assuming that feed and condensate samples show no definite problem, how could manipulating power level aid you in finding the problem? (1.25)

c. Would decreasing power have any effect on how fast steam generator conductivity levels were increasing? Explain. (1.0)

7.5 During plant heatup from cold shutdown to hot standby, how is the reactor coolant system protected from over pressurization when one or more of the RCS cold legs is $\leq$ 188°F. (152°F Unit 2) (Tech Spec Requirements) Include all options and setpoints. (1.5)

7.6 a. For each of the following situations indicate whether a Radiation Work Permit, an Extended Radiation Work Permit or neither would apply.

1. You must conduct a valve lineup of the CVCS in the auxiliary building. (0.5)

2. You must make a tour of the auxiliary building as part of the NRC examination preparations. NRC + CANDIDATE MAKING TOUR. (0.5)

3. You must enter a posted area of 6000 DPM/100 cm^2 β-δ loose surface contamination to rapidly isolate a leaking valve affecting plant safety. (0.5)

4. A SRO and RO must enter the containment for inspection after power operation. (0.5)

5. The refueling crew must enter the containment to commence refueling operations. (0.5)

b. Whose authority is required to deviate from the stated working conditions of the Radiation Work Permit? (List 3) (1.0)

7.7 List five (5) areas at D. C. Cook which are formally designated as Extreme High Radiation Areas. (Reactor power > 20%) (2.0)

7.8 a. Under what 5 conditions is emergency boration required per procedure 2-OHP4022.005.002, "Emergency Boration"? (2.25)

b. What are the operator actions necessary to commence emergency boration per procedure? (2.25)

c. Complete the following statement: The rate of reactivity insertion due to Emergency Boration @ 75 GPM is (1)ΔK/K every (2) minutes. (0.5)

7.9 What is the SI termination criteria during a large steam break accident? (2.0)

deleted 7.10 In the OHP for steam generator tube rupture the operator is instructed to isolate AF flow to the ruptured S/G once its level is in the narrow range. Why must AF flow be maintained to the ruptured S/G until the U- tubes are covered. (1.0)

7.11 The RCP seal leakoff valve must be closed whenever RCS pressure is less than 100 psig per OHP Hot Standby to cold shut down procedure.

a. Why does this step exist in procedure: (0.5)

b. What undesirable effects could result if these valves were opened? (1.0)

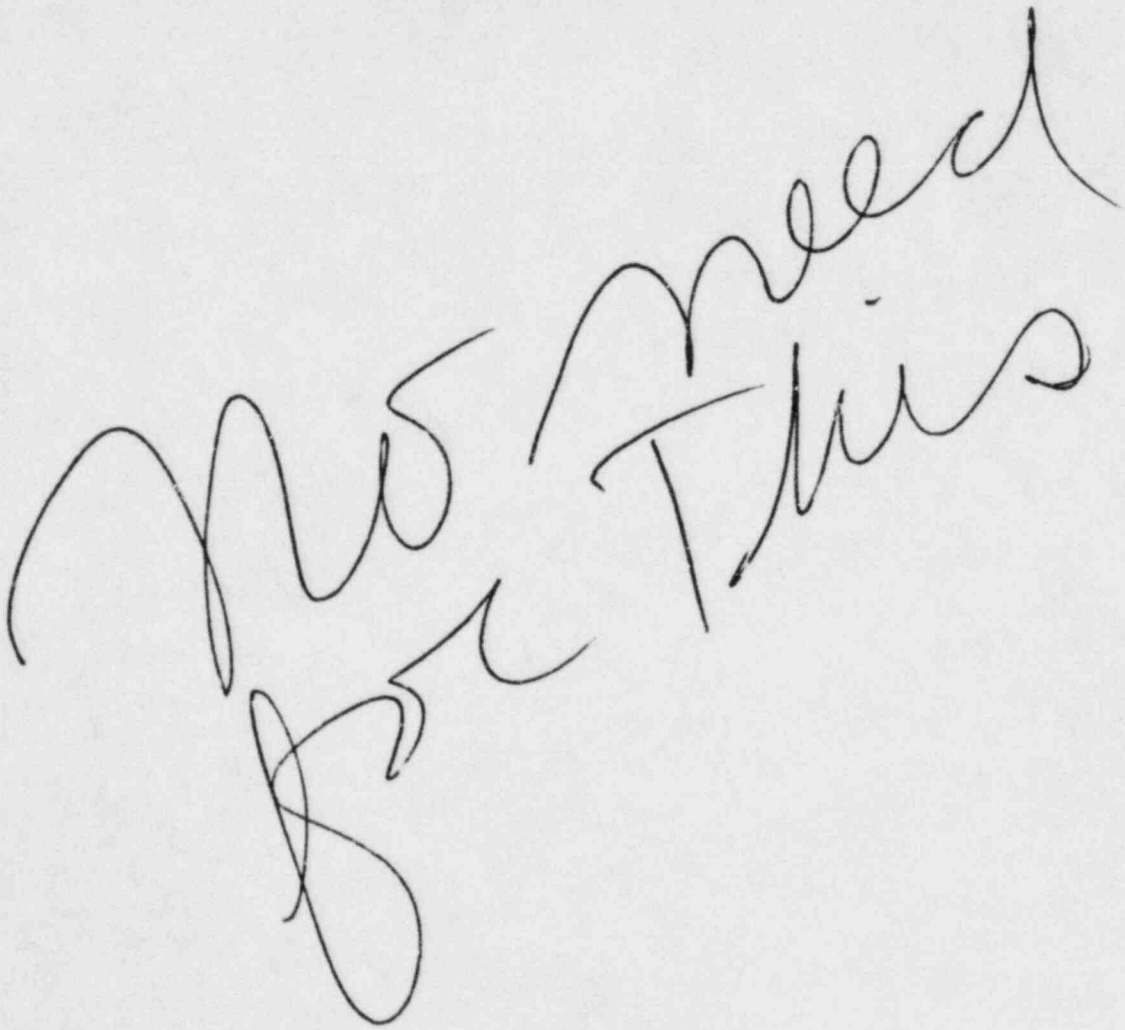
7.12 Whose permission is required to start up the reactor following a known reactor trip? (0.75)

STOP!

END OF SECTION (7)

CHECK ALL QUESTIONS ARE ANSWERED.

NOW PROCEED TO SECTION (8).



8. ADMINISTRATIVE PROCEDURES, CONDITIONS AND LIMITATIONS

8.1 By Technical Specifications is a pressurizer PORV considered inoperable if its block valve is closed because of PORV leakage? Yes/No? Why/Why Not? (1.0)

8.2 The plant is at 10% power with three (3) inoperable steam generator safety valves. All four (4) RC loops are in operation. Your permission is requested to raise power to 30% and the instrument technicians also want to perform surveillance on the nuclear instrumentation. What precaution should you take in light of the plant status before authorizing a power escalation and NI surveillance? (2.0)

8.3 List all conditions required to relax containment integrity requirements per D. C. Cook Plant Management Instructions. (2.0)

8.4 The two-man rule shall be in effect for all personnel entering the Containment to do work. Yes/No? Why/Why Not? (1.0)

8.5 The Shift Supervisor is immediately acting as On Site Emergency Coordinator (OSEC).

a. What are the responsibilities of the (OSEC) for overall plant emergency response functions per PMP 2080 EPP .015? (2.0)

b. What emergency levels are required to activate emergency support ~~personnel~~ centers and what are these emergency support ~~personnel~~ centers? (2.0)

8.6 As the oncoming SRO in charge of shift operations, you are confronted with the following concerns. Briefly explain their significance to plant operations. The plant is at 50% power steady state conditions following a rapid backdown.

a. A maintenance technician, repairing a damaged instrument air line, recommends that the affected letdown isolation valve be blocked open while its air line is being replaced. (1.0)

b. Assistant Shift Supervisor discovers Unit 1 emergency diesel generator room cardox system isolated with no names on the entry board. (1.0)

c. A maintenance technician performing a monthly surveillance on the ECCS system A BIT inlet isolation valve accidentally allows dilution of the BIT to 19,019 ppm. (1.0)

d. A maintenance technician performing containment spray surveillance tests not following procedures accidentally drains 1000 gallons of the Refueling Water Storage Tank via the Containment Spray System. (1.0)

8.7 Match the following items for their specific function as identified best in the D. C. Cook instructions. Choose one (1) answer each.

___ 1. Required whenever temporary ground straps are used on all ≥ 600 volt electrical circuits requiring electrical maintenance. (1.0)

___ 2. Used to identify all component names and numbers, isolation points, required positions, and the sequence of placing and removing tags. (1.0)

___ 3. Used to identify the status of all Clearance Permits issued. (1.0)

___ 4. Shall not be used in place of a procedure change or to provide personnel/equipment protection in place of the proper requirements. (1.0)

___ 5. Identifies the work to be performed inside the listed boundaries by job order or procedure number and by signature and date of person performing the work. (1.0)

a. Tagout Audit Sheet
b. Red Tag Clearance Transfers
c. Caution Tag
d. Master Clearance Permit
e. Shift Supervisors Log Book
f. Caution Tag Log
g. Equipment Position Sheet
h. Information Tag
i. Striped Tag Clearance Permit
j. Red Tag Clearance Permit (Ref. PMI-2110) NOT PART OF ANSWER

8.8 What actions shall be taken per Technical Specifications in the event a reactor safety limit is violated at 80% power? (2.0)

8.9 As Shift Supervisor, who would you assign to correct the following problems? Indicate how the problem would be corrected.

a. The Technical Specifications equipment status board is not up to date. (1.0)

b. There are three (3) blocked alarms in the control room that are not noted or logged anywhere. (1.0)

c. A temporary jumper installed is not documented anywhere. (1.0)

8.10 For each occurrence below, note the type of leakage it would be classified as per Technical Specifications.

a. Slight seepage through an elbow socket weld on an RTD bypass line. (0.5)

b. Valve packing leaks of unknown origin. (0.5)

END OF SECTION 8

REVIEW ENTIRE TEST FOR COMPLETE ANSWERS.

HAND IN EXAMINATION TO EXAMINER

WHEN THIS IS EXPIRED!

RULES AND GUIDANCE APPLICABILITY

During the administration of this examination the following rules and guidance apply:

a. Cheating on the examination means an automatic denial of your application and could result in more severe penalties.

b. You should sign the statement on the cover sheet that indicates that the work is your own and you have not received or been given assistance in completing the examination. This should be done after the examination has been completed.

c. Restroom trips are to be limited and only one candidate at a time may leave. You must avoid all contacts with noncandidates outside the examination room to avoid even the appearance or possibility of cheating.

d. When you complete your examination, you shall

   (1) Turn in your copy of the examination and all pages used to answer the examination questions.

   (2) Turn in all scrap paper and the balance of the paper that you did not use for answering the questions.

   (3) Leave the examination area, as defined by the examiner. If after leaving you are found in this area while the examination is still in progress, your license may be denied.

e. Print your name in the blank provided on the cover sheet of the examination.

f. Fill in the date on the cover sheet of the examination.

g. Print your name in upper right-hand corner of the first page of each section of the answer sheet.

h. Consecutively number each answer sheet, write "End of Category _____" as appropriate and "Last Page" on last answer sheet, and write on only one side of paper.

i. Number each answer as to category and number, for example, 1-4, 6-3.

j. Use black ink or dark pencil only to facilitate legible reproductions.

k. Use abbreviations only if they are commonly used in facility literature.

l. Show all calculations, methods, or assumptions used to obtain an answer to mathematical problems whether indicated in the question or not.

m. Separate answer sheets from pad and place finished answer sheets face down on your desk or table.

n. If part of the parts of the examination are not clear as to intent, ask questions of the examiner only.

o. Allow at least three lines between each answer.

p. Partial credit may be given; do not leave any answer blank.

After passing out the examination, the examiner should ask the candidates to verify that all parts of the examination are in their copy by page checking the examination, and then distribute answer sheet paper that has been furnished to the chief examiner by the facility in unopened packages.

The examiner should repeat the instruction that are included on the facing sheet of the examination by reading the following instruction verbatim:

a. use on the paper provided by the examiner for answers.

b. Staple your copy of the examination questions on top of the answer sheets before turning in your papers.

c. The point value for each question is indicated in parentheses after the question and can be used as a guide for the depth of answer required. If more points are assigned to a question, the question requires that more items be discussed.

The examiner should inform the candidates that to pass the examination they must achieve an overall grade of 80% or greater and at least 70% in each category.

The examiner should inform the candidates that there is a time limit of 6 hours for completion of the examination. For candidates taking one or more section of a written examination, each section should be limited to one-quarter of the allotted time per section.

After the examiner has completed the instruction, he should tell the candidates to start the examination, record the time, and keep the candidates advised periodically of the time that remains to complete the examination. Normally, a blackboard is available and can be used for this purpose.

During the examination, candidates are not permitted to communicate or refer to any tests or descriptive material other than tables furnished by the examiner. If the examiner has asked a question that involves use of a formula or infrequently used constant, then this formula or constant will be supplied on the equation sheet. All reference material shall be furnished by the examiner.

5. THEORY OF NUCLEAR POWER PLANT OPERATION, FLUIDS, AND THERMODYNAMICS (25.0 POINTS)

Q.

(2.00) 5.1 During the initial core designing, one engineer proposes to eliminate the poison rods and only use soluble poison in their place. Another engineer is against the idea. Which engineer do you agree with? Explain your answer.

ANSWER: A.

5.1 The poison rods are necessary in our reactor to reduce the boric acid dissolved in the coolant. If only chemical shim were used the moderator temperature coefficient would be positive early in core life. This would make the reactor difficult to control, and remove one of the built in safety factors of our plant.

Q.

(2.40) 5.2 During a routine startup, the reactor is subcritical with a stable count rate of 100 cps on N31/N32 and the Shutdown Banks fully withdrawn. The operator withdraws Bank A to 100 steps and notes a count rate of 150 cps after he stops rod motion.

a. If the operator performed no rod motion for five minutes would the count rate increase, decrease, or remain the same? Explain.

b. Would the change in count rate be different if the reactor was slightly subcritical (K = .995) as compared with a greatly subcritical (K = .95)? Assume the same amount of rod withdrawal and explain your answer.

c. Suppose Bank A is maintained at 100 steps for <u>two</u> hours. What would you expect count rate to do over that period? Assume no temperature/poison change and explain your answer.

ANSWER: A.

5.2 a. The count rate would <u>increase</u> due to the appearance of neutrons born from <u>delayed neutrons precursors (DNP's)</u>. The exposure of more fuel to the source increased subcritical multiplication which caused more DNP's to appear. As they go through their decay scheme, added neutrons appear until a higher stable count rate is established.

b. Assuming that the same rod withdrawal inserted the same amount of reactivity, then the count rate for the higher K_{eff} of 0.995 would produce <u>a greater change</u>. This is due to the fact that <u>more fuel is exposed to the source.</u> Therefore you have increased subcritical multiplication. The closer you get to criticality, the longer it takes to reach equilibrium and the higher it goes due to more DNP's being born.

c. <u>Count rate would remain the same</u> due to subcritical multiplication based upon the reactivity level in the core. The source neutrons are being multiplied by the exposed fuel plus they are part of the total number of neutrons so count rate will establish at a steady state subcritical fission rate even though K_{eff} is less than 1.

Q.

(1.60) 5.3 Why is the thermal utilization factor of such great importance to reactor operation? Explain your answer.

ANSWER: A.

5.3 The operator can control the thermal utilization factor by control rod movement and by changing boron concentration. He does not have this direct control over the other terms in the criticality equation.

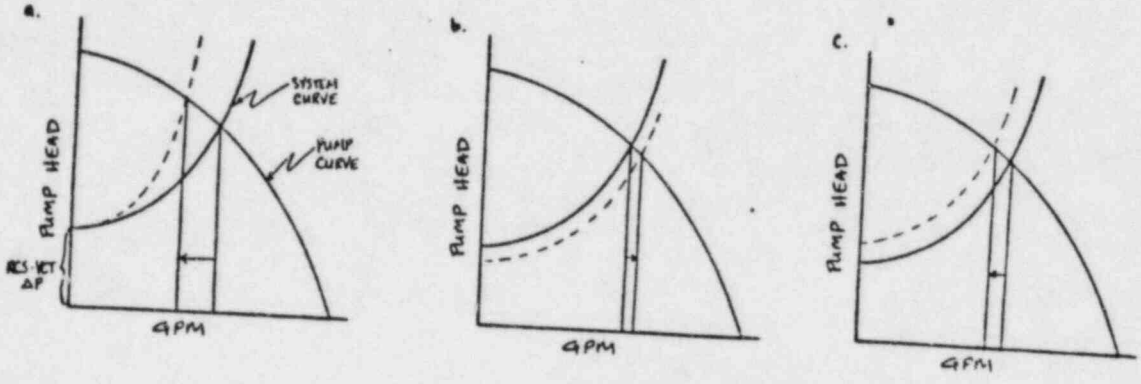
Q.

(1.80) 5.4 Using general system and pump characteristic curves, show how a centrifugal charging pump flow rate will be affected by the following:

a. Throttling down the flow control valve.
b. VCT pressure increase.
c. RCS pressure increase.

ANSWER: A.

5.4



Q.

(2.00) 5.5 Select the answer that best completes the following statement: "Boron differential worth (PCM/PPM) becomes less negative

a. As the RCS temperature increases."

b. As the nuclear fuel is depleted."

c. As the control rods are withdrawn."

d. As the reactor power decreases."

ANSWER: A.

5.5 (a)

Q.

(2.00) 5.6 Describe reflux flow.

ANSWER: A.

5.6 This is when boiling is taking place in the core and the steam produced flows up through the hot leg and into the upside of the steam generator tubes. The steam is then condensed due to the cool feedwater and flows by gravity back down into the core area.

Q.

(3.00) 5.7 Attached is a graph of saturation pressure versus saturation temperature (Figure 5.7). Starting from the point on the curve where the hot leg operates at full power, sketch and explain what will happen to this point (with arrows) for the following small break LOCA's:

a. Makeup flow equals break flow at 1000 psia; no auxiliary feedwater available; break flow and makeup flow insufficient to remove decay heat.

b. Makeup flow equals break flow at 1700 psia; adequate heat sink available.

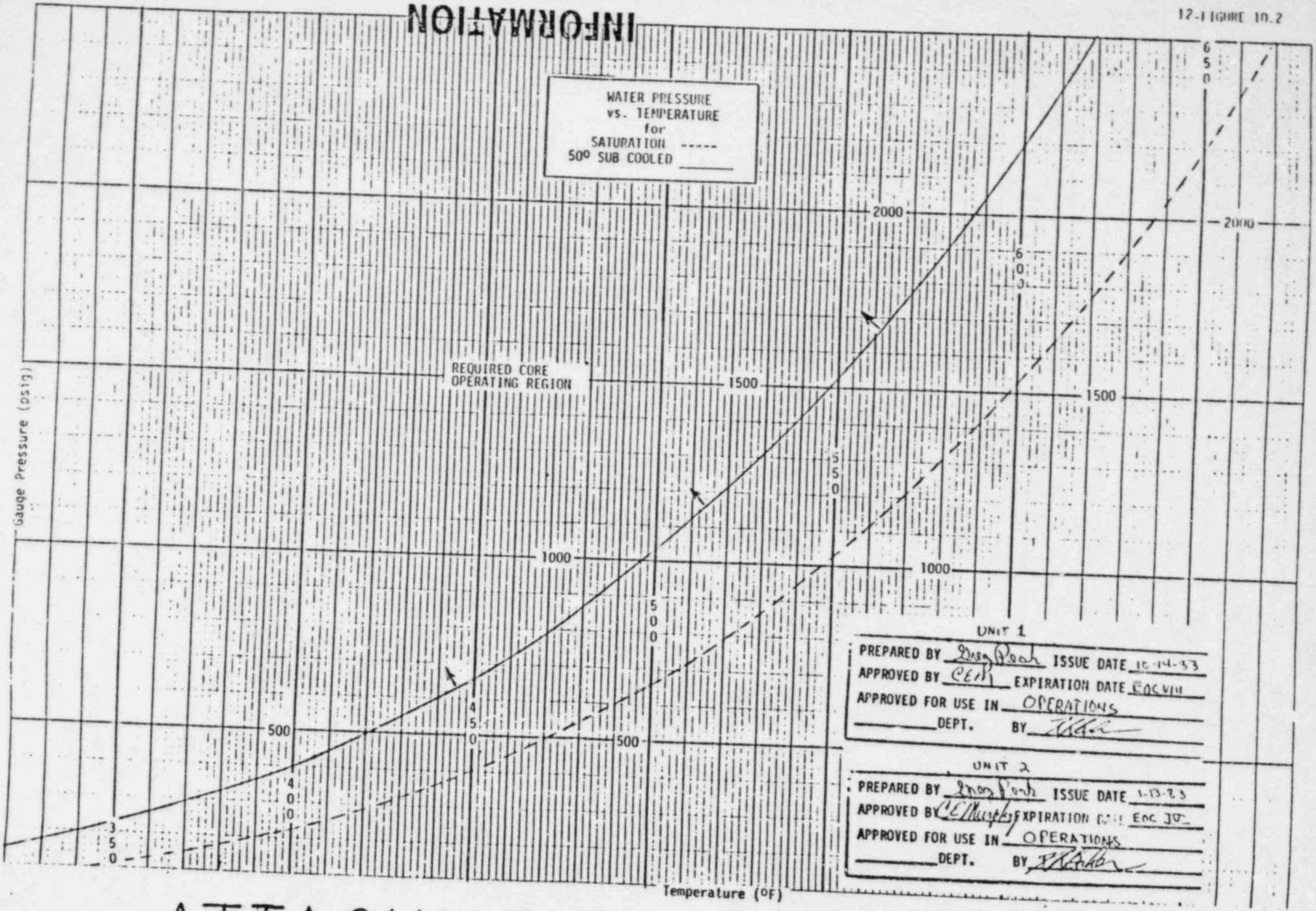
ANSWER: A.

5.7 (See Attachment 5.7)

a. Pressure decreases until the reactor trip set point is reached. The trip and steam dump actuation cause a decrease in temperature to 547°F. Pressure will continue to decrease until saturation pressure is reached, then temperature will decrease with pressure to saturation conditions at 1000 psia. Due to the lack of heat sink, continued heat addition from the core will cause the hot leg to go to saturated vapor and then to superheated vapor.

b. Case B follows Case A except that the higher pressure coupled with adequate heat sink ensures that the hot leg remains subcooled. Operator manipulation of the steam dump system could increase the subcooling as shown.

12-FIGURE 10.2



UNIT 1

PREPARED BY Dana Rook ISSUE DATE 10-14-83

APPROVED BY CEM EXPIRATION DATE EOC VIII

APPROVED FOR USE IN OPERATIONS

_____ DEPT. BY _____

UNIT 2

PREPARED BY Dana Rook ISSUE DATE 1-13-83

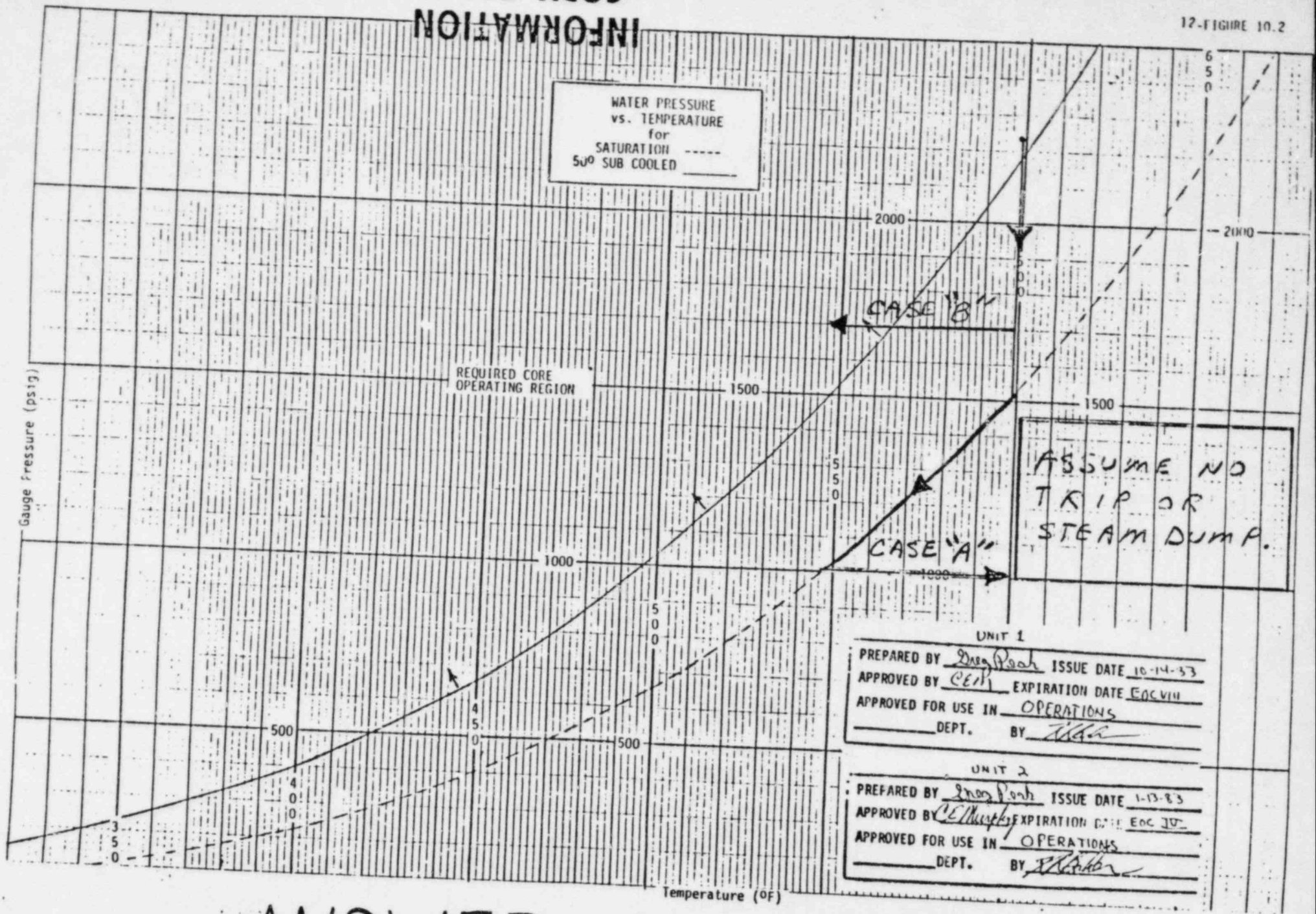
APPROVED BY C.E. Murphy EXPIRATION DATE EOC 10

APPROVED FOR USE IN OPERATIONS

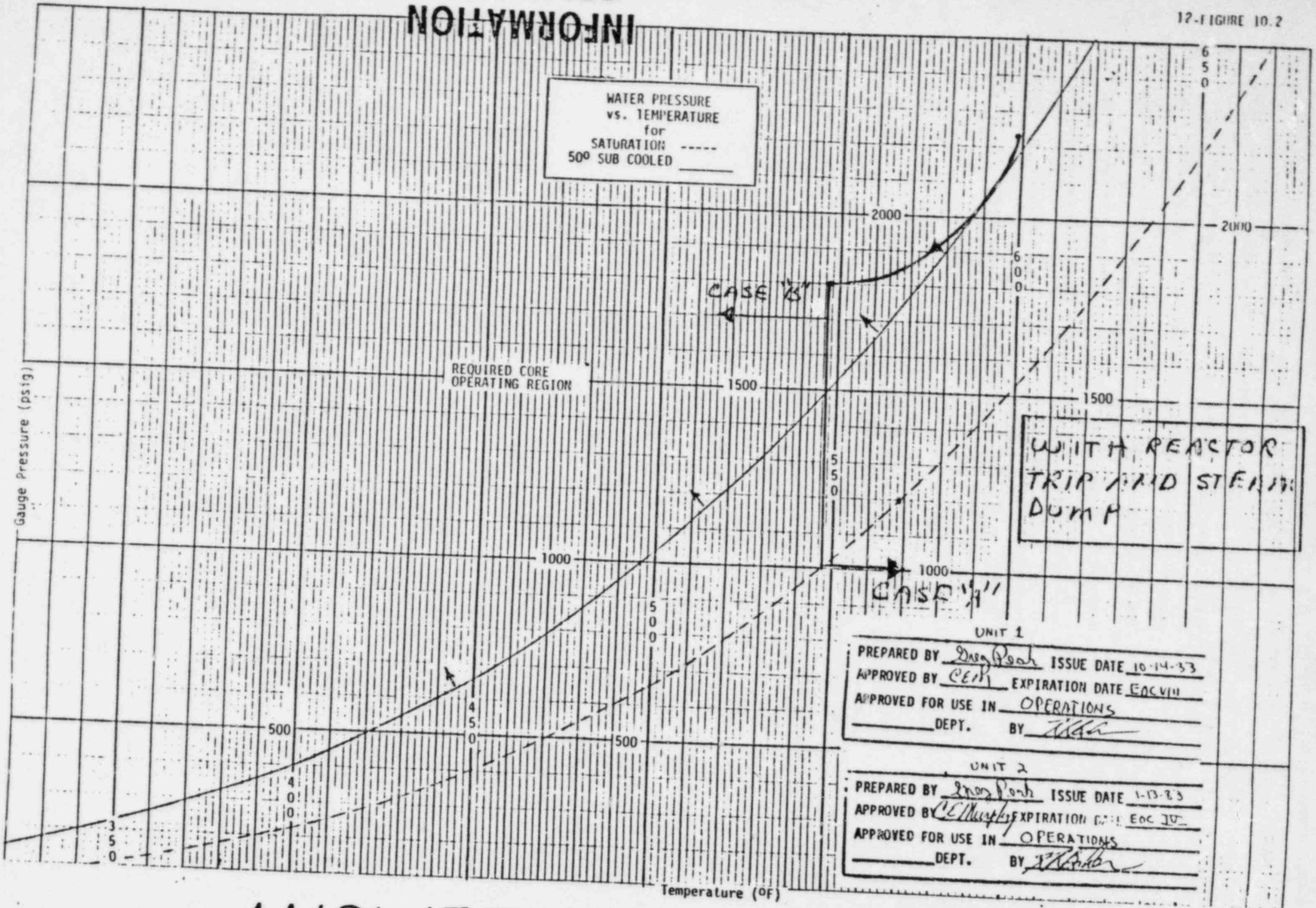
_____ DEPT. BY _____

ATTACHMENT 5.7

12-FIGURE 10.2



ANSWER - 2 Q 5.7


INFORMATION
WATER PRESSURE
vs. TEMPERATURE
for
SATURATION -----
50° SUB COOLED _____
REQUIRED CORE
OPERATING REGION
CASE "B"
CASE "A"
WITH REACTOR
TRIP AND STEAM
DUMP
Gauge Pressure (psig)
Temperature (°F)
500
1000
1500
2000
350
400
450
500
550
600
650
UNIT 1
PREPARED BY Dana Rook ISSUE DATE 10-14-83
APPROVED BY CEB EXPIRATION DATE EOC VII
APPROVED FOR USE IN OPERATIONS
DEPT. BY
UNIT 2
PREPARED BY Dana Rook ISSUE DATE 1-13-83
APPROVED BY CE Murphy EXPIRATION DATE EOC IV
APPROVED FOR USE IN OPERATIONS
DEPT. BY

ANSWER 1, Q 5.7

Q.

(1.60) 5.8 a. Explain why DNB is undesirable.

b. Which heat transfer mode dominates once DNB has occurred?

ANSWER: A.

5.8 a. DNB is undesirable because it will result in cladding temperatures that exceed the Zr - H_2O reaction limit. This can result in ultimate cladding failure. (Other answers acceptable, person grading test should use judgment.)

b. Radiation heat transfer.

Q.

(2.90) 5.9 a. What would be the major radioactive isotopes released to the reactor coolant system for a rod rupture accident?

b. How could you determine if fuel melting occurred?

ANSWER: A.

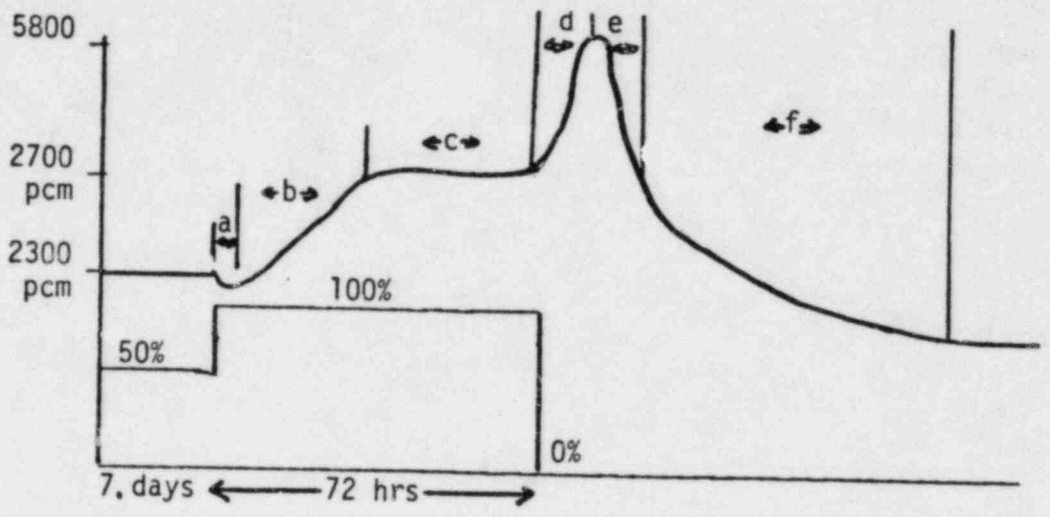
5.9 a. Xenons, kryptons, iodines, cesiums. 1.45

b. An increase in strontium levels and also fuel, U & Pu. 1.45

Q.

(2.50) 5.10 Unit 1 has been operating at 50% power for about a week. Reactor power is increased to 100% and held at this power level for 72 hours. At this time, a reactor trip occurs. Draw the corresponding Xenon concentration variation for this power history. Explain these variations and give approximate values.

ANSWER: A. 5.10



a. Dips for 2-4 hours.

b. Reaches new equilibrium in approximately 30-40 hours.

c. Approximately 30 hours.

d. 8-10 hours peak.

e. Approximately 14-16 hours to reach equilibrium value.

f. 50-75 hours to Xenon free.

Q.

(2.00) 5.11 What four plant parameters would you check to verify that natural circulation was established? Provide a brief explanation of parameter trends or indications.

ANSWER: A.

5.11 Natural circulation can be verified by noting:

1) RCS ΔT less than full power ΔT.

2) Hot leg or core exit thermocouple temperatures constant or decreasing.

3) Steam generator pressures constant or decreasing at a rate consistent with RCS temperature.

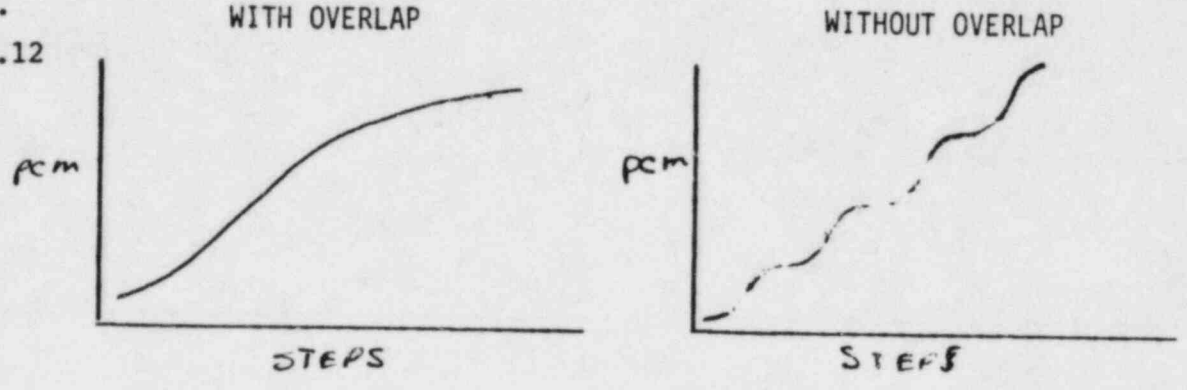
4) Constant steam generator level with continuous auxiliary feedwater flow.

Q.

(2.00) 5.12 Draw a typical integral rod worth curve for our plant with rod withdrawal of banks A, B, C, and D in overlap and another integral rod worth curve for withdrawal of banks A, B, C, and D without overlap. Explain the reasons for the differences.

ANSWER: A.

5.12



The smooth curve with overlap is achieved by moving rods in the upper area of the core and the bottom area of the core at the same time to produce the same reactivity effect as moving one bank in the center of the core.

Section 6 - Answer Key

6.1 No. Day tank allows for 2 hours of operation at full load. Day tank capacity 500 gallons (1.0)

Ref: AS-10-9

6.2 Reject load without exceeding overspeed trip setpoint and go to standby. (1.0)

Ref: T.S. 3/4 8-3

6.3 Mechanical overspeed trip device. This is only trip device available when DC control power is lost because all others require DC control power for their operation. (1.0)

Ref: AS-10

6.4
- a. Fails open — dwg 5129-7
- b. Fails closed — NS-6-37
- c. Fails as is — NS-6-58
- d. Fail open — (loss of control air procedure) (2.0)

6.5
- a. Letdown orifice valves QRV-160, 161, 162 (2.0)
  [illegible]
- b. QCR-300 letdown containment isolation valve
  [illegible]
- c. QCM-250 seal water filter inlet valves NS-6-45
  [illegible]
- d. QCM-350 seal water filter inlet valves NS-6-45
  [illegible]

Ref: NS 6-9

6.6 Letdown line down-stream of orifices - SV-51 (2.0)
charging pump suction relief SV-56
seal return relief SV-50
RHR heat exchanger safety valve SV-98
emergency core cooling system relief valve (ECCS relief valves) SV-98
RHR loop relief valves SV-103, 104 hot leg

Ref: NS-6-41, Figure NS-3-1

6.7 Centrifugal charging pumps (2.0)
Safety injection pumps
Residual Heat Removal pumps

Ref: AS-10-70

6.8 Valves { QRV-160 letdown orifice iso. valve (2.0)
-161 letdown orifice iso. valve
-162 letdown orifice iso. valve
QCR-300 letdown line iso. valve
-301 low pressure letdown valve
QMO-451 VCT outlet valve
-452 VCT outlet valve
QMO-225 centrifugal charging pump outlet valve (recirc)
-226 centrifugal charging pump outlet valve (recirc)
-200 charging header iso. valve
-201 charging header iso. valve
QCM-250 seal water filter inlet valve
-350 seal water filter inlet valve
IMO-910 RWST outlet valve
-911 RWST outlet valve

Ref: NS-6-75

6.9 Level channel 1 switch uses level channel 3 and level channel 2 for control circuitry. (2.0)

Ref: NS-6-14 FIG NS-3-6

6.10 Ice condenser system limits the peak pressure within containment to less than its design value following a design bases accident. (1.0)

Ref: NS-14-4

6.11 ~~Seal oil backup~~ UNIT 2 CONTROL OIL pump and EH pumps (UNIT 1 FLUID pumps) (1.0)

6.12 Office of Inspection and Enforcement Info Notice January 25, 1984. (2.0)

Backleakage from main feedwater system permits hot water to enter the AFW pump casings, flash to steam and bind the pumps. The unavailability of the AFW system due to steam binding would contribute significantly to an increased risk of core melt in PWR's. The AFW designs at Westinghouse plants appeared more susceptible to backleakage than other vendor designs.

6.13 False. Operation of positive and negative cyclone separators must be alternated due to the ice condenser bridge crane can only position one cyclone separator at a time. (1.0)

Ref: NS-14-5

6.14 The 600 ~~VOLT~~ bus tie breaker will close automatically only on 4160/600 volt feeder transformer fault (hand reset auxiliary relay HEA operates) and the respective 600 volt bus feeder breaker (11A11, 11C1, 11B11 or 11D1) open interlock is satisfied. DIESELS AREN'T RUNNING (BKRS open) (2.0)

Ref: PGS 14-37, 15.59-1, 15-9

6.15 When turbine feed pump (TFP) flow reaches a minimum value, two emergency leak off valves open on the TFP Discharge to allow water to flow to spray pipes in the condenser. (2.0)

Ref: PGS-10 pp 6, 14, 16

6.16 Ref: system descriptions

1) letdown florate increases

2) charging flow increases to maintain pzr level

3) VCT level increases

4) VCT high level switchover to hld up tanks

5) higher temperatures in letdown line could cause divert around demineralizers (mixed bed)

6) Back pressure regulater would position more to maintain proper back pressure (1.0)

(only 4 required for full credit)

Section 7 - Answer Key

7.1 140°F will provide sufficient auxiliary spray nozzle Delta T limit for ~~420°F~~ 320° PZR temperature. Check temperature with facility (1.0)

Ref: OHP 4021.001.004 para 6.30

7.2 1. Hot leg RTD's not pegged. (2.0)

2. No more than 4 (four) incore thermocouples pegged.

3. ECCS System flow being delivered to the RCS.

4. Auxiliary feedwater is being delivered to the intact steam generators.

Ref: OHP 4023.001.015

7.3 Valve closures would prevent thermal shocking of the pump seals. (1.0)

Ref: OHP 4023.001.016 PARA 5.1

7.4 a. - Leak in main condenser [0.5]
- Leak in feed pump condenser [0.5]
- Impure make up water [0.5] (1.5)

b. If the problem was due to a very small main or feed pump condenser tube leak, by manipulating power with constant leak, the increased conductivity levels, in the feed and condensate stream, would be easier to detect. (Main Condenser A, B or Feed Pump Condensers.) (1.25)

c. If the problem was due to a tube leak there would be no effect because the leak would be constant and all the impurities would end up in steam generator. Even though the steaming rate has decreased, the amount of impurities in the feedwater has increased. If the problem was due to make up water impurities the situation would be the same if make up rate was constant. (1.0)

Ref: 7, 2-OHP 4022.001.004

7.5 At least one of the following overpressure protection systems shall be OPERABLE: (1.5)

a. Two power operated relief valves (PORVs) with a lift setting of less than or equal to 435 psig, or

b. One power operated relief valve (PORV) with a lift setting of less than or equal to 435 psig and the RHR safety valve with a lift setting of less than or equal to 450 psig, or

c. A reactor coolant system vent of greater than or equal to 2 square inches.

APPLICABILITY: When the temperature of one or more of the RCS cold legs is less than or equal to 188°F, except when the reactor vessel head is removed.

Ref: OHP-4021.001.001 p. 344
T.S. p. 3/4 4-29, Unit 2

7.6 a.
1. RWP (.5)
2. RWP (.5)
3. Neither (.5)
4. RWP (.5)
5. RWP (.5)

b.
1. Plant Radiation Protection Supervisor (or) (1.0)
2. Someone authorized by Plant Radiation Supervisor (or)
3. Shift Supervisor

Ref: Radiation Protection Manual p. 122 of 127

7.7 The following areas at D. C. Cook are formally designated as Extreme High Radiation Areas: (2.0)

- Lower Containment, inside the Crane Wall (when power is greater than 10%).
- Regenerative Heat Exchanger Area (when power is greater than 10%).
- Ice Condenser, lower plenum (when power is greater than 20%).
- Incore Instrument Room (unless a clearance is taken on the incore flux mapping system to assure all detectors remain below the seal table level).
- Reactor Cavity Pit (except when seal table is assembled such that incore detector thimbles cannot be moved).
- CVCS/Boric Acid Evaporator Feed Ion Exchanger Rooms
- Drum Storage Facility
- Reactor Coolant Filter/Seal Water Filter Room
- Seal Water Supply Filter Room
- Spent Resin Storage Tank Room
- Spent Fuel Pit Demineralizer Room
- Deborating Demineralizers

Ref: Radiation Protection Manual, p. 79

7.8 a.
1. Excessive Control rod insertion
2. Failure of a control rod to drop following a reactor trip.
3. Uncontrolled reactor coolant cooldown following a reactor trip.
4. Unexplained or uncontrolled reactivity increase.
5. Shutdown Margin less than 1.6% ΔK/K. (0.45 each) (2.25)

b.
1. With normal charging and letdown established, open emergency boration valve (QMO-420). (0.75)

2. Transfer the operating boric acid transfer pump to fast speed. (UNIT 1) (0.75)

3. Close recirc valves to Boric acid storage tanks (2-IRV-251, -252, 255). (UNIT 2) (0.75)

c. 1. 1%
2. 4 [0.25 each] (0.5)

Ref: 7, 2-OHP 4022.005.002

7.9 1. One wide range T_H < 350°F and (2.0)
2. wide range pressure above 700 psig and increasing or stable and
3. the pressurizer water level is above 20% and rising and
4. the RCS subcooling is greater than 45°F using T_H RTDs or 33°F using thermocouples.

Ref: OHP 4023.001.005

7.10 Ref: 402.001.004 para. 4.2.3, 5.2.9, 5.2.13

If the tubes are exposed to the steam space in the S/G, it will condense the steam. This will result in a decrease in S/G pressure. The resulting effect is that break flow rate into the S/G will increase. (1.0)

7.11 Ref: 4021.001.004, para. 6.32

a. Prevents blowing stagnant unfiltered water into the RCP seal area. (0.5)

b. This could result in seal damage when RCP is started. (1.0)

7.12 Plant Manager or designee Ref: 4021.001.002 (0.75)

Section 8 - Answer Key

8.1 A PORV is not considered inoperable if its block valve is closed because of PORV leakage. It is only inoperable if it can not open or close. (1.0)

Ref: T.S.

8.2 Ensure that the technicians reset the trip to no more than the maximum allowed by Technical Specifications for these conditions. (2.0)

Ref: T.S. 3.7.1.1

8.3 1. Reactor is in Cold Shutdown Mode (Keff < .99) and average coolant temperature is less than or equal to 200°F or (mode 5) (2.0)

2. The reactor is in the Refueling Mode (Keff less than .95) and the average coolant temperature is less than or equal to 140°F whenever the reactor vessel head is unbolted or removed and fuel is in the vessel. (mode 6)

Ref: PMI-2100 page 2

8.4 Two-man rule shall be in effect except when in modes 5 & 6. It shall be permissible for one man to enter containment to perform an inspection of work in progress. (1.0)

Ref: PMI-2100

8.5 The On-Site Emergency Coordinator (OSEC) is responsible for overall plant emergency response functions. As such, the OSEC is responsible for: (2.0)

Declaration of an Emergency Condition
Determination of Protective Actions
Ensuring Prompt Notification of emergency classification and appropriate protective actions to off-site authorities
Overall management of site resources in response to the emergency
Declaration of entry into a recovery phase (de-escalation of event classification of operations)

The OSEC is addition responsible for ensuring activation of:

The Technical Support Center and Operations Staging Area for an Alert Classification
The Joint Public Information Center, the American Electric Power Emergency Response Organization, and the Emergency Operations Facility for a Site Emergency Classification

8.6 a. Same incident occurred at D. C. Cook before. Blocking open containment isolation is not allowed by T.S. (1.0)

b. Fire watch should be posted. (1.0)

Ref: LER 82-040 T.S. 3.7.93 page 3/4 7-47

c. BIT is now considered inoperable. Restore tank to operable status, change ppm concentration to (20,000 (-) 22,500 ppm) or be in Hot Standby and borated to shutdown margin -1% ΔK/K or 200°F within 6 hours. (1.0)

Ref: LER 82-039, T.S. 3.5.4.1

d. File a 30 day report, observed inadequacies in the implementation of administrative. (Written Report) (1.0)

Ref: T.S. 6.9.1.13(c) page 6-21

8.7 1. j (1.0)
2. g (1.0)
3. e OR A (1.0)
4. c (1.0)
5. d (1.0)

Ref: PMI-2110

8.8 Thermal power, pressurizer pressure, Tavg shall not exceed limits as per Fig. 2.1-1, 2.1-2. If exceeded be in hot standby within 1 hour. (2.0)

Ref: T.S. 2.1 pg 2-1

ASS OR SS (Acceptable Answer)

8.9 a. Shift Operating Engineer should update the status board. (1.0)

b. Unit Equipment Operator should enter in the control log for blocked alarms. (1.0)

c. Unit Equipment Operator should enter in the control log jumper section. (1.0)

Ref: 050.035 & .037

8.10 a. Pressure boundary leakage (0.5)

b. Unidentified leakage (0.5)

Ref: T.S. 3.4.6.2 page 3/4 4-16