U.S. NUCLEAR REGULATORY COMMISSION

REGION III

Report No. 50-456/OL-87-03

Docket Nos. 50-456; 50-457 Licenses No. NPF-72; NPF-75

Licensee: Commonwealth Edison Company
Braidwood Station
R. R. 1, Box 84
Braceville, IL 60407

Facility Name: Braidwood Station

Examination Administered At: Braidwood Station and Production Training Center

Examination Conducted: December 14-22, 1987

Examiners: _____ 1/20/88
D. J. Damon Date

_____ 1/20/88
J. A. Lennartz Date

_____ 1/20/88
P. R. Sunderland Date

Approved By: _____ 1/20/88
Thomas M. Burdick, Chief Date
Operating Licensing Section

Examination Summary

Examination administered on December 14-22, 1987 (Report No. 50-456/OL-87-03)) to six operator and eight senior operator candidate.
Results: One senior reactor operator candidate failed the examination.

REPORT DETAILS

1. Examiners

*D. J. Damon
J. A. Lennartz
P. R. Sunderland

*Chief Examiner

2. Exit Meeting

On December 23, 1987 the examiners met with members of the plant staff to discuss findings made during the course of the examinations. The following personnel attended the exit meeting.

Commonwealth Edison Company (CECo)

E. Fitzpatrick, Station Manager
G. Masters, Assistant Operations Superintendent
D. O'Brien, Services Superintendent
W. McGee, Training Supervisor
G. Vanderheyden, Training Instructor
D. Huston, Training Instructor

US NRC

T. Tongue, Senior Resident Inspector
P. R. Sunderland, Region III Examiner
J. A. Lennartz, Region III Examiner
J. A. Hopkins, Region III Examiner

a. Generic Strengths

(1) In over half of the simulator scenarios, the candidates were required to trip bistables as a result of an instrument malfunction. The candidates demonstrated positive control in each phase of the tripping procedure.

(2) The candidates exhibited strong team work and practiced good communication skills by using "repeat backs" for most communications and acknowledgements on most orders.

(3) The candidates exhibited good familiarity with the General, Normal, Abnormal, and Emergency Procedures.

b. Generic Weaknesses

(1) In general, the NSOs, especially the BOPs, did not perform all of the immediate actions of BwEP-0, "Reactor Trip or Safety Injection," without the SRO first reading the steps.

(2) In simulator scenarios when an inadvertent Phase A isolation occurred, the NSOs did not verify that all required valves changed position and did not restore all systems to their normal lineup. In two cases, a Technical Specification (TS) violation occurred on containment temperature.

c. General Comments

Although these topics were not covered by every examiner and are not considered generic in nature, the examiners feel they deserve mention in this report.

(1) Some SROs demonstrated ALARA awareness by advising "B-men" sent into radiation areas to wait in "low dose zones" while a malfunction was being evaluated.

(2) The candidates were unsure how to apply the 5 (N-18) "dose bank" in 10 CFR 20.101.b.2.

3. Examination Review

Following are facility comments on the written examinations and their respective NRC resolutions:

RO EXAM COMMENTS

Question 1.10 a, b

Facility Comment: Exactly five hours for xenon to peak after a power to decrease may not always be exactly correct. Suggest a band of 4-7 hours be acceptable.

NRC Resolution: Concur. Answer key has been modified to reflect this.

Question 1.11.b

Facility Comment:

1. Increasing FW flow to the S/G's reduces Tave.
   a. Since steady state power is constant, ΔT is constant.
   b. If ΔT is constant, Th and Tc decrease by the same amount.
2. Since density changes are greater at higher temperatures, more positive reactivity is added to the top of the core by a decrease in Th than at the bottom of the core by an equal decrease in Tc.
3. This causes flux to shift up in the core and ΔI becomes more positive.

NRC Resolution: Concur. Answer key has been modified to reflect this.

Question 2.05

Facility Comment: Since the question asked for four "conditions" that will cause the "250 VDC Batt CHGR 123 TRBL" alarm to alarm, the probable causes listed on the attached BwAR 1-20-C10 should also be considered for acceptable answers.

NRC Resolution: Concur. The answer key has been modified to accept answers from the reference provided that are not redundant to answers on the key.

Question 2.08 a, b

Facility Comment:

2.08 a The question asks for interlocks to open 8804B. In parenthesis, the question states this is the charging pump suction crossover from RHR. In reality, the 8804B is the SI pump crossover. We suggest that either valve interlock should be accepted.

2.08 b Overpressurization of CV pump suction would be the correct answer if 8804A is used in part a.

NRC Resolution: Concur. Either valve interlock will be accepted for part a, and the associated reasons for the valve used in part a will be the correct answer for part b. The question will be modified for future exams.

Question 2.10

Facility Comment: 2.10 b The response "inserts speed and voltage control while maintaining only the emergency trips" should be acceptable since a specific list was not requested by the question.

NRC Resolution: Concur. The answer key has been modified to reflect this.

Question 2.12

Facility Comment: Another acceptable answer should be loop flow indications.

NRC Resolution: Concur. The answer key has been modified to reflect this.

Question 3.09 b

Facility Comment: Lo Tave value indicated in exam key (64°) should be (564°).

NRC Resolution: Concur. Answer key has been modified to reflect this.

Question 3.11 a

Facility Comment: Present inputs to Subcooling Margin Monitor are:

1. Average of 10 highest CET's.
2. RCS wide range pressure.
3. Containment pressure.
4. Containment radiation.

This change is still in routing and has not been incorporated into all of the Braidwood training material. Any of these four answers should be accepted.

NRC Resolution: Concur. The answer key has been modified to accept any three of the proposed four answers for full credit.

Question 3.13 a

Facility Comment: Answer should be FALSE. The LOCAL/REMOTE switch does not affect switchgear operation. A pump may always be started (no trips present) by locally installing the switchgear breaker and closing it.

NRC Resolution: Concur. The answer key has been modified to reflect this.

Question 4.08

Facility Comment: Other acceptable answers related to the upper limit of < 1000 psig should be thermal shocking of the pump shaft, bearing and seal, a general statement concerning damage to the pump components.

NRC Resolution: Do not concur. Thermal shock of the pump shaft, seal, and pump bearing would occur only if a loss of seal injection were experienced as stated in the provided reference. Therefore, credit will be given for the proposed response only if the candidate states that a loss of seal injection has occurred. A general statement about damage to pump components by itself will be given partial credit.

Question 4.14 a

Facility Comment: a. These switches are placed in the ISOL position in the event:

Damage has possibly occurred to any remote DG Control Circuitry

OR

Control Room has been evacuated

A fire in the C.R. or AEER is only one example of possible damage - many other types of damage could cause us to go to ISOL.

Full credit should be given for other events that could cause damage to remote circuitry or the above listed answers.

NRC Resolution: Concur. The answer key has been modified to reflect this.

Question 4.15 a

Facility Comment:	Key is only partially correct. In addition to lowering pressure to allow low head injection to occur it is also to recover the core via SI accumulator injection.
NRC Resolution	Concur. The answer key has been modified to reflect this.

SRO EXAM COMMENTS

Question 5.01

Facility Comment: By the definition of QPTR in Tech Specs if one detector is inoperable it is not used in QPTR calculation. Recommend an alternate acceptable answer be "no change" if above assumption made.

NRC Resolution: Concur. Answer key expanded.

Question 5.08, b

Facility Comment:

1. Increasing FW flow to the S/G's reduces Tave.
   a. Since steady state power is constant, ΔT is constant.
   b. If ΔT is constant, Th and Tc decrease by the same amount.
2. Since density changes are greater at higher temperatures, more positive reactivity is added to the top of the core by a decrease in Th than at the bottom of the core by an equal decrease in Tc.
3. This causes flux to shift up in the core and ΔI becomes more positive.

NRC Resolution: Concur. Answer key corrected.

Question 5.09

Facility Comment: It is felt that RCS pressure should be an acceptable alternative to pressurizer pressure, in that pressurizer pressure controls RCS pressure and the pressure in the RCS is the concern in DNB.

NRC Resolution: Concur. Answer key expanded.

Question 5.10 d and e

Facility Comment: To obtain gauge pressure 15 psia should be subtracted from the answer, not added.

d. 1161-15 = 1146 psig

e. 893 psia - 15 = 878 psig

NRC Resolution: Concur. Answer key corrected.

Question 6.02

Facility Comment: If the breaker is racked in and shut the pump will be running. A more appropriate answer would be the breaker racked in with DC control power available.

NRC Resolution: Concur. Answer key modified.

Question 6.06

Facility Comment: The limit of 325 psig also accounts for NPSH requirements, backpressure, pressure losses, and instrument losses. Any combination of these along with the seal ΔP requirements should be acceptable.

NRC Resolution: Concur. No credit will be deducted for discussion of these other factors, as long as seal delta-P requirements are also discussed.

Question 6.07

Facility Comment: The question specifically asks about the sequence of events "from the time the annunciator is received until voltage is restored to the bus." The last statement of the answer key, "Loads are sequenced back on bus," occurs after voltage is restored to the bus and thus should not be required for full credit.

NRC Resolution: Concur. Answer key modified and point valve adjusted.

Question 7.04 a

Facility Comment: In general, this statement is true, since skipping steps is almost always an exception based upon plant conditions not assumed by the procedure. We suggest this question be deleted.

NRC Resolution: Do not concur. It is apparent from the comment and phone conversations with facility personnel that this question was interpreted to say that all steps must be completed in order prior to preceding to the next step. However, the words "in order" did not appear in the question.

The original reference cited in the question supports the answer as given in the original answer key. The facility submitted no additional reference material to refute the original reference. Therefore, the answer key remains unchanged.

Question 7.05

Facility Comment: The question infers that all of the RNO steps could not be completed. Therefore, the first portion of the answer key, "if further contingency actions are provided, perform the next contingency action" should not be required for full credit.

NRC Resolution: Concur. Answer key modified and point valve adjusted to 1.0.

Question 7.08

Facility Comment: BwCA 0.1 and BwCA 0.2 should also be acceptable since it is stated the status trees are monitored for information only and NOT to implement the BwFR's.

NRC Resolution: Concur. Answer key expanded to include:

4. During BwCA 0.1 Steps 1-9

5. During BwCA 0.2 Steps 1-7

Question 7.09

Facility Comment: 7.09 b Since the 1B CCP has been out of service for > 72 hrs. and the plant is still in MODE 1 (was not placed in hot standby in the following 6 hrs, etc.) conditions have degraded beyond the Tech Spec limitations. Thus, an alert level should be acceptable per EAL 14.

7.09 f Not enough information given to warrant activation of GSEP by condition 25 (Fuel Handling Building exhaust has been diverted through the charcoal filters) at this point. For condition 31, the stated conditions would probably develop into a GSEP conditions, but for the point in time pertaining to conditions stated in the question, NONE should also be an acceptable answer.

NRC Resolution: Partially concur. Answer key for part b is modified as requested. Answer key for part f is modified to accept either "None" or "Unusual Event."

Question 8.05

Facility Comment: It is felt that the following should be added as acceptable answers.

1. Write a temporary or permanent change if required.

2. Return the system to the as found positions in the applicable M or E lineup if the procedure is to be terminated.

3. System placed in a stable condition.

NRC Resolution: Partially concur. The facility requested answers dealing with system lineups are added to the answer key. However, the NSO is not normally the person who makes the decision and implements writing procedure changes. Since the question specifically asked for NSO actions, this answer is not added to the answer key.

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

FACILITY: BRAIDWOOD 1&2

REACTOR TYPE: PWR-WEC4

DATE ADMINISTERED: 87/12/14

EXAMINER: DAMON, D.

CANDIDATE: _____

INSTRUCTIONS TO CANDIDATE:

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%. Examination papers will be picked up six (6) hours after the examination starts.

CATEGORY VALUE	% OF TOTAL	CANDIDATE'S SCORE	% OF CATEGORY VALUE		CATEGORY
25.00	25.25	_____	_____	5.	THEORY OF NUCLEAR POWER PLANT OPERATION, FLUIDS, AND THERMODYNAMICS
24.50	24.75	_____	_____	6.	PLANT SYSTEMS DESIGN, CONTROL, AND INSTRUMENTATION
24.50	24.75	_____	_____	7.	PROCEDURES - NORMAL, ABNORMAL, EMERGENCY AND RADIOLOGICAL CONTROL
25.00	25.25	_____	_____	8.	ADMINISTRATIVE PROCEDURES, CONDITIONS, AND LIMITATIONS
99.00		_____ Final Grade	_____%		Totals

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

_____
Candidate's Signature

NRC RULES AND GUIDELINES FOR LICENSE EXAMINATIONS

During the administration of this examination the following rules apply:

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

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

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

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

5. Fill in the date on the cover sheet of the examination (if necessary).

6. Use only the paper provided for answers.

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

8. Consecutively number each answer sheet, write "End of Category __" as appropriate, start each category on a new page, write only on one side of the paper, and write "Last Page" on the last answer sheet.

9. Number eachanswer as to category and number, for example, 1.4, 6.3.

10. Skip at least three lines between each answer.

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

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

13. The point value for each question is indicated in parentheses after the question and can be used asa guide for the depth of answer required.

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

15. Partial credit may be given. Therefore, ANSWER ALL PARTS OF THE QUESTION AND DO NOT LEAVE ANY ANSWER BLANK.

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

17. You must 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 must be done after the examination has been completed.

18. When you complete your examination, you shall:

a. Assemble your examination as follows:

(1) Exam questions on top.

(2) Exam aids - figures, tables, etc.

(3) Answer pages including figures which are part of the answer.

b. Turn in your copy of the examination and all pages used to answer the examination questions.

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

d. 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 or revoked.

DATA SHEET

REACTOR THEORY FORMULAS:

$$P = P_0 e^{t/\tau}$$

$$P = \frac{\Sigma \phi_{th} V}{3.12 \times 10^{10} \text{ fissions/sec}}$$

$$P_{th} = \frac{1}{1 + (B^2 L_{th}^2)} = e^{-(B^2 L_{th}^2)}$$

$$P_f = e^{-(B^2 L_f^2)}$$

$$p = e^{-[N][I_{eff}]/\xi\Sigma_s}$$

$$C_1 (1-K_{eff1}) = C_2 (1-K_{eff2})$$

$$m = \frac{1}{1-K} = \frac{C_{final}}{C_{initial}}$$

$$\alpha_T = \frac{1}{f}\frac{\Delta f}{\Delta t} + \frac{1}{p}\frac{\Delta p}{\Delta t} - B^2 \left(\frac{\Delta L_f^2}{\Delta t} + \frac{\Delta L_{th}^2}{\Delta t}\right)$$

$$K_{eff} = \epsilon P_f p P_{th} f \eta$$

$$P = P_0 10^{SUR(t)}$$

$$SUR = 26.06/\tau$$

$$\rho = \frac{l^*}{\tau} + \frac{\overline{\beta}_{eff}}{1 + \lambda\tau}$$

$$\rho = \frac{K - 1}{K}$$

$$\Delta\rho = \ln \frac{K_{final}}{K_{initial}}$$

$$\tau = \frac{\overline{\beta}_{eff} - \rho}{\lambda\rho}$$

$$\tau = \frac{l^*}{\rho}$$

$$P_1 = P_0 \frac{\overline{\beta}_{eff} - \rho_0}{\overline{\beta}_{eff} - \rho_1}$$

DATA SHEET

THERMODYNAMICS AND FLUID MECHANICS FORMULAS:

$$\dot{Q} = \dot{m}\,\Delta h$$

$$\dot{Q} = U A (\Delta T_m)$$

$$\dot{Q} = \dot{m} c_p (\Delta T)$$

$$\eta = \frac{\dot{Q}_{in} - \dot{Q}_{out}}{\dot{Q}_{in}}$$

$$\eta_p = \frac{W_{actual}}{W_{supplied}}$$

$$\dot{m} = \rho A V$$

$$\dot{m} = KA \sqrt{\Delta P_x \rho}$$

$$\Delta T_m = \frac{\Delta T\ (in) - \Delta T\ (out)}{\ln\left(\frac{\Delta T\ (in)}{\Delta T\ (out)}\right)}$$

$$T_{cl} - T_{ps} = \frac{Gr^2}{4k}$$

$$\dot{Q} = \frac{A\,\Delta T_{total}}{\frac{\Delta x_a}{K_a} + \frac{\Delta x_b}{K_b} + \ldots + \frac{\Delta x_n}{K_n}}$$

$$\dot{Q} = \frac{2\pi L \Delta T}{\frac{1}{K} + \frac{\ln R_2/R_1}{K_2} + \frac{\ln R_3/R_2}{K_3}}$$

$$\dot{Q} = \alpha \delta A R^4$$

$$\eta = \frac{(h_{in} - h_{out})_{real}}{(h_{in} - h_{out})_{ideal}}$$

$$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$$

$$\rho_1 A_1 V_1 = \rho_2 A_2 V_2$$

$$\dot{m}_{nc} = KA_Q \sqrt[3]{Q} = KA\,\Delta T \sqrt{\Delta T} = KA\,\Delta p \sqrt{\Delta P}$$

$$G = \frac{\Sigma_f \delta_{th}}{8.8 \times 10^9}$$

$$\dot{Q} = \frac{kA\Delta T}{\Delta x}$$

DATA SHEET

CENTRIFUGAL PUMP LAWS:

$$\frac{N_1}{N_2} = \frac{\dot{m}_1}{\dot{m}_2} \qquad \frac{(N_1)^2}{(N_2)^2} = \frac{H_1}{H_2} \qquad \frac{(N_1)^3}{(N_2)^3} = \frac{P_1}{P_2}$$

RADIATION AND CHEMISTRY FORMULAS:

$R/hr = 6CE/d^2$ $\qquad I_x = I_0\, e^{-mx}$ $\qquad C_1V_1 = C_2V_2$

$G = \frac{\text{Dilution Rate}}{\text{Volume}}$ $\qquad I = I_0 \left(\frac{i}{10}\right)^n$ $\qquad C = C_0\, e^{-Gt}$

$A = A_0\, e^{-\lambda t}$ $\qquad A = \lambda N$

CONVERSIONS:

1 gm/cm^3 = 62.4 lbm/ft^3	Density of water (20 C) = 62.4 lbm/ft^3
1 gal = 8.345 lbm	
1 ft^3 = 7.48 gal	Avogadro's Number = 6.023×10^{23}
1 gal = 3.78 liters	Heat of Vapor (H_2O) = 970 Btu/lbm
1 lbm = 454 grams	Heat of Fusion (ICE) = 144 Btu/lbm
e = 2.72	1 AMU = 1.66×10^{-24} grams
π = 3.14159	Mass of Neutron = 1.008665 AMU
1 KW = 738 ft-lbf/sec	Mass of Proton = 1.007277 AMU
1 KW = 3413 Btu/hr	Mass of Electron = 0.000549 AMU
1 HP = 550 ft-lbf/sec	One atmosphere = 14.7 psia = 29.92 in. Hg
1 HP = .746 KW	°F = 9/5 °C + 32
1 HP = 2545 Btu/hr	°C = 5/9 (°F - 32)
1 Btu = 778 ft-lbf	°R = °F + 460
1 MEV = 1.54×10^{-16} Btu	°K = °C + 273
h = 4.13×10^{-21} M-sec	
1 W = 3.12×10^{10} fissions/sec	
g_c = 32.2 lbm-ft/lbf-sec^2	c^2 = 931 MEV/AMU
1 inch = 2.54 cm	C = 3×10^8 m/sec
σ = 0.1714×10^{-8} Btu/hr ft^2 R^4	

DATA SHEET

AVERAGE THERMAL CONDUCTIVITY (K)

Material	K
Cork	0.025
Fiber Insulating Board	0.028
Maple or Oak Wood	0.096
Building Brick	0.4
Window Glass	0.45
Concrete	0.79
1% Carbon Steel	25.00
1% Chrome Steel	35.00
Aluminum	118.00
Copper	223.00
Silver	235.00
Water (20 psia, 200 degrees F)	0.392
Steam (1000 psia, 550 degrees F)	0.046
Uranium Dioxide	1.15
Helium	0.135
Zircaloy	10.0

MISCELLANEOUS INFORMATION:

$E = mc^2$

$KE = 1/2\ mv^2$

$PE = mgh$

$V_f = V_0 + at$

Geometric Object	Area	Volume
Triangle	$A = 1/2\ bh$	////////////////////
Square	$A = s^2$	////////////////////
Rectangle	$A = L \times W$	////////////////////
Circle	$A = \pi r^2$	////////////////////
Rectangular Solid	$A = 2(L \times W + L \times H + W \times H)$	$V = L \times W \times H$
Right Circular Cylinder	$A = (2\ \pi r^2)h + 2(\pi r^2)$	$V = \pi r^2 h$
Sphere	$A = 4\ \pi r^2$	$V = 4/3\ (\pi r^2)$
Cube	////////////////////////////////	$V = s^3$

DATA SHEET

MISCELLANEOUS INFORMATION (continued):

Material	Half-Life	Gamma Energy MEV per Disintegration		10 CFR 20 Appendix B Table I Col I Air uc/ml	Table I Col II Water uc/ml	Table II Col I Air uc/ml	Table II Col II Water uc/ml
Ar-41	1.84 h	1.3	Sub	2×10^{-6}	-----	4×10^{-8}	------
Co-60	5.27 y	2.5	S	3×10^{-7}	1×10^{-3}	1×10^{-8}	5×10^{-5}
I-131	8.04 d	0.36	S	9×10^{-9}	6×10^{-5}	1×10^{-10}	3×10^{-7}
Kr-85	10.72 y	0.04	Sub	1×10^{-5}	-----	3×10^{-7}	------
Ni-65	2.52 h	0.59	S	9×10^{-7}	4×10^{-3}	3×10^{-8}	1×10^{-4}
Pu-239	2.41×10^{4} y	0.008	S	2×10^{-12}	1×10^{-4}	6×10^{-14}	5×10^{-6}
Sr-90	29 y	-----	S	1×10^{-9}	1×10^{-5}	3×10^{-11}	3×10^{-7}
Xe-135	9.09 h	0.25	Sub	4×10^{-6}	-----	1×10^{-7}	------
Any single radionuclide with $T_{1/2}$ > 2 hr which does not decay by alpha or spontaneous fission				3×10^{-9}	9×10^{-5}	1×10^{-10}	3×10^{-6}

Neutron Energy (MEV)	Neutrons per cm^2 equivalent to 1 rem	Average flux to deliver 100 mrem in 40 hours
thermal	970×10^{6}	670
0.02	400×10^{6}	280 (neutrons)
0.5	43×10^{6}	30 ----------
10	24×10^{6}	17 cm^2 x sec

Linear Absorption Coefficients μ (cm^{-1})				
Energy (MEV)	Water	Concrete	Iron	Lead
0.5	0.090	0.21	0.63	1.7
1.0	0.067	0.15	0.44	0.77
1.5	0.057	0.13	0.40	0.57
2.0	0.048	0.11	0.33	0.51
2.5	0.042	0.097	0.31	0.49
3.0	0.038	0.088	0.30	0.47

QUESTION 5.01 (1.50)

The plant is operating at 50% power with control rods in manual. How does a HIGH failure of power range channel N-44 LOWER detector affect the following indications? Limit your answer to INCREASE, DECREASE, MORE NEGATIVE, LESS NEGATIVE, or NO CHANGE. (.5 ea)

a. Lower Quadrant Power Tilt Ratio

b. Delta Flux indication (channel 4)

c. OP delta T setpoint (channel 4)

QUESTION 5.02 (1.50)

A cooling water pump is operating at 1500 rpm. Its capacity is 250 gal/min at a discharge pressure of 15 psig which requires 40 KW of power. Determine the pump capacity, speed and power requirement if the pump discharge pressure drops to 10.0 psig due to reduced speed.

QUESTION 5.03 (2.00)

Unit 1 is operating at 100% power (3411 MWt) as indicated on nuclear power instrumentation. The following data is recorded:

Feedwater Temperature	439 deg F
Total Feedwater Flow	15.1x10E6 LBM/HR
Steam Pressure	992 psig
Feedwater Enthalpy(hf)	418.5 BTU/LBM
Other System Losses and Gains	- 0 -

From the information provided determine the actual percentage power output of the primary system.

QUESTION 5.04 (1.00)

Although the control rods may be positioned axially anywhere in the core, the rods must be above a specified height during reactor operations. This height is referred to as the rod insertion limit. State the three reasons for the control rod insertion limits.

(***** CATEGORY 05 CONTINUED ON NEXT PAGE *****)

QUESTION 5.05 (2.00)

Indicate whether the following situations result in SUBCOOLED, SATURATED, or SUPERHEATED fluid conditions. Assume NOT/NOP, 100% power.

a. Pressurizer PORV relieving to the PRT (0.5)

b. Steam generator safety valve relieving to atmosphere (0.5)

c. Steam from a Moisture Separator Reheater entering a low pressure turbine (0.5)

d. Condensate exiting the condenser hotwell (0.5)

QUESTION 5.06 (3.00)

A questionable ECC calculation shows that criticality should be achieved when 3000 pcm has been added to the core. A boron diluion of 150 ppm (1500 pcm) is planned, followed by control rod withdrawal to criticality. The initial count rate is 50 cps.

a. WHAT is the expected count rate after the 150 ppm boron dilution? (1.0)

b. Following the first 75 ppm dilution, the source ranges indicate 80 cps. WHAT amount of reactivity in pcm should the original ECC calculation have derived as sufficient to reach criticality? (2.0)

QUESTION 5.07 (2.50)

After operation at 100% power for several weeks near the end of cycle, it is decided to reduce power to 75% using rods only.

a. After reaching 75% power, what rod motion would be required to maintain the plant at 75% power over the next 40 hours assuming no change in boron concentration? Include any applicable time periods. (1.0)

b. Explain how the fission product production and removal mechanisms cause a reactivity transient after a power reduction from 75% to 50% power. Include time periods for the various reactivity effects up to equilibrium. (1.5)

(***** CATEGORY 05 CONTINUED ON NEXT PAGE *****)

QUESTION 5.08 (1.50)

Would the Axial Flux Difference become MORE NEGATIVE or LESS NEGATIVE for the following conditions? STATE THE REASONING FOR YOUR CHOICE. (.5 ea)

a. OT Delta-T runback from 100% power with rods in automatic to 50% power.

b. Feed flow increases to the steam generators with rods in manual.

c. Xenon is building into the bottom of the core more than in the top of the core.

QUESTION 5.09 (3.00)

Name the THREE primary parameters that affect DNB and DNBR which can be controlled by the reactor operator, other than core flow or flux distribution. Briefly explain how an INCREASE in each of these other three parameters affects the DNBR. Treat each parameter separately and assume all other parameters remain constant.

QUESTION 5.10 (2.50)

The plant is operating at 33% power when the 1B S/G Main Steam Isolation Valve fails shut. Using the below initial conditions, calculate the new steady state values for the listed parameters.
Assume no operator action, rod control system in manual, all other control systems in automatic, no reactor trip and no SI actuation.
State all assumptions and show all work.
Initial conditions: Tavg = 554 F
Tstm = 539 F
Core Delta T = 18 F

a. Turbine power
b. Tavg (loop 1B)
c. Tavg (loop 1D)
d. S/G pressure (loop 1B)
e. S/G pressure (loop 1D)

(***** CATEGORY 05 CONTINUED ON NEXT PAGE *****)

QUESTION 5.11 (1.00)

TRUE or FALSE?

a. As Keff approaches unity, a smaller change in neutron level will result for identical changes in Keff.

b. As Keff approaches unity, a longer period of time is required to reach the equilibrium neutron level for identical changes in Keff.

QUESTION 5.12 (1.00)

During a reactor startup, the first reactivity addition caused count rate to increase from 10 cps to 16 cps. The second reactivity addition caused count rate to increase from 16 cps to 32 cps. Which one of the following statements describing the relationship between the reactivity values of the first and second reactivity additions is correct?

a. The first reactivity addition was larger.

b. The second reactivity addition was larger.

c. The first and secon reactivity additions were equal.

d. There is not enough data given to determine relationship of reactivity values.

QUESTION 5.13 (1.00)

When performing a reactor S/U to full power that commenced five hours after a trip from full power equilibrium conditions, a 0.5% per min ramp was used. How would the resulting xenon transient vary if instead a 2% per min ramp was used? (Choose one)

a. The xenon dip for the 2% per min ramp would occur sooner and the magnitude of the dip would be smaller.

b. The xenon dip for the 2% per min ramp would occur later and the magnitude of the dip would be smaller.

c. The xenon dip for the 2% per min ramp would occur sooner and the magnitude of the dip would be larger.

d. The xenon dip for the 2% per min ramp would occur later and the magnitude of the dip would be larger.

(***** CATEGORY 05 CONTINUED ON NEXT PAGE *****)

QUESTION 5.14 (1.50)

A reactor is critical at 10 -8 amps in the intermediate range. An inadvertent boron dilution puts the reactor on a 0.5 DPM startup rate. Calculate the change in boron concentration caused by this dilution. STATE any assumptions you make and assume BOL conditions.

(***** END OF CATEGORY 05 *****)

QUESTION 6.01 (2.50)

Concerning the steam dump system, state all the conditions that will activate each of the following permissives. Include setpoints and coincidence, where applicable. (1.25 pts each)

1. C-7 (loss of load)

2. C-8 (turbine trip)

QUESTION 6.02 (2.00)

What 4 conditions must be satisfied in order for the common "0" CCW pump to auto-start? Assume NO safety injection or blackout. Setpoints not required.

QUESTION 6.03 (1.50)

Complete the following table regarding steam generator level setpoints: (.25 pts each)

Item		Unit 1		Unit 2
Hi Hi Turbine Trip (% NR)	(a)	_____%	(b)	_____%
Hi Level Alarm (% WR)		92.4 %		92.4 %
Normal Operating Level (% NR)	(c)	_____%	(d)	_____%
Lo Level Alarm (% NR)		45.8 %		22 %
Lo Lo Reactor Trip (% NR)	(e)	_____%	(f)	_____%

QUESTION 6.04 (2.00)

Concerning the RHR System:

a. What is the purpose of and the reason for the minimum flow recirculation lines? (1.0)

b. What is the purpose of and the reason for the heat exchanger bypass flow control valves (FCV-618, FCV-619)? (1.0)

(***** CATEGORY 06 CONTINUED ON NEXT PAGE *****)

QUESTION 6.05 (.50)

True or False?

The major reason that the pressurizer spray line taps off of a cold leg is because the lower temperature coolant wil reduce pressure in the pressurizer faster than would coolant from a hot leg.

QUESTION 6.06 (1.50)

RCP's may be operated only when the RCS pressure is greater than 325 psig. Explain the basis for this restriction.

QUESTION 6.07 (2.50)

Describe the sequence of events associated with a 4160V ESF bus that occur when the bus undervoltage annunciator is illuminated, from the time the annunciator is received until voltage is restored to the bus. Assume the cause of the annunciator is a degraded transformer that must be replaced and that bus voltage is 90% of nominal. Assume NO operator action.

QUESTION 6.08 (1.50)

There are 18 automatic and manual trips associated with the Emergency Diesel Generators. During an emergency start, all but three of these trips are disabled. What three automatic and/or manual trips are still operational during an emergency start?

QUESTION 6.09 (2.50)

Unit 1 is at 75% power, Cycle 2, 450 ppm boron concentration. CVCS is lined up with a 75 gpm orifice on line, 1B centrifugal charging pump in operation, and control systems in automatic. The makeup system is set up for a 5 ppm boration. All other control systems are in automatic.

Pressurizer level channel 459 (controlling channel) then fails to 0%. Several minutes later you notice rods stepping out and Tave dropping rapidly. After rods stop, Tave continues to drop.

Assume no reactor trip and no operator action. Explain why Tave is dropping, including in the explanation any initiating signals and interlocks.

(***** CATEGORY 06 CONTINUED ON NEXT PAGE *****)

QUESTIO 6.10 (1.50)

Following a blackout on Unit 2, both diesel generators automatically start, but you notice that breaker 2423 (2B DG output breaker) did not close. What are THREE (3) logic conditions needed for breaker 2423 to automatically close? Setpoints not required.

QUESTION 6.11 (1.50)

Unit 1 has tripped. You are given the following data concerning parameters immediately prior to the trip: (Assume all channels read the same)

Reactor power 95%

Unit Aux transformer output voltage 5200 volts

Loop flows 96%

Turbine emergency trip system oil pressure 440 psig

Pressurizer pressure 2285 psig

Steam generator levels 50%

List all possible causes of the reactor trip from the above data. Include in your answer the applicable setpoints (coincidence not required).

QUESTION 6.12 (1.50)

Unit 1 is in mode 3 with shutdown banks withdrawn. A shutdown was performed 12 hours ago to repair a failed-low turbine impulse channel. I&C technicians are performing repairs on the failed channel.

The I&C foreman has requested permission to test the failed channel. A temporary procedure change was written to allow testing of the channels in other than mode 1. What precautions/limitations must be observed before you will allow the test? Why?

(***** CATEGORY 06 CONTINUED ON NEXT PAGE *****)

QUESTION 6.13 (1.50)

The reactor operator reports to you that there is a demand for automatic rod withdrawal, but the rod control system is not responding. You direct him to place rod control in manual and attempt to withdraw rods. The rods move outward in manual.

What TWO (2) possible rod withdrawal interlocks may have existed to prev . the automatic withdrawal of rods?

QUESTION 6.14 (2.00)

On the previous shift, loop 1 Thot RTD failed low. The appropriate bistables were tripped and repairs are being performed. It is estimated that repairs will require 12 hours.

One hour into your shift, pressurizer pressure channel 456 (division II) fails low.

What actions should be performed with regard to the bistables associated with the pressurizer pressure channnel? Assume mode 1.

(***** END OF CATEGORY 06 *****)

QUESTION 7.01 (3.00)

For each of the following cases, state whether or not emergency boration is required per BwOA-PRI-2, "Emergency Boration": (.375 ea)

a. One control rod fails to insert on a reactor trip

b. Reactor is in mode 6 with boron concentration of 1900

c. Reactor power is 100% with control bank D at 78 steps

d. Delta I is at -17. Target delta I is -3

e. RCS temperature is stable at 551 degrees F following a trip when a steam generator bccomes faulted

f. Reactor is in mode 3 with Keff of .98

g. During a startup, the reactor goes critical with the "Rod Insertion Low Limit" alarm lit

h. During a reactor startup, a steam dump failure results in a cooldown to 550 degrees F

(***** CATEGORY 07 CONTINUED ON NEXT PAGE *****)

QUESTION 7.02 (3.00)

While functioning as Shift Supervisor, a condition arises which requires entry into containment while critical at 30% power. The operator entering will receive an estimated whole body dose of 40 mrem. The following data is available:

Operator	1	2	3	4
Sex	Male	Female	Male	Female
Age	27	24	38	20
Wk/Exposure	35 mrem	0 mrem	180 mrem	30 mrem
Qtr/Exposure	1230 mrem	165 mrem	970 mrem	1120 mrem
Life Exposure		5200 mrem	54730 mrem	9970 mrem
Remarks	History Unavailable	2 months pregnant	Form 4 on file	Form 4 on file

Each operator is technically competent and physically capable of performing the task. Emergency limits do not apply and Rad-Chem will not approve extensions. These are the only operators available and at least one of them MUST be chosen for the job.

Give your reasons (based on legal/admin limits) for accepting or rejecting EACH operator. (.75 ea)

QUESTION 7.03 (1.50)

What are the entry conditions for BwEP ES-0.0, "Rediagnosis"?

QUESTION 7.04 (1.50)

Concerning the BwEP's, answer the following TRUE or FALSE: (0.5 each)

a. In general, a required task as stated in a procedural step MUST be completed prior to proceeding to the next step.

b. The procedures are applicable in modes 1 through 5.

c. The only entry point into the BwEP's is through BwEP-0.

(***** CATEGORY 07 CONTINUED ON NEXT PAGE *****)

QUESTION 7.05 (1.00)

While performing BwEP-1, "Loss of Reactor or Secondary Coolant," you enter a step where the Action/Expected Response is not satisfied (left hand column). You enter the Response Not Obtained (right hand column) for that step and find that you cannot complete the actions as stated. What is your next action concerning use of the BwEP?

QUESTION 7.06 (1.50)

While performing BwEP-3, "Steam Generator Tube Rupture," conditions are such that you decide to use the "adverse containment" values for performance of the BwEP. State ALL conditions that must be satisfied before you can again use the "normal containment" values in the BwEP. State any assumptions you make.

QUESTION 7.07 (1.00)

The reactor operator reports that he intends to trip the RCP's while you are performing BwEP-1, Loss of Reactor or Secondary Coolant. The following data is available to you.

RCS cooldown rate:	30 degrees F/hr on steam dumps
RCS pressure:	1250 psig
Charging Flow:	75 gpm
CC water to RCP's:	available
Containment Phase B:	not actuated

Assume all other indications/system status are normal.

Per the foldout page for BwEP-1, do you allow the RO to trip RCP's? Why or why not? (What criteria are/are not met?)

QUESTION 7.08 (1.50)

Describe two instances, while performing emergency procedures, when an exit to a functional restoration guideline from the CSF status trees is not performed, even if a red path is obtained.

(***** CATEGORY 07 CONTINUED ON NEXT PAGE *****)

QUESTION 7.09 (4.00)

Using the attached pages from BwZP 200-1A1, classify each of the following events. Consider each event separately. Limit your answer to None, Unusual Event, Alert, Site Emergency, or General Emergency. Assume that any condition not stated is normal and satisfies LCO requirements.

a. A fire in the control room results in thick smoke in the control room and subsequent evacuation of the control room.

b. 1B centrifugal charging pump has been out of service for the last 7 days. Assume mode 1.

c. A steam generator code safety is blowing by and cannot be isolated.

d. A steam generator tube fails, resulting in a 70 gpm leak in 2B steam generator. Leak rate prior to the failure was 3 gph.

e. An I&C error during surveillance results in an ECCS actuation. Primary pressure remains stable at 2235 psig.

f. An irradiated fuel assembly is dropped in the cavity. Bubbles escaping from the assembly are reported.

g. An aircraft crashes in the switchyard. The resulting fire requires the complete de-energizing of the switchyard ring busses.

h. A demonstration at the main gate prevents the oncoming crews from entering the station for 2 hours.

(***** CATEGORY 07 CONTINUED ON NEXT PAGE *****)

QUESTION 7.10 (2.25)

Given the following data concerning the power range nuclear instruments:

Channel	NR41	NR42	NR43	NR44
Upper detector current	104	0	116	114
Upper 100% current	208	224	224	216
Lower detector current	106	0	112	108
Lower 100% current	212	220	224	216

All readings are in milliamps. NR42 is inoperable and out of service with bistables tripped.

a. What is the quadrant power tilt ratio? 1BwOS 2.4.1.a-1 is included for your use. (1.25)

b. Assuming the QPTR is greater than 1.09, what actions must be taken according to Technical Specifications? Assume that control rods and shutdown rods are aligned properly, and that power is 75%. Time limits not required. (1.0)

QUESTION 7.11 (.75)

You are working in containment when your self-reading dosimeter falls out of your pocket. You retrieve it and the indicator is missing. What 3 actions must be taken by you per BwRP 1000-A1, "Radiation Protection Standards"?

QUESTION 7.12 (2.50)

a. Per BwRP 1000-A1, "Radiation Protection Standards," describe the differences between a Type 1 RWP and a Type 2 RWP, concerning the following items: (2.0)

   1. Dose rate

   2. Length of time that the RWP is valid

b. True or False?

   A worker may be allowed to enter an airborne radioactivity area under a Type 1 RWP. (.5)

(***** CATEGORY 07 CONTINUED ON NEXT PAGE *****)

QUESTION 7.13 (1.00)

A startup is performed on Unit 1 with an ECC of Bank D at 150 steps. Criticality is not achieved by the time Bank D reaches 228 steps. Per BwGP 100-2, "Plant Startup," what 2 actions must be performed?

(***** END OF CATEGORY 07 *****)

QUESTION 8.01 (1.00)

Answer the following TRUE or FALSE per BwAP 330-6, "Caution Card Procedure":

a. All caution cards shall be authorized by the Shift Foreman (or designee).

b. Only the person that requested a caution card may authorize removal.

QUESTION 8.02 (1.50)

Refer to the attached page from BwEP-1.

BwAP 340-1, "Use of Procedures for Operating Department," contains specific guidance for the use of "open bullets" and "closed bullets" in the BwEP's. What is the difference, to you as an operator, between "open bullets" and "closed bullets" when using the BwEP's?

(***** CATEGORY 08 CONTINUED ON NEXT PAGE *****)

QUESTION 8.03 (5.00)

For each of the following conditions, state whether or not a Technical Specification LCO should be entered (yes/no only - no explanation required). Treat each case independently. Assume all other conditions not stated satisfy LCO requirements. (0.5 ea)

a. Primary containment average air temperature is 126 degrees F. The reactor is in mode 6.

b. RWST boron concentration is 2000 ppm with temperature of 40 degrees F. The reactor is in mode 1.

c. MSIV's are tested and stroke from full open to full closed in 30 seconds. The reactor is in mode 3.

d. The containment purge isolation system is inoperable. Purge isolation valves are shut. The reactor is in mode 1.

e. One containment air lock door is innperable. The reactor is in mode 4.

f. One transformer of the System Auxiliary Transformer bank is out of service due to an inoperable disconnect. The reactor is in mode 3.

g. One of the transmission lines from the switchyard is out of service. The reactor is in mode 1.

h. Shutdown margin is .13% delta k/k. The reactor is in mode 1.

i. "B" centrifugal charging pump discharge valve is shut and inoperable. The reactor is in mode 2.

j. Boric acid storage tank temperature is 70 degrees F.

QUESTION 8.04 (1.00)

Answer each of the following True or False according to BwAP 300-1, "Conduct of Operations." (.5 pts each)

1. Control room personnel will man the fire brigade if required to fight a fire.

2. If an NSO must go behind the back panels of the control board, he is still considered "At the controls."

(***** CATEGORY 08 CONTINUED ON NEXT PAGE *****)

QUESTION 8.05 (2.00)

Low power testing is in progress on Unit 2 when the NSO discovers that two approved procedures for the testing appear to conflict. The NSO directs that testing be halted and notifies the shift supervisor. According to BwAP 340-1, "Use of Procedures for Operating Department," what 2 additional actions should be taken by the NSO?

QUESTION 8.06 (2.50)

List in order, from most severe to least severe, the critical safety function status trees and the color priorities for the status trees.

QUESTION 8.07 (2.25)

Per BwAP 1300-3, "Preparation and Approval of Temporary Procedures and Temporary Changes to the Permanent Procedures", 3 criteria must be met before a temporary procedure or temporary change may be written. What are these criteria?

QUESTION 8.08 (1.00)

If a temporary procedure/change is NOT authorized for EXTENDED use, when does it become invalid?

QUESTION 8.09 (1.75)

Technical Specification 3.4.8 places limits on reactor coolant specific activities. Per Tech Spec Bases, what are these limits based on? Include any applicable time limits.

QUESTION 8.10 (1.50)

Reference is made in the technical specifications to various systems, components or pieces of equipment being OPERABLE. Per the technical specifications definition, what is meant by OPERABLE?

(***** CATEGORY 08 CONTINUED ON NEXT PAGE *****)

QUESTION 8.11 (3.00)

Technical Specification 3.4.6.2 addresses RCS leakage. In this Tech Spec, limits are placed on pressure boundary leakage, unidentified leakage, identified leakage, and controlled leakage.

Per the Tech Spec definitions, define IDENTIFIED LEAKAGE, CONTROLLED LEAKAGE, UNIDENTIFIED LEAKAGE, and PRESSURE BOUNDARY LEAKAGE.

QUESTION 8.12 (2.50)

In technical specifications, section 2, there are two (2) specific SAFETY LIMITS imposed.

a. What are these 2 safety limits? (1.5)

b. If a safety limit is exceeded, what action must be taken by the operator? Include maximum time limits. Assume mode 1. (1.0)

(***** END OF CATEGORY 08 *****)
(********** END OF EXAMINATION **********)

ANSWERS -- BRAIDWOOD 1&2 -87/12/14-DAMON, D.

ANSWER 5.01 (1.50)

a. INCREASE (will accept NO CHANGE if candidate states that the channel is inoperable.)

b. MORE NEGATIVE

c. NO CHANGE

REFERENCE
Braidwood Rx Theory, Ch 8, obj 7, 11 and pp 8-17 to 8-22
015000A105 015000A202 015000K501 ...(KA'S)

ANSWER 5.02 (1.50)

N1=1500rpm V1=250 gpm Hp1=15psig P1= 40 KW

N2 = 1500 sqr root(10.0/15) = 1224.7 rpm [0.5]

V2 = (1224.7/1500)(250 gpm) = 204.1 gpm [0.5]

$P2 = (1224.7/1500)^3 (40\ KW) = 21.7\ KW$ [0.5]

REFERENCE
Braidwood Fluid Flow, Ch 2, obj 4 and pp 2-26 to 2-33
003000A203 191004K105 ...(KA'S)

ANSWER 5.03 (2.00)

Q = m delta h

SYSTEM ENTHALPY (BTU/LBM) hg	FW ENTHALPY (BTU/LBM) hf	ENTHALPY RISE (BTU/LBM) hfg	POWER hfg x Total FWFlow BTU/HR
1193	418.5	774.5	11.695x10E9

(1.0)

11.695x10E9 BTU/HR X 1MW /3.413x10E6 BTU/HR = 3426.6 MW (0.5)

3426.2 MW/3411 MW = 100.5% (0.5)

REFERENCE
Braidwood Thermodynamics, Ch 3, obj 5 and pp 3-69 to 3-80, 3-109 to 3-111
W Thermal-Hydraulic Principles and Applications to the PWR, Pg. 6-47.
193007K106 193007K108 ...(KA'S)

ANSWERS -- BRAIDWOOD 1&2 -87/12/14-DAMON, D.

ANSWER 5.04 (1.00)

1. Minimize the consequences of a rod ejection accident, OR potential effects of rod misalignment on associated accident analysis are limited.
2. Guarantee a sufficient shutdown margin from a given power level.
3. Produce an axial flux distribution which prevents high local peak power levels, or acceptable power distribution is maintained. (If the control rods are inserted to far into the core , the power production in the core is suppressed in the top of the core raising the power production i the bottom of the core. The higher power in the bottom of the core could cause abnormally high fuel temperatures and melt the fuel.)

(.33 ea answer)

REFERENCE
Braidwood Rx Theory, Ch 6, obj 9 and pp 6-23 to 6-26
W Reactor Core Control for Large PWR's, pp. 6-29 & 6-30.
192005K114 192005K115 192005K116 ...(KA'S)

ANSWER 5.05 (2.00)

a. Saturated

B. Superheated

c. Superheated

d. Subcooled (0.5 each)

REFERENCE
Braidwood Thermodynamics, Ch 3, obj 9 and pp 3-101 to 3-107
Mollier Diagram
Steam Tables
193004K115 ...(KA'S)

ANSWERS -- BRAIDWOOD 1&2 -87/12/14-DAMON, D.

ANSWER 5.06 (3.00)

a. (Since the amount of reactivity inserted is one-half of the total amount needed to reach criticality,) the count rate should double, or about 100 cps. [1.0]

OR

For rho = K-1 (valid approximation)

$$CR1/CR0 = (1-K0)/(1-K1)$$
$$= (1-(rho0 + 1))/(1-(rho1 + 1))$$
$$= rho0/rho1$$
$$= 2$$
$$CR1 = 2*CR0 = 100 \text{ cps (actual is 98.54 cps)} \quad [+1.0]$$

b. For rho = K-1

$$CR1/CR0 = rho0/rho1$$
OR
$$rho0 = rho1*CR1/CR0 \quad [+0.5]$$

Since the change in reactivity was 750 pcm (one-half of the total dilution): [+0.5]

$$rho0 = (rho0 + 750 \text{ pcm})*CR1/CR0$$
$$= (rho0 + 0.0075)*80/50$$
$$= 1.6\ rho0 + 0.012$$

$$-0.6\ rho0 = 0.012$$
$$rho0 = -0.02$$
$$= -2000 \text{ pcm}$$

Therefore, the original ECC should have determined that criticality would be achieved if 2000 pcm was added to the core. [1.0]

REFERENCE
Braidwood Rx Theory, Ch 5, obj 7 and pg 5-3
Braidwood Rx Physics, Ch 6, obj 13 and pp 6-21 to 6-24
Ch 7, obj 4 and pp 7-37 to 7-45
W Fundamentals of Nuclear Reactor Physics, pp 5-22 to 5-29, B-39 to B-41
004000K50B ...(KA'S)

ANSWERS -- BRAIDWOOD 1&2 -87/12/14-DAMON, D.

ANSWER 5.07 (2.50)

a. Rods will need to be withdrawn for about 5 hours [0.5] and then inserted for the next 35 hours. [0.5]

b. After the power decrease, the production of xenon from fission [0.25] and from the decay of iodine [0.25] is greater than the removal by decay of xenon [0.25] and burnout by flux. [0.25] After five hours, the removal rate is greater than the production [0.25] and positive reactivity is being added until equilibrium at about 40 hours. [0.25]

REFERENCE
Braidwood Rx Theory, Ch 4, obj 1 and pp 4-14 to 4-29
001000K533 ...(KA'S)

ANSWER 5.08 (1.50)

a. MORE NEGATIVE [0.25] because rods are inserted and push the flux to the bottom of the core [0.25]

b. LESS NEGATIVE [0.25] because more reactivity is added to top of core with delta T constant and Thot decreasing [.25]

c. LESS NEGATIVE [0.25] because Xe inserts MORE negative reactivity in the bottom of the core than in the top of the core. [0.25]

REFERENCE
Braidwood Rx Theory, Ch 8, obj 3, 4 and pp 8-13 to 8-24
001000K506 001000K538 ...(KA'S)

ANSWER 5.09 (3.00)

1) Reactor power [0.5]. Increasing reactor power results in increased heat flux and DNBR decreases. [0.5]

2) Temperature [0.5]. If Tave is increased, subcooling will decrease. Therefore the heat flux required to reach DNB will decrease and the DNBR will decrease. [0.5]

3) Pressurizer (RCS) pressure [0.5]. If pressure increased, subcooling increases and DNBR increases. [0.5]

ANSWERS -- BRAIDWOOD 1&2 -87/12/14-DAMON, D.

REFERENCE
Braidwood Heat Transfer, Ch 9, obj B and pp 9-22 to 9-28
193008K105 ...(KA'S)

ANSWER 5.10 (2.50)

a. Turbine power - stays constant at 33% power (0.50)
[due to EHC being in auto]

b. Tavg (loop 1B)
due to no heat sink, goes to Th = 554 F + 18/2 = 563 F (0.50)

c. Tavg (loop 1D)
total reactor power has not changed; however, the power that 1D S/G must produce has increased by a factor of 1/3 to compensate for 1B loop
Qrx = m Cp (Th - Tc)
initial Delta T was 18 F, increase by 1/3 ==> final Delta T = 24 F
final Tavg = Th - Delta T/2 = 563 - 24/2 = 551 F (0.50)

d. S/G Pressure (loop 1B)
saturation pressure for 563 F =1161 psia [or 1146 psig] (0.50)
[also acceptable if assume that safeties will be lifting starting at 1065 psig]

e. S/G Pressure (loop 1D)
as with part c above, the appropriate Delta T will increase by 1/3
Qsg = U A (Tavg - Tstm)
initial Delta T = Tavg - Tstm = 554 - 539 = 15 F
final Tstm = Tavg - Delta T/2 = 551 - 15(4/3) = 531 F
final Pstm ==> saturation for 531 F = 893 psia [or 878 psig] (0.50)

REFERENCE
Braidwood Thermodynamics, Ch 3, obj 6 and pp 3-66 to 3-76
000074A204 039000K305 ...(KA'S)

ANSWER 5.11 (1.00)

a. False
b. True

REFERENCE
Braidwood Rx Theory, Ch 8, obj 1, 2 andpp 8-13 to 8-41
004000K508 ...(KA'S)

ANSWERS -- BRAIDWOOD 1&2 -87/12/14-DAMON, D.

ANSWER 5.12 (1.00)

a

REFERENCE
Braidwood Rx Theory, Ch 8, obj 2 and pp 8-13 to 8-41
004000K508 ...(KA'S)

ANSWER 5.13 (1.00)

a

REFERENCE
Braidwood Rx Theory, Ch 4, obj 1 and pp 4-14 to 4-29
Westinghouse Simulator Trng book, "Rx Theory and Core Physics", Fig I-5-54
001000K538 ...(KA'S)

ANSWER 5.14 (1.50)

Assume: boron worth = -12 pcm/ppm (Allow full credit for
Beta bar eff. = 0.007 any reasonable assumption
lambda eff. = 0.08 sec of these values)

The stable period is given by:

T = 26/SUR = 26/.5 = 52 Sec [0.5]

The reactivity associated with the stable period:

p = beff/1+ lambda T = .007/ 1+(.08)(52)
= 0.001357 dk/k = 135.7 PCM [0.5]

The change in boron concentration:

d CB = 135.7 pcm/-12 pcm/ppm = 11.3 ppm [0.5]

REFERENCE
Braidwood Rx Theory, Ch 5, obj 7 and pg 5-13
Braidwood Rx Physics, Ch 6, obj 13 and pp 6-21 to 6-24
Ch 7, obj 4 and pp 7-37 to 7-45
004000K507 004000K520 ...(KA'S)

ANSWERS -- BRAIDWOOD 1&2 -87/12/14-DAMON, D.

ANSWER 6.01 (2.50)

1. 10% [.25] step decrease in load [.25] or

   5%/min. [.25] load decrease [.25] for 2 minutes [.25]

2. 4/4 [.25] turbine stop valves shut [.25] or

   2/3 [.25] turbine emergency trip header pressure [.25] less than 540 psig [.25]

REFERENCE
Braidwood System Descript.on, Chapter 24, Objectives 4a, 4b, pp. 24-13 to 24-14
041000G007 ...(KA'S)

ANSWER 6.02 (2.00)

1. Breaker racked-in and DC control power available
2. Pump control switch in standby (after-trip)
3. Low header pressure
4. Other pump on same bus in PULL-TO-LOCK

(0.5 pts each)

REFERENCE
Braidwood System Description, Chapter 19, Objective 7, pg. 19-12
008000K401 ...(KA'S)

ANSWER 6.03 (1.50)

(a) 81.4%
(b) 78.1%
(c) 66%
(d) 50%
(e) 40.8%
(f) 17%

(.25 pts each)

Note: All answers will be allowed a tolerance of +/- 2%

REFERENCE
Braidwood System Description, Chapter 22, Objective 4a, Table 22-3
035000G010 035010A301 035010K112 035010K401 ...(KA'S)

ANSWERS -- BRAIDWOOD 1&2 -87/12/14-DAMON, D.

ANSWER 6.04 (2.00)

a. To insure that the RHR pumps do not overheat or vibrate (.5) when the discharge line is shut. (.5)

b. Maintain the total RHR system flow rate constant (.5) when the heat exchanger flow control valves are adjusted. (.5)

REFERENCE
Braidwood System Description, Chapter 18, Objective 4i, pg. 18-14
and Objective 4h, pg. 18-20
005000K403 005000K406 ...(KA'S)

ANSWER 6.05 (.50)

False.

REFERENCE
Braidwood System Description, Chapter 12, Objective 2.h.7, pg. 12-15
002000K109 ...(KA'S)

ANSWER 6.06 (1.50)

Ensures that number 1 seal differential pressure remains above 200 psi. (1.0) This prevents the seal from "closing" and being damaged. (.5)

(Will accept discussion of NPSH requirements, backpressure and losses as long as the delta P requirement is also discussed.)

REFERENCE
Braidwood System Description, Chapter 13, Objective 9b, pg. 13-17
003000K407 003000K602 ...(KA'S)

ANSWER 6.07 (2.50)

5 minute timer is actuated (will accept "after 5 minutes") (.5)
When timer times out, feeder breaker is sent a trip signal (.5)
All load breakers on bus are sent a trip signal (.5)
Associated DG starts on UV (.5)
DG breaker auto closes on bus (.5)

ANSWERS -- BRAIDWOOD 1&2 -87/12/14-DAMON, D.

REFERENCE
Braidwood System Description, Chapter 4, Objective 10a, pg. 4-40 to 4-41

062000A216 064000A311 ...(KA'S)

ANSWER 6.08 (1.50)

Overspeed
High differential current
Emergency manual stop pushbutton

(.5 pts each)

REFERENCE
Braidwood System Description, Chapter 9, Objective 5, pg. 9-54
064000K401 064000K402 ...(KA'S)

ANSWER 6.09 (2.50)

The level channel failing low causes orifice isolation valves to shut at 17% level [0.5]. This level signal also causes charging flow to increase, beyond the capacity of the makeup system in this mode [0.5]. At 5% level on both VCT channels [0.5], RWST suction valves open and VCT suction valves close [0.5] causing boration of the RCS from the RWST [0.5].

REFERENCE
Braidwood System Description -
Chapter 14, Objective 21 and pg. 14-43 to 14-45
Chapter 15a, pg. 15a-31
004000A202 004000A206 004000A207 004000K101 004000K106
004000K123 ...(KA'S)

ANSWER 6.10 (1.50)

Any 3 of the following (.5 ea)

1. Diesel generator up to rated speed.

2. Diesel generator up to rated voltage.

3. No lockout (fault) on Bus 242

4. Control switch for 2423 in after trip

5. Breakers 2421, 2422, 2424 open

REFERENCE
Braidwood System Description, Chapter 4, Objective 11c and pg. 4-101
Chapter 9, pp 9-61 to 9-62
062000K401 064000A401 064000K401 ...(KA'S)

ANSWER 6.11 (1.50)

1. RCP undervoltage (due to undervoltage on UAT) (0.5)

   Setpoint - 5268 volts (.25)

2. Turbine trip above P-7 (10%) (due to low ET system pressure) (0.5)

   Setpoint - less than 540 psig ET pressure (.25)

[Note to grader: deduct .5 for any incorrect trip given]

REFERENCE
Braidwood System Description Chapter 60b, Objective 4, pp 60b-8 to 60b-20

012000G012 012000K402 045000A304 045000K411 ...(KA'S)

ANSWERS -- BRAIDWOOD 1&2 -87/12/14-DAMON, D.

ANSWER 6.12 (1.50)

Since testing of the impulse channel may give P-13 which feeds P-7 with the turbine tripped, causing a reactor trip, you must do one of the following: (.75) (Either answer accepted for .75)

a. Restrict testing of the impulse channel to less than 10%

b. Insert shutdown banks and open trip breakers prior to testing

REFERENCE
Braidwood System Description, Chapter 60b, Objective 4c and pg. 60b-22
012000K401 012000K402 012000K610 ...(KA'S)

ANSWER 6.13 (1.50)

1. Turbine first stage pressure less than 15% (or C-5) (.75)

2. Control bank D greater than 223 steps (or C-11) (.75)

REFERENCE
Braidwood System Description, Chapter 28, Objective 14, and pp 28-72 to 28-73
001000K407 ...(KA'S)

ANSWER 6.14 (2.00)

The concern is with making up logic for the OT delta T trip.(.75) Since tripping the bistables associated with the pressure channel will generate the coincidence necessary to cause a reactor trip,(.75) the operator should not trip bistables associated with OT delta T.(.5)

REFERENCE
Braidwood System Description, Ch 12, pp 12-32 to 12-33
Ch 60b, figures 60b-5 and 60b-8
BwOA-INST-2, attachment B, pg 13 caution
012000K401 012000K405 012000K601 ...(KA'S)

ANSWERS -- BRAIDWOOD 1&2 -87/12/14-DAMON, D.

ANSWER 7.01 (3.00)

a. No
b. Yes
c. Yes
d. No
e. Yes
f. No
g. No
h. No

(.375 pts each)

REFERENCE
BwOA-PRI-2, Entry Conditions
000024A205 000024K301 000024K302 ...(KA'S)

ANSWER 7.02 (3.00)

Operator #1 Rejected [.25] since he has no history on file and will exceed 1.25 REM/QTR whole body exposure [.50]

Operator #2 Accepted [.25] since she will not exceed 500 mrem whole body exposure during the term of her pregnancy [.25] or the weekly/quarterly limits [.25]

Operator #3 Accepted [.25] since he will not exceed 300 mrem weekly admin limit [.25] or the 1.25 R/Qtr limit. [.25]

Operator #4 Accepted [.25] since she will not exceed 300 mrem weekly admin. limit [.25] and will not exceed 1.25 REM/QTR whole body [.25]
(5[n-18] criteria does not apply since the operator will not exceed the allowable quarterly limit of 1.25 REM/QTR whole body.)

REFERENCE
BwRP 1000-A1, pp. 24 to 25
10 CFR 20.101
USNRC Regulatory Guide 8.13
194001K103 194001K104 ...(KA'S)

ANSWERS -- BRAIDWOOD 1&2 -87/12/14-DAMON, D.

ANSWER 7.03 (1.50)

1. Entered based on operator judgement when: (0.5)

22. SI is actuated or required (0.5)
and
3. BwEP-0 has been implemented and a transition to another BwEP has been made (0.5)

REFERENCE
BwEP ES-0.0, pg. 1
000007G011 ...(KA'S)

ANSWER 7.04 (1.50)

a. False
b. False
c. False

REFERENCE
ERG Executive Volume, Users Guide, pp 5, 20-25
BwCA-0.0 Entry Conditions
000007G011 000007G012 000056G011 000056G012 ...(KA'S)

ANSWER 7.05 (1.00)

Perform the next step or substep in the left hand column. (1.0)

REFERENCE
BwAP 340-1 pg 5
ERG Executive Volume, Users Guide, pg. 5
000009G012 000011G012 ...(KA'S)

ANSWERS -- BRAIDWOOD 1&2 -87/12/14-DAMON, D.

ANSWER 7.06 (1.50)

1. Containment pressure less than 5 psig and (.75)

2. Containment radiation level remained less than 1E5 R/hr. (.75)

Note: Will accept for Item 2: Containment rad level less than 1E5 R/hr. and integrated dose less than 1E6 R.

Will also accept a stated assumption that containment rad levels never exceeded 1E5 R/hr.

REFERENCE
BwEP-0, pg. 3 note
ERG Executive Volume, Generic Instrumentation, pg. 21
000038G011 000038G012 103000G015 ...(KA'S)

ANSWER 7.07 (1.00)

No. [0.5] do not meet criteria for tripping RCP's of no RCS cooldown in progress [0.5].

REFERENCE
BwEP-F.1, RCP trip criteria
003000G010 003000G015 ...(KA'S)

ANSWER 7.08 (1.50)

Any 2 of the following: (.75 pts each)

1. During performance of BwEP-0 prior to step 33 (will accept "prior to the step requiring monitoring of status trees")

2. During performance of BwCA-0.0 (will accept "during loss of all AC")

3. During performance of BwEP ES-1.3 steps 1-5 (will accept "while changing RHR lineups")

4. During BwCA 0.1 steps 1-9

5. During BwCA 0.2 steps 1-7

ANSWERS -- BRAIDWOOD 1&2 -87/12/1--DAMON, D.

REFERENCE
BwEP ES-1.3, pg. 2
ERG Background E-0 step 27
000007G012 000055G012 ...(KA'S)

ANSWER 7.09 (4.00)

a.	Site Emergency	(9)	e.	None	(22)
b.	Alert	(14)	f.	None or Unusual Event	(25, 31)
c.	Unusual Event	(17)	g.	Site Emergency	(1)
d.	Alert	(16)	h.	Unusual Event	(7)

(numbers refer to the EAL classification used by the grader)
(0.5 pts each)

REFERENCE
BwZP 200-1A1, Items 9, 14, 17, 16, 22, 31, 1, 7
194001A116 ...(KA'S)

ANSWER 7.10 (2.25)

a. 1.03 [.25] [1.25 total]
(Credit .125 for each correct normalized detector current)

b. Calculate QPTR at least once per hour (.25)
Reduce power to less than 50% (.25)
Reduce PR Hi flux trip setpoint to 55% (.25)
Identify and correct cause of tilt (.25)

REFERENCE
1BwOS 2.4.1.9-1
TS 3.2.4.C
015000A104 015000G007 015000G008 ...(KA'S)

ANSWER 7.11 (.75)

Leave containment immediately [.25] and report to your supervisor [.25] and then report to Rad/Chem [.25].

REFERENCE
BwRP 1000-A1, pg. 33
194001K104 ...(KA'S)

ANSWERS -- BRAIDWOOD 1&2 -87/12/14-DAMON, D.

ANSWER 7.12 (2.50)

a.

	Type 1	Type 2 (.5 each answer)
1.	Less than 50 mrem/day	Greater than 50 mrem/day
2.	Max. of 1 year	Length of job

b. True

REFERENCE
BwRP 1000-A1, pp. 11-17
194001K104 ...(KA'S)

ANSWER 7.13 (1.00)

1. Reinsert all control banks (.5)

2. Recalculate ECC (.5)

REFERENCE
BwGP 100-2, pg. 9
001010A207 ...(KA'S)

ANSWERS -- BRAIDWOOD 1&2 -87/12/14-DAMON, D.

ANSWER 8.01 (1.00)

a. False
b. False

(0.5 pts each)

REFERENCE
BAP 330-6, pp 2 to 3
194001K102 ...(KA'S)

ANSWER 8.02 (1.50)

"Closed bullet" requires all steps to be completed in any order [.75].
"Open bullet" requires only the steps that apply to be completed in any order [.75].

REFERENCE
BwAP 340-1, pg. 5
000007G012 ...(KA'S)

ANSWER 8.03 (5.00)

a. No
b. No
c. Yes
d. No
e. Yes
f. No
g. No
h. Yes
i. Yes
j. No (.5 ea)

REFERENCE
Braidwood Technical Specifications 3.6.1.5, 3.5.4, 4.7.1.5, 3.9.9, 3.6.1.3, 3.8.1.1, 3.1.1.1, 3.1.2.4, 3.1.2.6
004000G011 005000G011 022000G011 029000G011 039000G011
062000G011 103000G011 ...(KA'S)

ANSWER 8.04 (1.00)

1. False
2. False

REFERENCE
BwAP 300-1, pp. 12, 10
194001K105 194001K116 ...(KA'S)

ANSWERS -- BRAIDWOOD 1&2 -87/12/14-DAMON, D.

ANSWER 8.05 (2.00)

Any 2 of the following (1.0 ea)

1. Maintain plant operation inside the FSAR described design envelope.

2. Make log entries describing the situation and resolution.

3. Return system to the as-found position if procedure to be terminated.

4. Place system in stable condition.

REFERENCE
BwAP 340-1, pg. 2
194001A102 ...(KA'S)

ANSWER 8.06 (2.50)

Monitored in order (1.5)
Subcriticality, core cooling, heat sink, integrity, containment, inventory

(.25 pts for each in correct order, - .125 if correct status tree in wrong order)

Color priority in order (1.0)
red, orange, yellow, green

(.25 for each in correct order, - .125 if correct color and out of order)

REFERENCE
BwAP 340-1, pg. 7
000029G010 000029G011 194001A102 ...(KA'S)

ANSWER 8.07 (2.25)

1. No current procedure describes the proposed action.

2. There is no change in intent for any established procedure.

3. The proposed procedure does not involve an unreviewed safety question.

(.75 pts each)

REFERENCE
BwAP 1300-3, pg. 1
194001A101 194001A102 ...(KA'S)

ANSWER 8.08 (1.00)

14 days from the implementation date.

REFERENCE
BwAP 1300-3
194001A101 194001A102 ...(KA'S)

ANSWER 8.09 (1.75)

Limitations ensure that the resulting 2 hour dose at the site boundary [.5] will not exceed a small fraction of 10 CFR 100 guidelines [.5] following a SGTR [.5] in conjunction with a 1 gpm steady-state primary to secondary leak [.25].

REFERENCE
Braidwood TS Bases 3/4.4.8
002000G006 004000G006 073000G006 ...(KA'S)

ANSWER 8.10 (1.50)

OPERABLE means that the item being addressed is capable of performing its specified function(s) [.5] and all necessary attendant auxiliary equipment and instrumentation that is required for this item to perform its function [.5] are also capable of performing their related support functions [.5].

ANSWERS -- BRAIDWOOD 1&2 -87/12/14-DAMON, D.

REFERENCE
Braidwood Tech Spec 1.19
061000G005 061000G006 061000G011 ...(KA'S)

ANSWER 8.11 (3.00)

Controlled leakage is the seal water flow supplied to the RCP seals. (.75)

Pressure boundary leakage is through a nonisolable fault in an RCS component (.75)

Identified is leakage (except controlled) into closed systems [.25] or into containment atmosphere from specifically known sources (not pressure boundary) [.25] or into a steam generator [.25].

Unidentified is all leakage which is not identified or controlled. (.75)

REFERENCE
Braidwood Tech Spec 1.8, 1.15, 1.22, 1.37
002000A301 002000G005 002000G015 002000K405 ...(KA'S)

ANSWER 8.12 (2.50)

a. 1. Combination of thermal power [.25], pressurizer pressure [.25], and highest operating loop Tave [.25] shall not exceed limit for four loop operation [.25].

2. RCS pressure [.25] shall not exceed 2735 psig. (.25)

b. Be in hot standby [.5] within 1 hour [.5].

REFERENCE
Braidwood Tech Spec 2.1
003000G005 010000G005 015000G005 016000G005 ...(KA'S)

U. S. NUCLEAR REGULATORY COMMISSION
REACTOR OPERATOR LICENSE EXAMINATION

FACILITY: BRAIDWOOD 1&2

REACTOR TYPE: PWR-WEC4

DATE ADMINISTERED: 87/12/14

EXAMINER: LENNARTZ, J.

CANDIDATE: _____

INSTRUCTIONS TO CANDIDATE:

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%. Examination papers will be picked up six (6) hours after the examination starts.

CATEGORY VALUE	% OF TOTAL	CANDIDATE'S SCORE	% OF CATEGORY VALUE		CATEGORY
25.00	25.00	_____	_____	1.	PRINCIPLES OF NUCLEAR POWER PLANT OPERATION, THERMODYNAMICS, HEAT TRANSFER AND FLUID FLOW
25.00	25.00	_____	_____	2.	PLANT DESIGN INCLUDING SAFETY AND EMERGENCY SYSTEMS
25.00	25.00	_____	_____	3.	INSTRUMENTS AND CONTROLS
25.00	25.00	_____	_____	4.	PROCEDURES - NORMAL, ABNORMAL, EMERGENCY AND RADIOLOGICAL CONTROL
100.00		_____ Final Grade	_____%		Totals

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

_____
Candidate's Signature

MASTER COPY

NRC RULES AND GUIDELINES FOR LICENSE EXAMINATIONS

During the administration of this examination the following rules apply:

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

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

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

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

5. Fill in the date on the cover sheet of the examination (if necessary).

6. Use only the paper provided for answers.

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

8. Consecutively number each answer sheet, write "End of Category __" as appropriate, start each category on a new page, write only on one side of the paper, and write "Last Page" on the last answer sheet.

9. Number each answer as to category and number, for example, 1.4, 6.3.

10. Skip at least three lines between each answer.

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

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

13. 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.

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

15. Partial credit may be given. Therefore, ANSWER ALL PARTS OF THE QUESTION AND DO NOT LEAVE ANY ANSWER BLANK.

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

17. You must 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 must be done after the examination has been completed.

18. When you complete your examination, you shall:

a. Assemble your examination as follows:

(1) Exam questions on top.

(2) Exam aids - figures, tables, etc.

(3) Answer pages including figures which are part of the answer.

b. Turn in your copy of the examination and all pages used to answer the examination questions.

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

d. 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 or revoked.

EQUATION SHEET

$f = ma$

$w = mg$

$E = mc^2$

$KE = 1/2\ mv^2$

$PE = mgh$

$V_f = V_o + at$

$W = v\ \Delta P$

$\Delta E = 931\ \Delta m$

$\dot{Q} = \dot{m} C_p \Delta t$

$\dot{Q} = UA \Delta T$

$Pwr = W_f \Delta h$

$P = P_o 10^{sur(t)}$

$P = P_o e^{t/T}$

$SUR = 26.06/T$

$SUR = 26\rho/\ell^* + (\beta - \rho)T$

$T = (\ell^*/\rho) + [(\beta - \rho)/\bar{\lambda}\rho]$

$T = \ell/(\rho - \beta)$

$T = (\beta - \rho)/(\bar{\lambda}\rho)$

$\rho = (K_{eff} - 1)/K_{eff} = \Delta K_{eff}/K_{eff}$

$\rho = [(\ell^*/(T K_{eff})] + [\bar{\beta}_{eff}/(1 + \bar{\lambda}T)]$

$P = (\Sigma\phi V)/(3 \times 10^{10})$

$\Sigma = \sigma N$

$v = s/t$

$s = V_o t + 1/2\ at^2$

$a = (V_f - V_o)/t$

$w = \theta/t$

$A = \frac{\pi D^2}{4}$

$\dot{m} = V_{av} A \rho$

Cycle efficiency = (Net work out)/(Energy in)

$A = \lambda N \qquad A = A_o e^{-\lambda t}$

$\lambda = \ln 2/t_{1/2} = 0.693/t_{1/2}$

$t_{1/2}^{eff} = \frac{[(t_{1/2})(t_b)]}{[(t_{1/2}) + (t_b)]}$

$I = I_o e^{-\Sigma x}$

$I = I_o e^{-\mu x}$

$I = I_o\ 10^{-x/TVL}$

$TVL = 1.3/\mu$

$HVL = -0.693/\mu$

$SCR = S/(1 - K_{eff})$

$CR_x = S/(1 - K_{effx})$

$CR_1(1 - K_{eff1}) = CR_2(1 - K_{eff2})$

$M = 1/(1 - K_{eff}) = CR_1/CR_o$

$M = (1 - K_{effo})/(1 - K_{eff1})$

$SDM = (1 - K_{eff})/K_{eff}$

$\ell^* = 10^{-4}$ seconds

$\bar{\lambda} = 0.1$ seconds^{-1}

$I_1 d_1 = I_2 d_2$

$I_1 d_1^{\ 2} = I_2 d_2^{\ 2}$

$R/hr = (0.5\ CE)/d^2 (meters)$

$R/hr = 6\ CE/d^2$ (feet)

Water Parameters

1 gal. = 8.345 lbm.
1 gal. = 3.78 liters
1 ft^3 = 7.48 gal.
Density = 62.4 lbm/ft^3
Density = 1 gm/cm^3
Heat of vaporization = 970 Btu/lbm
Heat of fusion = 144 Btu/lbm
1 Atm = 14.7 psi = 29.9 in. Hg.
1 ft. H_2O = 0.4335 lbf/in.

Miscellaneous Conversions

1 curie = 3.7×10^{10} dps
1 kg = 2.21 lbm
1 hp = 2.54×10^3 Btu/hr
1 mw = 3.41×10^6 Btu/hr
1 in = 2.54 cm
°F = 9/5°C + 32
°C = 5/9 (°F-32)
1 BTU = 778 ft-lbf

QUESTION 1.01 (2.00)

Indicate whether EACH of the following parameters would INCREASE, DECREASE or remain UNCHANGED for the conditions listed in a. through h. on the table below: (Consider each condition separately.)

Condition	Local CHF	DNBR
RCS Average Temperature Decreases	a	b
RCS Pressure Decreases	c	d
RCS Flow Decreases	e	f
Reactor Power Level Decreases	g	h

QUESTION 1.02 (1.00)

During a reactor startup, WHAT are TWO reasons that 10E-8 amps is the power level at which critical data is taken?

QUESTION 1.03 (2.00)

The thermal rated power of the reactor is 3411 Mw. Assume C-p is 1.3 BTU/lbm-F.

a. WHAT flow rate (lbm/hr) is required to keep the temperature rise across the reactor vessel less than 60 degrees F? (Show all work) (.75)

b. Using the flow rate in part a., WHAT is the enthalpy rise (BTU/lbm) across the reactor? (Show all work) (.75)

c. HOW does a decrease in mass flow rate affect the enthalpy rise? (0.5)

(***** CATEGORY 01 CONTINUED ON NEXT PAGE *****)

QUESTION 1.04 (1.50)

The plant is operating at 50% power with control rods in manual. IF power range channel N-44 LOWER detector fails HIGH, how would it affect the following indications? (Limit your answer to INCREASE, DECREASE, MORE NEGATIVE, LESS NEGATIVE, or NO CHANGE.)

a. Lower Quadrant Power Tilt Ratio

b. Delta Flux indication (Channel 4)

c. OP delta T setpoint (Channel 4)

QUESTION 1.05 (1.50)

Indicate whether EACH of the following situations result in SUBCOOLED, SATURATED, or SUPERHEATED fluid conditions. (Assume RCS Tave at 588 degrees F and RCS pressure at 2235 psig, and reactor power at 100%.)

a. Pressurizer PORV relieving to the PRT

b. S/G Safety Valve relieving to the atmosphere.

c. Steam from a Moisture Separator Reheater entering a low pressure turbine.

d. Condensate exiting the condenser hotwell.

QUESTION 1.06 (1.50)

Indicate whether EACH of the following will cause shutdown margin to INCREASE, DECREASE, or REMAIN THE SAME. (Consider each independently.)

1. Control rods withdrawn 10 steps with no change in turbine power or boron concentration.

2. Turbine power decreased 10 percent with no change in boron concentration or rod position.

3. Normal power increase from 50 to 60 percent with no change in boron concentration and rods in automatic.

4. Boron concentration is increased 10 ppm with rods in automatic.

(***** CATEGORY 01 CONTINUED ON NEXT PAGE *****)

QUESTION 1.07 (1.50)

How will EACH of the following affect a calorimetric power calculation? Limit your answer to CALCULATED LOWER THAN ACTUAL, CALCULATED HIGHER THAN ACTUAL, or CALCULATED SAME AS ACTUAL. (Consider each case separately.)

a. Measured feedwater temperature is 10 degrees higher than actual feedwater temperature.

b. Measured steam generator pressure is 30 psig lower than actual steam generator pressure.

c. Measured feedwater flow is 1E5 lbm/hr higher than actual feedwater flow.

QUESTION 1.08 (1.00)

Which ONE of the following statements concerning TOTAL POWER DEFECT is correct?

a. The Total Power Defect is the difference between the measured power coefficient and the predicted power coefficient.

b. The Total Power Defect increases the rod worth requirements necessary to maintain the desired shutdown margin following a reactor trip.

c. The Total Power Defect is more negative at beginning of core life because of the higher boron concentration.

d. The Total Power Defect necessitates the use of a ramped Tavg program to maintain an adequate reactor coolant system subcooling margin.

QUESTION 1.09 (1.50)

Assuming a Xenon-free reactor startup, while critical with power leveled off at 10-8 amps for critical data, Tave = 546 degrees F and RCS pressure 2235 psig, rod D-4 (control bank D) drops to the bottom. Describe reactor power, RCS temperature, and RCS pressure transients caused by the dropped rod. (End discussion at stable plant conditions.)

(***** CATEGORY 01 CONTINUED ON NEXT PAGE *****)

QUESTION 1.10 (2.00)

After operation at 100% power for several weeks near the end of cycle, it is decided to reduce power to 75% using rods only.

a. After reaching 75% power, what rod motion would be required to maintain the plant at 75% power, with Tavg and Tref matched, over the next 40 hours assuming no change in boron concentrations? Include any applicable time periods. (0.5)

b. Explain how the Xenon production and removal mechanisms cause a reactivity transient after a power reduction from 75% to 50% power. Include time periods for the various reactivity effects up to equilibrium. (1.5)

QUESTION 1.11 (1.50)

Would the Axial Flux Difference become MORE NEGATIVE or LESS NEGATIVE for the following conditions? (STATE THE REASONING FOR YOUR CHOICE) (0.5 each)

a. OT Delta-T runback from 100% to 50% power with rods in automatic.

b. Feed flow increases to the steam generators with rods in manual.

c. Xenon is building into the bottom of the core more than in the top of the core.

QUESTION 1.12 (1.00)

When performing a reactor S/U to full power that commenced five hours after a trip from full power equilibrium conditions, a 0.5% per min ramp was used. How would the resulting xenon transient vary if instead a 2% per min ramp was used? (Choose one)

a. The xenon dip for the 2% per min ramp would occur sooner and the magnitude of the dip would be smaller.

b. The xenon dip for the 2% per min ramp would occur later and the magnitude of the dip would be smaller.

c. The xenon dip for the 2% per min ramp would occur sooner and the magnitude of the dip would be larger.

d. The xenon dip for the 2% per min ramp would occur later and the magnitude of the dip would be larger.

(***** CATEGORY 01 CONTINUED ON NEXT PAGE *****)

QUESTION 1.13 (1.50)

A cooling water pump is operating at 1500 rpm. Its capacity is 250 gpm at a discharge pressure of 15 psig which requires 40 KW of power. Determine the pump capacity, speed, and power requirement if the pump discharge pressure drops to 10.0 psig due to reduced speed.

QUESTION 1.14 (1.00)

What effect will EACH of the following have on a 1/M plot? Limit your answer to UNDER-PREDICT criticality (conservative), OVER-PREDICT criticality (non-conservative), or NO CHANGE. (Assume you go critical in source range. Consider each case separately.)

a. Time interval between rod pulls on a startup is changed from 1 minute to 10 seconds.

b. Intermediate range nuclear instruments are over-compensated.

c. Source strength immediately prior to the startup is changed from 4 cps to 10 cps.

QUESTION 1.15 (2.50)

The plant is operating at 33% power when the 1B S/G Main Steam Isolation Valve fails shut. Using the below initial conditions, calculate the new steady state values for the listed parameters.

Assume no operator action, rod control system in manual, all other control systems in automatic, no reactor trip and no SI actuation. State all assumptions and show all work.

Initial Conditions: Tavg = 554 F
Tstm = 539 F
Core Delta T = 18 F

a. Turbine power
b. Tavg (loop 1B)
c. Tavg (loop 1D)
d. S/G pressure (loop 1B)
e. S/G pressure (loop 1D)

(***** CATEGORY 01 CONTINUED ON NEXT PAGE *****)

QUESTION 1.16 (2.00)

A questionable ECC calculation shows that criticality should be achieved when 3000 pcm has been added to the core. A boron dilution of 150 ppm (1500 pcm) is planned, followed by control rod withdrawal to criticality. The initial count rate is 50 cps.

a. WHAT is the expected count rate after the 150 ppm boron dilution? (0.75)

b. Following the first 75 ppm dilution, the source ranges indicate 80 cps. WHAT amount of reactivity in pcm should the original ECCS calculation have derived as sufficient to reach criticality? (Show all work) (1.25)

(***** END OF CATEGORY 01 *****)

QUESTION 2.01 (1.50)

Answer the following questions concerning the 120 Volt Instrument Bus:

a. WHAT design feature allows the Instrument Bus to automatically remain energized if the 480 volt ESF Bus Power supply to the Inverter is lost? (Include a brief explanation of how this design feature functions.) (1.0)

b. WHAT is the BACKUP source of power to the Instrument Bus if the Inverter is out of service? (0.5)

QUESTION 2.02 (1.00)

When the Pressurizer PORV's are in the ARM Low Temp mode, what signals are used as inputs to the PORV's to provide for overpressure protection? (1.0)

QUESTION 2.03 (1.50)

Piping connections between the RCS and Auxiliary Systems are normally made above the horizontal centerline of the RCS. An exception to this is the RHR pump suction connection with the RCS. WHERE (in relation to the RCS piping horizontal centerline) is the RHR pump suction connection, and WHY is it designed this way?

QUESTION 2.04 (2.00)

If EMERGENCY BORATION of the RCS is required, the preferred source and flowpath is from the Boric Acid Storage Tank through the Boric Acid Transfer Pump and the Emergency Boration Valve (8104). If the Boric Acid Transfer Pumps are not available, WHAT source and flowpath would be utilized to Emergency Borate the RCS? (Include in your answer, what the flow rate would be, and the reason for the flowrate.)

(***** CATEGORY 02 CONTINUED ON NEXT PAGE *****)

QUESTION 2.05 (1.50)

Answer the following questions concerning the 250 VDC Power System:

a. WHAT are FOUR conditions that will cause the "250 VDC BATT CHGR 123 TROUBLE" annunciator to alarm? (Annunciator test is not considered a valid condition.) (1.0)

b. WHAT is the 1/2 hour minimum time requirement that the 250 VDC battery must supply power to the Turbine #1 D.C. Emergency Bearing Oil Pump based on? (0.5)

QUESTION 2.06 (1.00)

WHAT are TWO reasons WHY you are limited to approximately 1 hour time limit when using the Reactor Makeup System in the ALTERNATE DILUTE mode?

QUESTION 2.07 (2.00)

State how EACH of the following valves will fail if Instrument Air is lost. (Limit your answer to OPEN, CLOSED, or THROTTLED)

1. TCV 381B (Boron Thermal Regeneration System Temperature Control Valve)

2. CV-8389A (Letdown Inlet to A Regenerative Heat Exchanger)

3. PVC-131 (Letdown Pressure Control Valve)

4. FCV-121 (Centrifugal Charging Flow Control Valve)

QUESTION 2.08 (2.50)

Answer the following questions concerning the Residual Heat Removal System:

a. WHAT INTERLOCK conditions must be satisfied in order to OPEN 8804B (Charging pump suction crossover isolation valve from RHR)? (1.5)

b. WHAT are the reasons for the interlocks in part a? (1.0)

(***** CATEGORY 02 CONTINUED ON NEXT PAGE *****)

QUESTION 2.09 (2.00)

Answer the following questions concerning the Component Cooling Water System:

a. WHAT are TWO signals/conditions that will AUTOMATICALLY start the standby CCW pump? (Assume CCW pump 1A is running and CCW pump 1B is in standby with power available.) (1.0)

b. CCW pump "0" is being powered from 4.16 KV ESF Bus 141, and in STANDBY, CCW Pump 1A is RUNNING, and CCW pump 1B is in PULL-TO-LOCK.

If CCW Pump 1A's shaft locks up, (tripping the motor breaker) will CCW pump "0" automatically start? (Explain WHY or WHY NOT)

QUESTION 2.10 (2.00)

Answer the following questions concerning the Emergency Diesel Generator:

a. WHAT is the 500 gallon capacity of the Diesel Oil Day Tank based on? (.75)

b. WHAT is the function of the Emergency Mode Speed/Voltage Control Switch on the MCB, when it is in the MANUAL EMERGENCY MODE position? (1.25)

QUESTION 2.11 (2.50)

Answer the following questions concerning the Auxiliary Feedwater System:

a. If 1B AFW pump is running during a loss of all AC power, WHAT indication do you have in the Control Room, if any, of how much AFW flow you have to S/G's. (Assume AFW flow meters to the S/G's are inoperable. Include any applicable setpoints.) (1.0)

b. HOW will the AFW Pump 1B starting circuit respond if AFW Pump 1B received an AUTOMATIC start signal and the engine does not reach 350 rpm within the 5 seconds crank time? (Include any applicable setpoints. Assume engine will not start.) (1.5)

(***** CATEGORY 02 CONTINUED ON NEXT PAGE *****)

QUESTION 2.12 (1.75)

WHAT are SEVEN RCP system parameters and/or indications that can be monitored on the Main Control Board? (Do not include annunciators. Redundant instrumentation will be credited as a single response.)

QUESTION 2.13 (.75)

WHAT are THREE conditions/signals that will generate a Containment Ventilation Isolation Signal? (Coincidence and setpoints not required)

QUESTION 2.14 (2.00)

WHAT are TWO safety related reasons for the generator trip time delay on a turbine trip? (Give explanation of each)

QUESTION 2.15 (1.00)

If a STATION BLACKOUT occurs, WHAT are FIVE loads that would be started by the Engineered Safety Features SAFE SHUTDOWN sequencer, once the Emergency D/G's output breaker is closed? (Assume no Safety Injection Signal present. Redundant equipment will be credited as a single response.)

(***** END OF CATEGORY 02 *****)

QUESTION 3.01 (1.00)

Which ONE of the following provides a signal to the Rod Insertion Limit computers?

a. Slave Cyclers
b. Bank Overlap Unit
c. P-A Converter
d. Master Cycler

QUESTION 3.02 (1.50)

Will the indicated PRZR level INCREASE, DECREASE, or REMAIN THE SAME for the following conditions? Give a brief explanation for each answer. (Consider each case separately)

a. Steam break inside containment
b. Bellows rupture
c. Reference leg leak/break

QUESTION 3.03 (1.50)

Braidwood Unit 2 has been operating at 92% power for sixty-three days when the Load Dispatcher requests a reduction in power to 70%. After starting the power reduction, a Tave/Tref mismatch is generated that demands rod movement (Rod Control is in Automatic). Describe what happens to Rod H8 (Control Bank D) if the moveable gripper coil CANNOT be energized in the rod movement sequence. Include any final results.

QUESTION 3.04 (1.50)

Prior to a plant startup, the START-UP RESET SWITCH is operated. What SIX resets are accomplished by this switch?

QUESTION 3.05 (1.50)

What TWO CONTROL Systems receive an input signal from Auctioneered nuclear power? (Describe how and why these inputs are used)

(***** CATEGORY 03 CONTINUED ON NEXT PAGE *****)

QUESTION 3.06 (1.50)

If PT-507 (Main Steam Header) fails LOW, HOW and WHY would this effect Main Feed Pump speed? (Assume plant at 100% power)

QUESTION 3.07 (1.50)

Braidwood Unit 1 is at 96% power at steady-state when the reactor trips. Concurrently, Thot fails high for loop 3. Describe how the Steam Dump System will operate under these conditions assuming all other equipment functions normally with no operator action concerning the failed Thot instrument.

QUESTION 3.08 (2.00)

Braidwood Unit 1 is at 86% power at steady-state when PRZR Pressure Channel 455 (controlling) fails HIGH. Assuming no operator action, describe the sequence of events that follow.

QUESTION 3.09 (1.50)

a. How is the P-4 (Reactor Trip) permissive generated? (0.5)

b. What FOUR functions are provided by P-4? (1.0)

QUESTION 3.10 (1.50)

The plant is operating at 100% steady state power with containment pressure channel IV (PB 934A) failed high. A technician troubleshooting the trip bistables inadvertently de-energizes the instrument power for containment pressure channel II. Will a Containment Spray Actuation occur? Explain why or why not.

(***** CATEGORY 03 CONTINUED ON NEXT PAGE *****)

QUESTION 3.11 (1.50)

Answer the following questions concerning the Subcooling Margin Monitor with respect to the following given plant conditions: RCS pressure is 1200 psig, RCS Tavg 350 degrees F, and the plant is currently being cooled down for a refueling outage.

a. List THREE inputs to the Subcooling Margin Monitor. (0.75)

b. What THREE displays are available on the Subcooling Margin Monitor primary display? (0.75)

QUESTION 3.12 (1.50)

The plant is operating at full power when a General Warning occurs on one train of the Solid State Protection System (SSPS).

a. List FOUR possible causes of the General Warning on SSPS. (1.0)

b. How is plant operation affected if a General Warning occurs on the other train of SSPS? (0.5)

QUESTION 3.13 (1.00)

Answer the following questions TRUE or FALSE concerning the Remote Shutdown Panel (RSP).

a. To operate a pump from its switchgear, the LOCAL/REMOTE switch must be in REMOTE.

b. If a pump on the RSP is in Pull-to-Lock on the MCB, then it may NOT be operated from the RSP even if the LOCAL/REMOTE switch is in LOCAL.

QUESTION 3.14 (2.00)

a. List FOUR conditions that actuate a STEAMLINE ISOLATION. Include setpoints and coincidences where applicable. (1.0)

b. What does steamline isolation prevent? (1.0)

(***** CATEGORY 03 CONTINUED ON NEXT PAGE *****)

QUESTION 3.15 (1.75)

Answer the following concerning radiation monitors.

a. What THREE monitors are used to indicate a S/G tube rupture? (0.75)

b. During refueling operations, the Fuel Handling Building Crane area monitor (ORE-AR039) alarms. What automatic action occurs? (0.5)

c. Welding causes the Component Cooling Heat Exchanger 0 Water Outlet Monitor (ORE-PR009) to alarm. How is the CCW system affected? (0.5)

QUESTION 3.16 (2.25)

a. List FOUR conditions that will automatically start a motor driven Auxiliary Feedwater pump (AFW). (1.0) (Include coincidences, where applicable)

b. To manually start a motor driven AFW pump, what one other condition must be present? (0.25)

c. What FOUR conditions will trip the motor driven AFW pump? (1.0)

(***** END OF CATEGORY 03 *****)

QUESTION 4.01 (3.00)

Indicate whether or not EACH of the following parameters/situations while in Mode 1 will require corrective action as dictated by TECHNICAL SPECIFICATIONS. (Consider each case independently. Assume all other operability requirements are met. Limit answer to YES or NO.)

a. RCS Accumulator C level of 58%

b. RCS to B S/G tube leakage at 0.5 gpm

c. Condensate Storage Tank Level of 35%

d. Containment internal pressure of 0.5 psig

e. PT 506 (HP Turbine First stage impulse pressure) failed HIGH

f. Boric Acid Storage Tank level of 44%

QUESTION 4.02 (1.00)

Answer each of the following questions concerning BwAP 330-1, "Station Equipment Out-of-Service Procedure":

1. When hanging OOS cards for the 1B CCW pump, indicate the order (1-4) in which the cards would be hung on the following components: (0.5)

   a. 1B CCW Pump Supply Breaker on Bus 142

   b. 1CC 9460B (1B CCW Pump Manual Discharge Isolation Valve)

   c. 1B CCW Pump Control Switch on the MCB

   d. 1CC6B (1B CCW Pump Manual Suction Isolation Valve)

2. TRUE or FALSE

   Placement of CAUTION CARDS requires the permission of the Shift Engineer (or designee). (0.5)

(***** CATEGORY 04 CONTINUED ON NEXT PAGE *****)

QUESTION 4.03 (1.00)

In accordance with BwAP 900-3, "Escort Duties," the NOMINAL number of visitors an Escort can have at a single time is: (Choose the ONE correct answer)

a. 3 in a Vital Area and 5 in other areas

b. 5 in a Vital Area and 5 in other areas

c. 3 in a Vital Area and 10 in other areas

d. 5 in a Vital Area and 10 in other areas

QUESTION 4.04 (1.00)

BwAP 300-1, "Conduct of Operations", allows an Operator to place a controller in the MANUAL mode from the AUTOMATIC mode whenever, in the Operators judgement, continued automatic operation is unsafe or whenever it may cause unnecessary transients. This SHOULD only be done under WHAT TWO conditions/situations?

QUESTION 4.05 (1.50)

a. In accordance with BwRP 1000-A1, "Radiation Protection Standards", describe the differences between a Type 1 RWP and a Type 2 RWP concerning the following items: (1.0)

1. Dose Rate

2. Length of time that the RWP is valid

b. TRUE or FALSE
A worker may be allowed to enter an airborne radioactivity area under a Type 1 RWP. (0.5)

QUESTION 4.06 (1.00)

A CAUTION in BwOA RCP-2, "Loss of Seal Injection," states that if seal injection flow is lost with RCS temperatures greater than 150 degrees F, CC flow to the RCP Thermal Barriers must be maintained. WHAT is the reason for this? (Briefly Explain)

(***** CATEGORY 04 CONTINUED ON NEXT PAGE *****)

QUESTION 4.07 (2.50)

BwFR-S.1, "Response to Nuclear Power Generation/ATWS," immediate action Step 2, has you verify that the tubine has tripped. WHAT actions should be carried out by the operator if the turbine has NOT tripped? (Include all contingency substeps contained in the response not obtained column in your answer.)

QUESTION 4.08 (2.25)

A precaution in BwOP RC-1, "Startup of a Reactor Coolant Pump," states that RCP #1 seal bypass should not be opened unless certain conditions are met. One of the conditions is that RCS pressure must be greater than 100 psig but less than 1000 psig.

a. WHAT are the bases for these 2 pressure limits for opening the #1 seal bypass valve? (1.25)

b. WHAT is the reason for opening the #1 seal bypass valve? (1.0)

QUESTION 4.09 (1.50)

In accordance with BwOA PRI-2, "Emergency Boration," WHAT are SIX conditions that would require you to EMERGENCY BORATE?

QUESTION 4.10 (1.50)

In BwOA Rod-4, "Dropped Rod Recovery," the procedure has you maintain power less than the MAXIMUM FUEL PRECONDITIONED LIMIT. WHAT is this limit defined as? (Assume that this is NOT the initial power ascension following a refueling outage.)

QUESTION 4.11 (1.50)

In accordance with BwRP 1110-1, "Radiation and Contamination Limits," WHAT are the Emergency Dose Limits you are allowed to receive if you need to enter an area to prevent conditions that would injure other people?

(***** CATEGORY 04 CONTINUED ON NEXT PAGE *****)

QUESTION 4.12 (2.00)

Immediate Action Step 4 of BwCA-0.0, "Loss of All AC Power," has you verify that the RCS is isolated. WHAT are FOUR indications/components that you have to verify to complete this step? (Include in your answer the required condition/position of each component/indication.)

QUESTION 4.13 (1.00)

There is a NOTE in BwAP 1450-1, "Access To Containment", that states for Modes 1,2,3, or 4, the MAXIMUM number of personnel that are allowed to enter containment is 30. WHAT is the reason for this restriction? (Briefly explain)

QUESTION 4.14 (2.00)

Answer the following questions concerning BwOA ELEC-3, "Local Emergency Start of a Diesel Generator":

a. Step 2.C of this procedure has you place isolation switches 43IS-1, 43IS-2, 43IS-3, and 43IS-4 on the D/G Control Panel in the ISOL position. WHAT is the reason for placing these switches in the ISOL position? (Include the plant event when this would be done.) (1.25)

b. The CAUTION just before step 2.c tells you to place DG Isolation Switch 43IS-4 in the ISOL position ONLY AFTER the other 3 switches have been placed in the ISOL position. WHAT is the reason for following that order when placing the switches in the ISOL position? (0.75)

QUESTION 4.15 (2.25)

BwFR-C.1, "Response to Inadequate Core Cooling," Step 9, has you depressurize all intact S/G's to 160 psig.

a. WHAT is the reason for depressurizing all intact S/G's? (1.0)

b. WHAT is the bases for stopping the S/G depressurization at 160 psig? (Explain) (1.25)

(***** END OF CATEGORY 04 *****)

(********** END OF EXAMINATION **********)

ANSWERS -- BRAIDWOOD 1&2 -87/12/14-LENNARTZ, J.

ANSWER 1.01 (2.00)

(0.25 pts each)

a.	Increases	b.	Increases
c.	Decreases	d.	Decreases
e.	Decreases	f.	Decreases
g.	Unchanged	h.	Increases

REFERENCE
Heat Transfer, Chapter 9, Figure HT-9-12
Terminal Performance Objective #8
193008K105 ...(KA'S)

ANSWER 1.02 (1.00)

1. Source neutrons are negligible.

2. It is below the POAH (or, Doppler and MTC effects are not present).

(0.5 pts each)

REFERENCE
Reactor Theory, Chapter 9, pg. 14
Terminal Performance Objective #4
192008K112 ...(KA'S)

ANSWERS -- BRAIDWOOD 1&2 -87/12/14-LENNARTZ, J.

ANSWER 1.03 (2.00)

a. Q-dot = (M-dot) (C-p) (delta-T)

M-dot = Q-Dot/(C-p)(Delta-T) (0.25)

= 3411x10E3 KW/(1.3 BTU/lbm-F) (60 F) X 3413 BTU/hr/kw

= (1.49)(10E8 lbm/hr) (0.5)

b. (Note: Grader must use M-dot from a. that candidate calculates. Answer in b. can be correct for data.)

Q-dot = (m-dot)(delta-h)

Delta-h = Q-dot/m-dot (0.25)

= 3411 x 10E3 KW/1.49 x 10E8 lbm/hr x 3413 BTU/hr/kw

= 78 BTU/lbm (0.5)

c. A decreasing mass flow rate increases the enthalpy rise. (0.5)

REFERENCE
Thermodynamics, Chapter 3, pg. 153
193007K108 ...(KA'S)

ANSWER 1.04 (1.50)

a. Increase
b. More Negative (Decrease)
c. No Change
(0.5 pts each)

REFERENCE
Braidwood Reactor Theory, Chapter 8, Objectives #7, 11, and pgs. 17-22
015000A105 015000A202 015000K501 ...(KA'S)

ANSWERS -- BRAIDWOOD 1&2 -87/12/14-LENNARTZ, J.

ANSWER 1.05 (1.50)

a. Saturated
b. Superheated
c. Superheated
d. Subcooled

(0.375 pts each)

REFERENCE
Braidwood Thermodynamics, Chapter 3, Objective #9 and pgs. 101-107
Steam Tables
193004K115 ...(KA'S)

ANSWER 1.06 (1.50)

1. Remain the Same
2. Remain the Same
3. Remain the Same
4. Increase

(0.375 pts each)

REFERENCE
Braidwood Reactor Theory Chap.7 pp. 7-13
192002K114 ...(KA'S)

ANSWER 1.07 (1.50)

a. Calculated lower than actual
b. Calculated higher than actual
c. Calculated higher than actual

(0.5 pts each)

REFERENCE
Braidwood Thermodynamics Chap. 4 pp. 64-91
BwOS 3.1.1-2
002000K509 015000A101 015000K504 ...(KA'S)

ANSWERS -- BRAIDWOOD 1&2 -87/12/14-LENNARTZ, J.

ANSWER 1.08 (1.00)

b. (1.0)

REFERENCE
Braidwood Reactor Theory Chap. 3 pp. 24-32
192004K113 ...(KA'S)

ANSWER 1.09 (1.50)

RCS temperature and RCS pressure unaffected by the dropped rod. (.25 each)

Reactor power will have initial prompt drop [.25], then will decrease [0.5], and level out at a lower power level in the source range (as supported by subcritical multiplication [.25].

REFERENCE
Braidwood Reactor Theory Chap. 9 pp. 13-15
Braidwood Reactor Nuclear Theory Chap. 8 pp. 13-19
Braidwood Nuclear Reactor Theory Chap. 7 pp. 53-57
000003K103 192005K103 192008K114 ...(KA'S)

ANSWER 1.10 (2.00)

a. Rods will need to be withdrawn for about 4-7 hours [.25] and then inserted for the next 35 hours [.25].

b. After the power decrease, the production of xenon from fission [0.25] and from the decay of iodine [0.25] is greater than the removal by decay of xenon [0.25] and burnout by flux [0.25]. After 4-7 hours, the removal rate is greater than the production [0.25] and positive reactivity is being added until equilibrium at about 40 hours [0.25].

REFERENCE
Braidwood Reactor Theory, Chapter 4, Objective #1, and pgs. 14-29
001000K533 ...(KA'S)

ANSWERS -- BRAIDWOOD 1&2 -87/12/14-LENNARTZ, J.

ANSWER 1.11 (1.50)

a. MORE NEGATIVE [0.25] because rods are inserted and push the flux to the bottom of the core [0.25].

b. LESS NEGATIVE [0.25] because more moderation will occur in the top of the core since there is a greater change in density with a change in temperature at higher temperatures (top of core). [0.25].

c. LESS NEGATIVE [0.25] because Xe inserts MORE negative reactivity in the bottom of the core than in the top of the core [0.25].

REFERENCE
Braidwood Reactor Theory, Chapter 8, Objectives #3, 4, and pgs. 13-24
001000K506 001000K538 ...(KA'S)

ANSWER 1.12 (1.00)

a. (1.0)

REFERENCE
Braidwood Reactor Theory, Chapter 4, Objective #1 and pgs. 14-29
Westinghouse Simulator Training Book, "Rx Theory and Core Physics," Figure I-5-54
001000K538 ...(KA'S)

ANSWER 1.13 (1.50)

N1 = 1500 rpm V1 = 250 gpm Hp1 = 15 psig P1 = 40KW
N2 = 1500 sqr. root (10/15) = 1224.7 rpm (1225 acceptable) (0.5)

V2 = (1224.7/1500)(250 rpm) = 204.1 gpm (204 acceptable) (0.5)

$P2 = (1224.7/1500)^3 (40\ KW) = 21.7\ KW$ (22 acceptable) (0.5)

REFERENCE
Braidwood Fluid flow, Chapter 2, Objective #4 and pgs. 26-33
191004K105 ...(KA'S)

ANSWERS -- BRAIDWOOD 1&2 -87/12/14-LENNARTZ, J.

ANSWER 1.14 (1.00)

a. Over-predict (non-conservative)
b. No Change
c. No Change

(0.33 pts each, 1.0 all three)

REFERENCE
Braidwood Nuclear Reactor Theory Chap. 8 pp. 20-30
C15000A202 015000K506 192008K104 ...(KA'S)

ANSWER 1.15 (2.50)

a. Turbine power - stays constant at 33% power (due to EHC being in auto). (0.5)

b. Tavg (loop 1B)
due to no heat sink, goes to Th = 554 F + 18/2 = 563 F (0.5)

c. Tavg (loop 1D)
total reactor power has not changed; however, the power that 1D S/G must produce has increased by a factor of 1/3 to compensate for 1B loop

QRX = m Cp (Th - Tc)
initial Delta T was 18 F, increase by 1/3 ==> final Delta T = 24 F
final Tavg = Th - Delta T/2 = 563 - 24/2 = 551 F (0.5)

d. S/G Pressure (loop 1B)
saturation pressure for 563 F - 1161 psia [or 1146 psig] (0.5)
[also acceptable if assume that safeties wil be lifting starting at 1065 psig]

e. S/G Pressure (loop 1D)
as with part c. above, the appropriate Delta T will increase by 1/3
QSG = U A (Tavg - Tstm)
initial Delta T = Tavg - Tstm = 554 - 539 = 15 F
final Pstm ==> saturation for 531 F = 893 psia [or 878 psig] (0.5)

REFERENCE
Braidwood Thermodynamics, Chapter 3, Objective #6, and pgs. 66-76
002000K511 039000K104 039000K305 ...(KA'S)

ANSWERS -- BRAIDWOOD 1&2 -87/12/14-LENNARTZ, J.

ANSWER 1.16 (2.00)

a. (Since the amount of reactivity inserted is one-half of the total amount needed to reach criticality,) the count rate should double, or about 100 cps. (.75)

OR

For rho = K-1 (valid approximation)

$$CR1/CR0 = (1-K0)/1-K1)$$
$$= (1-(rho0 + 1)/(rho1 + 1))$$
$$= rho/rho1$$
$$= 2$$
$$CR1 = 2*CR0 = 100 \text{ cps (actual is 98.54 cps)} \quad (.75)$$

b. For rho = K-1

$$CR1/CR0 = rho0/rho1$$
OR
$$rho0 = rho1*CR1/CR0 \quad (.25)$$

Since the change in reactivity was 750 pcm (one-half of the total dilution): (.25)

$$rho0 = (rho0 + 750 \text{ pcm})*CR1/CR0$$
$$= (rho0 + 0.0075)*80/50$$
$$= 1.6\ rho0 + 0.012$$

$$-0.6\ rho0 = 0.012$$
$$rho0 = -0.02$$
$$= -2000 \text{ pcm}$$

Therefore, the original ECC should have determined that criticality would be achieved if 2000 pcm was added to the core. (.75)

REFERENCE
Braidwood Rx Theory, Chapter 5, Objective #7 and pg. 3
Braidwood Rx Physics, Chapter 5, Objective #13, and pgs. 21-24
Chapter 7, Objective #4, and pgs. 37-45
Westinghouse Fundamentals of Nuclear Rx Physics, pgs. 5-22 to 5-29, 8-39 to 8-41
001010A207 004000K520 192008K103 ...(KA'S)

ANSWERS -- BRAIDWOOD 1&2 -87/12/14-LENNARTZ, J.

ANSWER 2.01 (1.50)

a. The Inverter is supplied with power from the 125 VDC Bus also, through a blocking diode [0.5]. If the AC power supply fails or drops below a certain value, then the 125 VDC Bus will take over automatically [0.5]. (1.0)

b. Self Regulating Transformer (480/120 volt). (0.5)

REFERENCE
Braidwood AC Electrical Power System, pgs. 49, 50
Terminal Performance Objective #14
062000K410 ...(KA'S)

ANSWER 2.02 (1.00)

1. Wide Range RCS Pressure

2. Function Generator (inputs from W.R. Hot Leg and W.R. Cold Leg temperature)

(0.5 pts each)

REFERENCE
Braidwood Pressurizer Pressure and Level Control, pg. 14
002000K410 010000K403 ...(KA'S)

ANSWER 2.03 (1.50)

45 degrees down from horizontal centerline [0.5], which enables water to be lowered in the RCS piping if required for maintenance [0.5] and continue to operate the RHR loop [0.5].

REFERENCE
Braidwood Reactor Coolant System, pg. 12
005000K109 ...(KA'S)

ANSWER 2.04 (2.00)

Use the RWST through CV-112 D/E and a Centrifugal Charging Pump [0.5] with at least 105 gpm charging flow [0.5].

Charging flow of 105 gpm with 2000 ppm boron (as contained in the RWST) [0.5], is equivalent to adding 7000 ppm boron as required by Technical Specifications [0.5].

REFERENCE
Braidwood Reactor Makeup Control, pg. 27, and Terminal Performance Objective #10
004000G010 004010A207 004010K609 ...(KA'S)

ANSWER 2.05 (1.50)

a. 1. Low DC Output Voltage (Charger Output Voltage Low)
2. High DC Output Voltage
3. Low Output Amps
4. Low AC Input Voltage (AC Input Breaker Trip)
5. High AC Input Amps
6. AC Power Failure
7. Charger Feeder Breaker Trip
8. Blown Fuses

(Any 4 @ .25 pts each)

b. The minimum time period is based on Main Turbine Coast-Down time. (0.5)

REFERENCE
Braidwood 250 VDC Pwr Distribution, pgs. 5, 13
BWAR 1-20-C1D
000055K301 063000G008 ...(KA'S)

ANSWER 2.06 (1.00)

Since some of the water is not directed to the inlet of the VCT:

1. The water is not degassed. (0.5)

2. The water is not exposed to hydrogen. (0.5)

ANSWERS -- BRAIDWOOD 1&2 -87/12/14-LENNARTZ, J.

REFERENCE
Braidwood Reactor Makeup Control, pg. 26
Terminal Performance Objective #7.d
004000G010 004000K106 004000K40 ...(KA'S)

ANSWER 2.07 (2.00)

1. Open
2. Closed
3. Open
4. Open

(0.5 pts each)

REFERENCE
Braidwood Chemical and Volume Control, pgs. 13, 17, 19, 36
004010A204 ...(KA'S)

ANSWER 2.08 (2.50)

a. 1. SI pump miniflow line valves (8814 and 8920) closed or SI pump common header miniflow valve (8813) closed.

2. RHR outlet isolation valve (8702A) or RHR inner isolation valve (8702B) closed.

3. Recirculation Sump Isolation Valve (8811B) open.

(0.5 pts each)

b. 1. Prevents overpressurization of the SI pumps.

2. Prevents radioactive recirculation water from being pumped to RWST.

(0.5 each)

REFERENCE
Braidwood Residual Heat Removal System, pg. 24
Terminal Performance Objective #6.e.
005000K407 ...(KA'S)

Also Acceptable

a For 8804 A

1. SI pump miniflow line valves (8814 and 8924) closed or SI pump common header miniflow valve (8813) closed
2. RHR outlet isolation valve (8701A) or RHR inner isolation valve (8701B) closed.
3. Recirculation Sump Isolation Valve (8811A) is open.

b For 8804 A

1. prevents overpressurization of CV pumps
2. prevents radioactive recirculation water from being pumped to the RWST.

ANSWERS -- BRAIDWOOD 1&2 -87/12/14-LENNARTZ, J.

ANSWER 2.09 (2.00)

a. Low discharge pressure (85 psig)
Return of power after station blackout
Safety Injection

(Any 2 @ 0.5 pts each)

b. No [0.5], it will not autostart on low pressure unless CCW pump 1A (the CCW pump on the same bus) is in PULL-TO-LOCK [0.5]. (1.0)

REFERENCE
Braidwood Component Cooling Water, pg. 12
Terminal Performance Objective #7.
008000K201 008000K401 ...(KA'S)

ANSWER 2.10 (2.00)

a. Provides enough fuel to allow the diesel to operate fully loaded [0.5] for 72 minutes [.25].

b. This position functions to permit speed and voltage control after an emergency start [0.5] with only the emergency trips enabled (generator differential, overspeed, and manual emergency). [.75]

REFERENCE
Braidwood Diesel Generator and Auxiliaries, pgs. 47, 68
064000G007 064000K608 ...(KA'S)

ANSWER 2.11 (2.50)

a. As flow incrases to greater than 80 gpm to each S/G [0.5], a DC powered status light will energize [0.5].

b. A reset time delay relay is energized for (10 seconds) [.25], and attempt to restart engine by cranking for 5 seconds [.25]. Four (4) attempted starts will be allowed [0.5], and then an "overcrank" alarm will energize in the Control Room [.25] and the engine will lock-out in (55 seconds) [.25].

REFERENCE
Braidwood Auxiliary Feedwater System, pgs. 23, 26
Terminal Performance Objective #13
000055A204 061000A204 061000G008 061000K406 ...(KA'S)

ANSWERS -- BRAIDWOOD 1&2 -87/12/14-LENNARTZ, J.

ANSWER 2.12 (1.75)

1. RCP Seal Injection Flow
2. RCP Seal Leak-off flow
3. RCP Seal Delta P
4. RCP Lower Radial Bearing Temperature
5. RCP #1 Seal Outlet Temperature
6. RCP Amps (current meter)
7. RCP Status Lights (running and trip)
8. RCP Oil Lift Pump Status Lights (running and trip)
9. Loop Stop Valve Permissive Lights
10. RCS Loop Flow

(Any 7 @ .25 pts each)

REFERENCE
Braidwood Reactor Coolant Pump, pgs. 25, 26
003000G008 ...(KA'S)

ANSWER 2.13 (.75)

1. Containment Atmosphere Area Radiation Monitor High Alarm
2. Manual Phase A Isolation
3. Safety Injection (AUTO or MANUAL)
4. Manual Containment Spray Actuation

(Any 3 @ .25 pts each)

REFERENCE
Braidwood Containment Ventilation and Purge System, pg. 57
Braidwood Engineered Safety Features, pg. 30
013000K101 103000K406 ...(KA'S)

ANSWERS -- BRAIDWOOD 1&2 -87/12/14-LENNARTZ, J.

ANSWER 2.14 (2.00)

1. Allows RCS forced flow to continue for the duration of the time delay [0.5] which would reduce the consequences if a loss of RCS flow occurs, since the reactor has been shut down for some time [0.5].

2. Minimizes RCP overspeed by locking RCP's at bus frequency (60 Hz) [0.5] which could prevent flywheel destruction forming missiles which could damage the containment liner (or ECCS components within containment) [0.5].

3. Prevents turbine overspeed [0.5] as a result of steam within the turbine shell expanding to the condenser [0.5].

(Any 2 @ 1.0 each)

REFERENCE
Braidwood Reactor Coolant Pump, pg. 45
045050K301 045050K408 ...(KA'S)

ANSWER 2.15 (1.00)

1. 4160V/480V Transformer

2. Centrifugal Charging Pump

3. Control Room Refrigeration unit

4. Component Cooling Pumps

5. Essential Service Water Pumps

6. Auxiliary Feedwater Pumps

(Any 5 @ 0.2 pts each)

REFERENCE
Braidwood Engineered Safety Features, pgs. 60, 61
Braidwood Diesel Generator and Auxiliary Equipment, pgs. 62, 63
Terminal Performance Objective #7
013000K112 064000K410 ...(KA'S)

ANSWERS -- BRAIDWOOD 1&2 -87/12/14-LENNARTZ, J.

ANSWER 3.01 (1.00)

c.

REFERENCE
System Descriptions, Rod Control, Chapter 28, Figure 28-25
Terminal Performance Objective #10
001000K403 ...(KA'S)

ANSWER 3.02 (1.50)

a. Increases [.25] due to reference leg heating. Reference leg becomes less dense and delta-P decreases across the detector [.25].

b. Remains the Same [.25] because the PRZR uses a double bellows [.25].

c. Increases [.25] because the height of the reference leg decreases and so delta-p across the detector decreases [.25].

REFERENCE
System Description, PRZR, Chapter 14, Appendix B, Review Question 39
Terminal Performance Objective #21
011000A101 ...(KA'S)

ANSWER 3.03 (1.50)

At the point in the sequence when the stationary gripper deenergizes the rod will fall into the core until the stationary gripper reenergizes [1.0]. This will generate into a series of short rod drops until the rod is fully inserted or the rod motion is stopped (by placing rods in manual or by termination of demand) [0.5].

REFERENCE
System Description, Rod Control, Chapter 28, pg. 22
Braidwood Simulator Malfunctions, CRF-4
001000K103 ...(KA'S)

ANSWERS -- BRAIDWOOD 1&2 -87/12/14-LENNARTZ, J.

ANSWER 3.04 (1.50)

(0.25 pts each)

1. Group Step Counters
2. Master Cycler
3. Slave Cyclers
4. Bank Overlap Unit
5. All internal memory and alarm circuits
6. P to A converter

REFERENCE
System Description, Rod Control, Chapter 28, pg. 55
Terminal Performance Objective #17
001010K402 ...(KA'S)

ANSWER 3.05 (1.50)

a. The signal is used in the Rod Control System [0.25] to quicken the reactor control units response during a transient [0.25] by comparing rate of change of nuclear power to turbine power [0.25].

b. The signal is used in the SGWLC system [0.25] to provide an anticipating signal for power changes [0.25] by adjusting the level error signal in the feed bypass valve controller [0.25].

(Note: Equivalent wording accepted)

REFERENCE
System Description, Pwr Rng NIS, Chapter 33, p. 33, Figure 33-1
Terminal Performance Objective #7c
System Description, SGWLC, Chapter 27, pg. 22
Terminal Performance Objective #5
System Description, Rod Control, Chapter 28, pg. 26
015000K103 035010K401 ...(KA'S)

ANSWER 3.06 (1.50)

The delta-P between steam and feed increases beyond the program [0.75]. To reduce this delta-P, MFP speed will decrease [0.75].

REFERENCE
System Description, SGWLC, Chapter 27, pgs. 29-30
Terminal Performance Objective #15c
035010A203 ...(KA'S)

ANSWERS -- BRAIDWOOD 1&2 -87/12/14-LENNARTZ, J.

ANSWER 3.07 (1.50)

The Tavg vs. Tno-load mismatch will trip the high-high bistable (30 degrees) and cause all dump valves to snap open [0.5]. All dump valves will remain full open until a Lo-Lo Tave signal is received [0.5]. Then all dump valves will shut [0.5]. (The hi-hi bistable will not clear.)

REFERENCE
System Description, Steam Dumps, Chapter 24, Figure 24-1
Terminal Performance Objective #3d4
041020K105 041020K411 041020K414 ...(KA'S)

ANSWER 3.08 (2.00)

The controlling circuits sense a high pressure [0.25] which will turn the sprays on full [0.25], open 455A-PORV [0.25] (and generate high pressure alert alarms). Actual pressure will decrease [0.25] and 455A-PORV closes when channel IV pressure drops below 2185 psig [0.25]. The sprays continue to lower pressure [0.25] until a low pressure Reactor Trip [0.25] and Safety Injection [0.25] are actuated.

REFERENCE
System Description, PRZR, Chapter 14, pg. 54
Terminal Performance Objective #21
010000A302 010000K601 ...(KA'S)

ANSWER 3.09 (1.50)

a. A reactor trip and bypass breaker open in the same train. (0.5)

b. (0.25 pts each)

1. Trips Main Turbine

2. Feedline isolation with Lo Tave (564 degrees F)

3. Prevents reactuation of SI after a manual reset

4. Prevents opening feedwater valves when closed by SI or P-14 (S/G Hi-Hi Level).

REFERENCE
System Description, RPS, Chapter 60b, pg. 21 and Appendix B
Terminal Performance Objective #4
System Description, ESF, Chapter 61, pg. 32-33

ANSWERS -- BRAIDWOOD 1&2 -87/12/14-LENNARTZ, J.

012000K610 ...(KA'S)

ANSWER 3.10 (1.50)

No [0.5]. Channel II must energize to actuate for an unsafe condition [1.0] (to avoid inadvertent spray actuation in the event of a loss of instrument power).

REFERENCE
System Description, ESF, Chapter 61, pg. 31, Figure 61-15
013000K101 013000K407 ...(KA'S)

ANSWER 3.11 (1.50)

a. (any three at 0.25 pts each)

1. RCS W.R. Pressure

2. Average of 10 highest CETs

3. Containment Pressure

4. Containment Radiation

b. (0.25 pts each)

1. Pressure margin to saturation

2. Temperature margin to saturation

3. Trends

REFERENCE
System Description, ICCM, Chapter 34b, Appendix A
Terminal Performance Objectives #6 and #7
000074A113 002000K603 017020K401 ...(KA'S)

ANSWER 3.12 (1.50)

a. (Any 4 @ 0.25 pts each)

1. Loss of power supply
2. Removal of printed circuit card
3. Placement of switches (in a train) to testing positions
4. Bypass breaker closed
5. Loss of continuity through the ground return fuse

b. The reactor trips. (0.5)

REFERENCE
System Description, SSPS, Chapter 60A, pg. 15
Terminal Performance Objective #6
012000A303 012000A307 012000A402 012000A404 ...(KA'S)

ANSWER 3.13 (1.00)

(0.5 pts each)

a. False
b. False

REFERENCE
System Description, RSP, Chapter 62, pg. 8 and Appendix A
Terminal Performance Objective #4
000068A121 ...(KA'S)

ANSWERS -- BRAIDWOOD 1&2 -87/12/14-LENNARTZ, J.

ANSWER 3.14 (2.00)

a. (0.25 pts each, 0.05 pts for setpoints and coincidences)

1. Lo Steamline Pressure, 640 psig, 2/3 channels on 1/4 S/G's

2. Hi Steam Rate, 100 psig/50 sec, 2/3 channels on 1/4 S/G's

3. Hi-2 Containment Pressure, 8.2 psig, 2/3

4. Manual

b. Prevents continuous, uncontrolled blowdown of more than one S/G in the event of a rupture [0.5] preventing an uncontrolled RCS cooldown [0.5].

REFERENCE
System Description, ESF, Chapter 61, pgs. 27 and Appendix B
Terminal Performance Objective #7A
013000K403 039000K405 ...(KA'S)

ANSWER 3.15 (1.75)

a. (0.25 pts each)

1. Steam Jet Air Ejectors (RE-PR027)

2. S/G Blowdown (RE-PR008)

3. Main Steamlines (RE-AR022-23)

b. Upward movement of the crane hoist is inhibited. (0.5)

c. Both units surge tank vent valves close. (0.5)

REFERENCE
System Description, RMS, Chapter 49, pgs. 42, 44, 48
Terminal Performance Objectives #4a3, #4b2, #14b
000036K202 000037A104 000037A106 000037A113 008000A204
...(KA'S)

ANSWERS -- BRAIDWOOD 1&2 -87/12/14-LENNARTZ, J.

ANSWER 3.16 (2.25)

a. (0.25 pts each, coincidences worth 0.05 if applicable)

1. SI
2. S/G Lo-Lo Level, 2/4 channels on 1/4 S/G's
3. Undervoltage on 2/4 RCP busses
4. UV on bus 141

b. Pump oil pressure greater than or equal to 6 psig (0.25)

c. (0.25 pts each)

1. Control switch trip
2. Overcurrent
3. Lo-Lo suction pressure
4. Undervoltage

REFERENCE
System Description, AFW, Chapter 26, pg. 53 and Figure 26-10
Terminal Performance Objectives #3, #5, and #7
061000A204 061000K402 061000K406 ...(KA'S)

ANSWERS -- BRAIDWOOD 1&2 -87/12/14-LENNARTZ, J.

ANSWER 4.01 (3.00)

a. No
b. Yes
c. Yes
d. No
e. Yes
f. No

(0.5 pts each)

REFERENCE
Braidwood Technical Specifications
002000G011 004000G011 012000G011 061000G011 ...(KA'S)

ANSWER 4.02 (1.00)

1. a. 2
b. 3
c. 1
d. 4

(0.5 for correct order)

2. True. (0.5)

REFERENCE
BwAP 330-1, pgs. 5, 8
194001K102 ...(KA'S)

ANSWER 4.03 (1.00)

d. (1.0)

REFERENCE
BwAP 900-3, pg. 1
194001K105 ...(KA'S)

ANSWERS -- BRAIDWOOD 1&2 -87/12/14-LENNARTZ, J.

ANSWER 4.04 (1.00)

1. Conditions are stable and under control

2. Continued operation would aggravate or worsen plant conditions (0.5 each)

REFERENCE
BwAP 300-1 p. 4
191003K111 ...(KA'S)

ANSWER 4.05 (1.50)

a.

Type 1	Type 2
1. Less than 50 mrem/day	1. Greater than 50 mrem/day
2. Maximum of 1 year	2. Length of job

(0.25 each)

b. TRUE (0.5)

REFERENCE
BwRP 1000-A1, pgs. 11-17
194001K104 ...(KA'S)

ANSWER 4.06 (1.00)

To prevent seal damage from overheating. (1.0)

REFERENCE
BwOA RCP-2, pg. 2
004000G010 ...(KA'S)

ANSWERS -- BRAIDWOOD 1&2 -87/12/14-LENNARTZ, J.

ANSWER 4.07 (2.50)

1. Manually trip turbine. (0.5)

2. Manually runback turbine. (0.5)

3. EH pumps to pull out. (0.5)

4. Initiate steamline isolation [0.5] and verify MSIV [0.25] and MSIV bypass valves closed [0.25].

REFERENCE
BwFR-S.1, pg. 3
000029K306 000029K312 ...(KA'S)

ANSWER 4.08 (2.25)

a. 1. > 100 psig - prevent backflow of dirty water from VCT. (0.625)

2. < 1000 psig - prevents cocking #1 seal (prevent thermal shock to pump shaft, seal, and pump bearing during a loss of seal injection).(0.625)

b. Opening the bypass allows more flow through the RCP lower radial bearing [0.5] which increases the cooling of the bearing [0.5].

REFERENCE
BwOP RC-1
BwOP RC-1, lesson Plan, pg. 9
003000G010 ...(KA'S)

ANSWERS -- BRAIDWOOD 1&2 -87/12/14-LENNARTZ, J.

ANSWER 4.09 (1.50)

1. Rods below rod insertion limit.
2. Failure of more than one RCCA to fully insert following a reactor trip or shutdown.
3. Unexplained or uncontrolled reactivity increase.
4. Failure of Reactor Makeup Control System.
5. Uncontrolled cooldown.
6. Inadequate shutdown margin.
7. The more restrictive of Keff less than .95 or boron concentration greater than or equal to 2000 ppm during refueling.

(Any 6 @ 0.25 pts each)

REFERENCE
BwOA PRI-2, pg. 1
000024G011 ...(KA'S)

ANSWER 4.10 (1.50)

The maximum fuel preconditioned limit is defined as the maximum power level achieved [0.5] for a cumulative 72 hours [0.5] during the previous 30 days of power operation [0.5].

REFERENCE
BwOA ROD-4, pg. 6
001000G010 ...(KA'S)

ANSWER 4.11 (1.50)

1. 75 rems - whole body
2. 200 rems - extremities

(0.75 pts each)

REFERENCE
BwRP 1110-1, pg. 6
194001K103 ...(KA'S)

ANSWERS -- BRAIDWOOD 1&2 -87/12/14-LENNARTZ, J.

ANSWER 4.12 (2.00)

1. Pressurizer PORV's - closed.

2. Letdown orifice isolation valves - closed. (8149 A,B,C)

3. Letdown line isolation valves - closed. (CV-459, 460)

4. Excess letdown isolation valves - closed. (CV-123, 8153 A,B) (0.5 pts. each)

REFERENCE
BwCA 0.0, pg. 4
000055G010 ...(KA'S)

ANSWER 4.13 (1.00)

This ensures that all personnel will be able to leave containment in one cycling of the personnel airlock (0.5) if containment evacuation would be necessary. (0.5)

REFERENCE
BwAP 1450-1, pg. 3
103000A204 103000G010 ...(KA'S)

ANSWER 4.14 (2.00)

a. It isolates the D/G controls [0.25] and indicators [0.25] from the Main Control Room [0.25] in the event that damage has occured to any DG control circuitry (or control room has been evacuated due to a fire). [0.5]

b. This prevents blowing backup fuses [0.75].

REFERENCE
BwOA ELEC-3, pg. 4, 5
Braidwood D/G and Auxiliaries, pg. 60
000068K207 064000G007 064000G010 ...(KA'S)

ANSWERS -- BRAIDWOOD 1&2 -87/12/14-LENNARTZ, J.

ANSWER 4.15 (2.25)

a. Depressurize all intact S/G's to cooldown and depressurize the RCS [0.5] which will increase ECCS injection flow into the RCS [0.25] and allow the SI Accumulators to inject. [0.25]

b. Prevent nitrogen from accumulators from being injected into RCS [0.5] which could collect in Rx Vessel Head and create a hard bubble [0.375] or can collect in the S/G tubes and reduce heat transfer [0.375].

REFERENCE
BwFR-C.1, pg. 11
BwFR-C.1, Lesson Plan, pgs. 60, 61
000074G007 000074K310 000074K311 ...(KA'S)