U.S. NUCLEAR REGULATORY COMMISSION

REGION III

Report No. 50-461/OL-85-01

Docket No. 50-461

Licensee: Illinois Power Company
500 South 27th Street
Decatur, IL 62525

Facility Name: Clinton Power Station

Examination Administered At: Clinton, IL

Examination Conducted: April 30 and June 24-28,1985

Examiners: E. Plettner for — Date 8/27/85

T. Lang for — Date 8/27/85

C. Kvamme for — Date 8/27/85

J. Munro for — Date 8/27/85

K. Brockman for — Date 8/27/85

M. King for — Date 8/27/85

T. Morgan for — Date 8/27/85

Approved By: J. I. McMillen
Section Chief

8/27/85
Date

Examination Summary

Examinations administered on April 30 and during the week of June 24, 1985
(Report No. 50-461/OL-85-01)
The written examination was administered on April 30, 1985, and oral examinations were conducted during the week of June 24, 1985.
Results: Eighteen candidates successfully completed the examinations.

REPORT DETAILS

1. Examiners

M. King, EG&G
C. Kvamme, EG&G
T. Morgan, EG&G
J. Munro, Region II
K. Brockman, Region II
T. Lang, Region III, Chief Examiner
E. Plettner, Region III

2. Examination Review Meeting

At conclusion of the written exam, the examiners met with six members of the plant staff for exam review. The list of comments generated are included on Attachment A for the RO exam and on Attachment B for the SRO exam.

3. Exit Meeting

At the conclusion of the site visit the examiners met with representatives of the plant staff to discuss the results of the examination. Those individuals who clearly passed the oral and/or simulator were identified in this meeting.

ATTACHMENT A

Resolution of Facility Comments
Clinton RO Exam
April 30, 1985

Question 1.20

Facility Comment: To vague as to what "rupture" means as three of the four could be correct answers.

Resolution: Comment accepted. Will include the words "caused by high stress" on future questions. No change to answer key.

Question 2.01

Facility Comment: Set point for timer was changed from 8 minutes to 6 minutes.

Resolution: Comment accepted with answer key change to show the correction.

Question 2.03:

Facility Comment: Answer for auto shift has been deleted in regards to low temperature in RCIC tank.

Resolution: Comment accepted with answer key changed to show deleted answer.

Question 2.04:

Facility Comment: Answers of high radiation in fuel building exhaust, fuel floor has been changed to just fuel building exhaust.

Resolution: Comment accepted and answer key corrected to show the change.

Question 2.05:

Facility Comment: Answer of load limit set point in some references say 110% instead of 105% and max combined flow some references say 110% instead of 115%.

Resolution: Comments accepted and answer key corrected to show both reference set points as acceptable answers.

Question 3.02:

Facility Comment: Answer flux manual control is also called loop auto and master manual control is also called flux auto at the facility.

Resolution: Comment accepted and answer key corrected to show both as acceptable answers.

Question 3.03:

Facility Comment: Answer of 9871 amps and 30,297 amps is usually expressed in percentages as 25% and 80%.

Resolution: Comment accepted and answer key corrected to show both as acceptable answers.

Question 3.04:

Facility Comment: These are three PT's the other two are for discharge pressure indication and F042 valve test.

Resolution: Comment noted but not needed to answer the question asked. No change to answer key made.

Question 3.05:

Facility Comment: At Clinton Power Station the feedwater flow signal is from the pump discharge. Correct answer for question asked is; "the loop flow is for recorder indication and for interlocks associated with Recirculation Pumps."

Resolution: Comment accepted and answer key changed to show correct answer.

Question 3.06:

Facility Comment: Answer of "half scram" does not exist at Clinton power station. Correct answer would be rod block.

Resolution: Comment accepted and answer key changed to show correct answer.

Question 3.10:

Facility Comment: Answer of hydraulic power unit failure may be broken down into high temperature or low level in oil reserve.

Resolution: Comment accepted with answer key changed to include them as correct answers.

Question 3.11:

Facility Comment: NRHX outlet of 140° will shut F004.

Resolution: Comment rejected since the question asked for isolation of system which includes both inlet and outlet valves. F004 is the inlet valve only.

Question 4.02:

Facility Comment: Reference number of 3304.04 should be 3304.01. Probable typing error.

Resolution: Comment accepted and answer key changed to show correct reference number.

Question 4.03:

Facility Comment: Answer has updated version of reference. We used older version in class. Either answer should be accepted.

Resolution: Comment accepted and answer key changed to accept either version as correct.

ATTACHMENT B

Resolution of Facility Comments
Clinton SRO Exam
April 30, 1985

Question 5.6:

Facility Comment: APLHGR is in the power distribution limit section of Technical Specification 3.2.1.

Resolution: Comment noted but MAPLHGR is more restrictive and thus no change to answer key.

Question 5.8:

Facility Comment: Answer (d) can also be correct. The power level is not dependant entirely on source. The rate of the rod pull is more significant.

Resolution: Comment rejected because rod pull rate was not changed only source count rate, thus no change to answer key.

Question 6.01:

Facility Comment: Answer possibly lifting of SRV's with water was not taught.

Resolution: Comment rejected, because it was in the training material.

Question 6.04:

Facility Comment: Question did not ask for setpoints in answer.

Resolution: Comment accepted. Setpoints were included in answer key as possible correct answers for low pressure or coolant temperature.

Question 6.08:

Facility Comment: Answer the one that remains most constant assumes control is correct, not the one that has a lesser change.

Resolution: Comment accepted and answer key changed to show correction.

Question 6.09:

Facility Comment: Answer of "because reactivity addition rate is important" from a different reference is also correct.

Resolution: Comment accepted and answer key changed to show both answers.

Question 8.12:

Facility Comment: Reference should be 1401.05 not 1404.05. Typing error.

Resolution: Comment accepted and answer key corrected.

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

FACILITY: Clinton
REACTOR TYPE: BWR - GE-6
DATE ADMINISTERED: April 30, 1985
EXAMINER: E. Plettner
APPLICANT: _____

INSTRUCTIONS TO APPLICANT:

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

Category Value	% of Total	Applicant's Score	% of Category Value	Category
25	25	_____	_____	5. Theory of Nuclear Power Plant, Operation, Fluids, and Thermodynamics
25	25	_____	_____	6. Plant Systems Design, Control, and Instrumentation
25	25	_____	_____	7. Procedures - Normal, Abnormal, Emergency, and Radiological Control
25	25	_____	_____	8. Administrative Procedures, Conditions, and Limitations
100	100	_____	_____	TOTALS

FINAL GRADE _____ %

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

_____
Applicant's Signature

Category 5 Theory of Nuclear Power Plant operations, Fluids and Thermodynamics

5.1 The change in reactivity associated with a change in Keff from 0.920 to 1.004 is approximately; (1.0)

a. 0.091
b. 0.084
c. 0.087
d. 0.080

5.2 Which of the following is NOT a characteristic of subcritical multiplication. (1.0)

a. For equal reactivity additions, it takes longer for the equilibrium subcritical multiplication level to be reached as Keff approaches unity.

b. If the reactor is shutdown long enough, the source range instruments will lose there ability to determine the subcritical multiplication level even though the core may still be at the middle of life.

c. If 2 notches of rod withdrawal increases the subcritical multiplication level by 10 cps, then 4 notches of rod withdrawal will increase the subcritical multiplication level by approximately 20 cps.

d. Doubling the indicated count rate by reactivity additions will reduce the margin to critical by approximately one half.

5.3 Which reactivity coefficient is the most dominant when pulling rods in startup and 150°F. (1.0)

a. Pressure coefficient
b. Moderator coefficient
c. Doppler coefficient
d. Void coefficient

5.4 The highest internal stresses placed on a pressurized system boundary such as reactor vessel is: (1.0)

a. on the thickest components during a heatup
b. on the thinnest components during a heatup
c. on the thinnest components during a cooldown
d. on the thickest components during a cooldown

5.5 The need to change the RTNDT of the reactor vessel over the life of the plant is the result of: (1.0)

a. thermal cycles (heatup and cooldown transients)
b. pressure cycles (changes in pressure)
c. gamma radiation
d. neutron radiation

5.6 During a design basis accident of a loss of coolant, the thermal limit that protects the fuel is (1.0)

a. LHGR
b. APLGHR
c. MAPLHGL
d. MCPR

5.7 The quality of steam to the turbine refers to: (1.0)

a. the ratio of the vapor mass to the sum of the liquid and vapor masses.

b. the ratio of the liquid mass to the sum of the liquid and vapor masses.

c. the ratio of the liquid mass to the vapor mass.

d. the ratio of the vapor mass to the liquid mass.

5.8 Which of the following statements describes the effect the magnitude of the initial level of source range counts would have on critical rod position and the power level (count rate) at criticality: (1.0)

a. The critical rod position would not be affected by the source range count rate and the power level (count rate) when criticality is reached would be higher.

b. The critical rod position would be lower since the source range count rate is higher and the power level (count rate) when criticality is reached would be higher.

c. The critical rod position would be lower since the source range count rate is higher and the power level (count rate) when criticality is reached would be lower.

d. The critical rod position would not be affected by the source range count rate and the power level (count rate) when criticality is reached would be lower.

5.9 Which of the following statements describes the reason for the change in critical power as the reactor pressure increases from 800 to 1100 psi. (1.0)

a. a decrease in local quality occurs which causes the margin between actual and critical qualities to increase and thus power increases.

b. Steam bubbles increase in quantity and collect more readily at the heat transfer surface, thus making the transition between nucleate and film boiling easier.

c. Local quality decreases along the boiling length and thus a greater critical power is necessary to drive quality up to the critical limit.

d. Boiling length decreases so the voids are formed lower in the core and thus the critical quality is greater lower in the core and transition boilings occurs at a point below the midpoint of the core.

5.10 EXPLAIN or DEFINE the following terms:

a. Prompt Critical (0.5)
b. Reactor Period (0.5)
c. Subcritical Multiplication (0.5)

5.11 (Assume 100% power) Then reactor power is reduced by driving rods. The recirculation pump ~~speed~~ remains constant. Core flow changes because of the actions taken. Choose the proper reason for the core flow change. (1.0)

a. Flow will decrease because of an increase in two phase flow conditions.

b. Flow will increase due to the increased natural circulation.

c. Flow will increase because of a reduction in two phase flow conditions.

d. Flow will increase because of an increase in two-phase flow conditions.

5.12 The MAPLHGR curve increase in early core life and as exposure increases the limit begins to increase at a decreasing rate and then decreases. Choose the condition that is NOT responsible for this: (1.0)

a. Burnable poison depletion
b. Fission gas build-up
c. Local peaking factors
d. Reduced heat transfer rate

5.13 Which of the following statements is correct concerning control rod worth? (1.0)

a. It is proportional to reactor power

b. It is lower in regions of higher relative neutron flux

c. It is proportional to rod speed

d. It is higher in regions of higher relative neutron flux

5.14 Regarding MCPR (Minimum Critical Power Ratio):

a. What PHENOMENON could exist if a fuel bundle were operated at a MCPR LESS THAN ONE and WHAT would very likely be the CONSEQUENCE of the phenomenon? (1.0)

b. WHY must the Technical Specification MCPR limit include a "K" factor when core flow is LESS THAN RATED? (1.0)

c. HOW is the margin to MCPR changed (INCREASES, DECREASES, or REMAINS CONSTANT) when inlet subcooling decreases? (0.5)

5.15 Which of the following radioactive isotopic found in the reactor coolant would not indicate a leak through the fuel cladding? (1.0)

a. I-131
b. Xe 133
c. Co-60
d. Kr-85

5.16 A moderator is necessary to slow neutrons down to thermal energies. Which of the following is the most correct reason for operating with thermal instead of fast neutrons. (1.0)

a. Increased neutron efficiency since thermal neutrons are less likely to leak out of the core than fast neutrons.

b. Reactors operating primarily on fast neutrons are inherently unstable and have a higher risk of going prompt critical.

c. The fission cross section of the fuel is much higher for thermal neutrons than for fast neutrons.

d. Doppler and moderator temperature coefficients become positive as neutron energy increases.

5.18 Which of the following statements best describes the condition known as "condensate depression"? (1.0)

a. Can lead to condensate pump cavitation if condensate depression is too great.

b. Decreases as hotwell level rises.

c. Reduces Rankine cycle efficiency.

d. Increases as condensate temperature increases.

5.19 Which of the following statements most correctly completes the following sentence? Departure from nucleate boiling is the point where: (1.0)

a. Void fraction equals one

b. The heat transfer mechanism changes from nucleate boiling to single phase convection.

c. Radiative heat transfer becomes insignificant.

d. The heat transfer rate ~~sustainable with~~ nucleate boiling reaches its maximum.

5.20 Which of the following in NOT correct concerning decay heat? (1.0)

a. Is the heat produced by the energy released from the radioactive decay of fission products.

b. Can be determined by the reading on the SRM's when the reactor is shutdown.

c. Is approximately 6% of the total energy released from fission.

d. Is still a significant contributor to the energy in the reactor core for approximately two hours after the reactor has been shutdown.

5.21 Figure 1.21 is a representation of how the resonance peaks of U-238 "flatten out" or Doppler broaden as fuel temperature increases. Which of the following are the correct labels for the X and Y axes? (1.0)

a. X is neutron flux; Y is interaction rate

b. X is neutron energy; Y is microscopic capture cross section

c. X is atom density of U-238; Y is neutron flux

d. X is interaction rate; Y is neutron density.

5.22 The ratio of Pu-239 and Pu-240 atoms to U-235 atoms changes over core life. Which of the pairs of parameters listed below are most affected by this change? (1.0)

a. Moderator temperature coefficient and doppler coefficient

b. Doppler coefficient and beta

c. Beta and moderator coefficient

d. Moderator temperature coefficient and neutron generation time.

5.23 Prior to startup (all rods in) the SRM countrate is 20CPS and K effective in 0.96. If the control rods are pulled to give a delta K of +0.035, what count rate on the SRM's could be expected when the period becomes infinite? (1.0)

a. 40
b. 160
c. 80
d. 120

5.24 Referring to the attached curve (Fig. 1), which of the following regions on the curve is associated with the heat transfer mechanism known as "transition boiling"? (1.0)

a. A + B
b. D
c. E
d. C + D
e. B + C

END OF CATEGORY 5

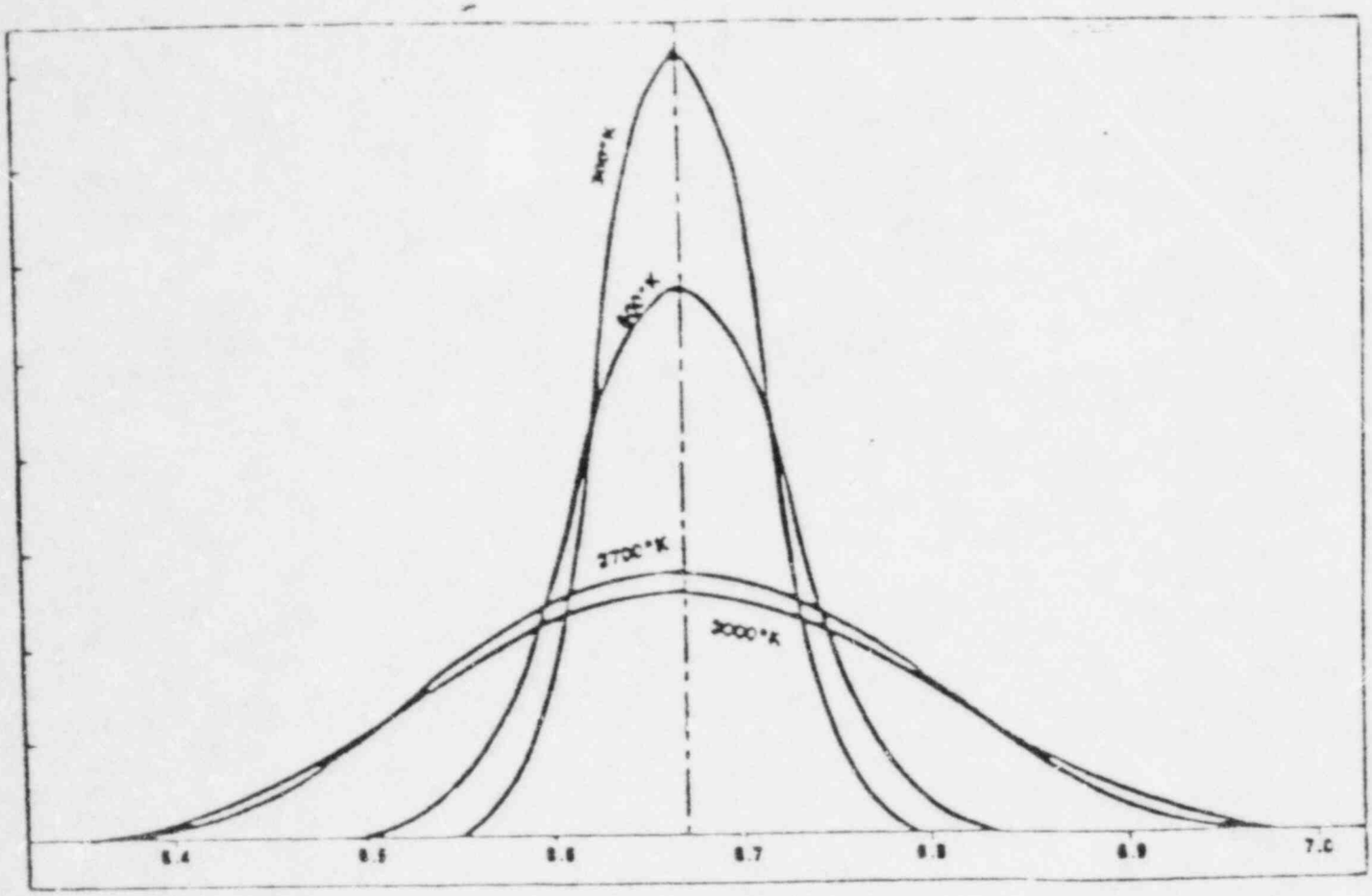

Figure 1.21

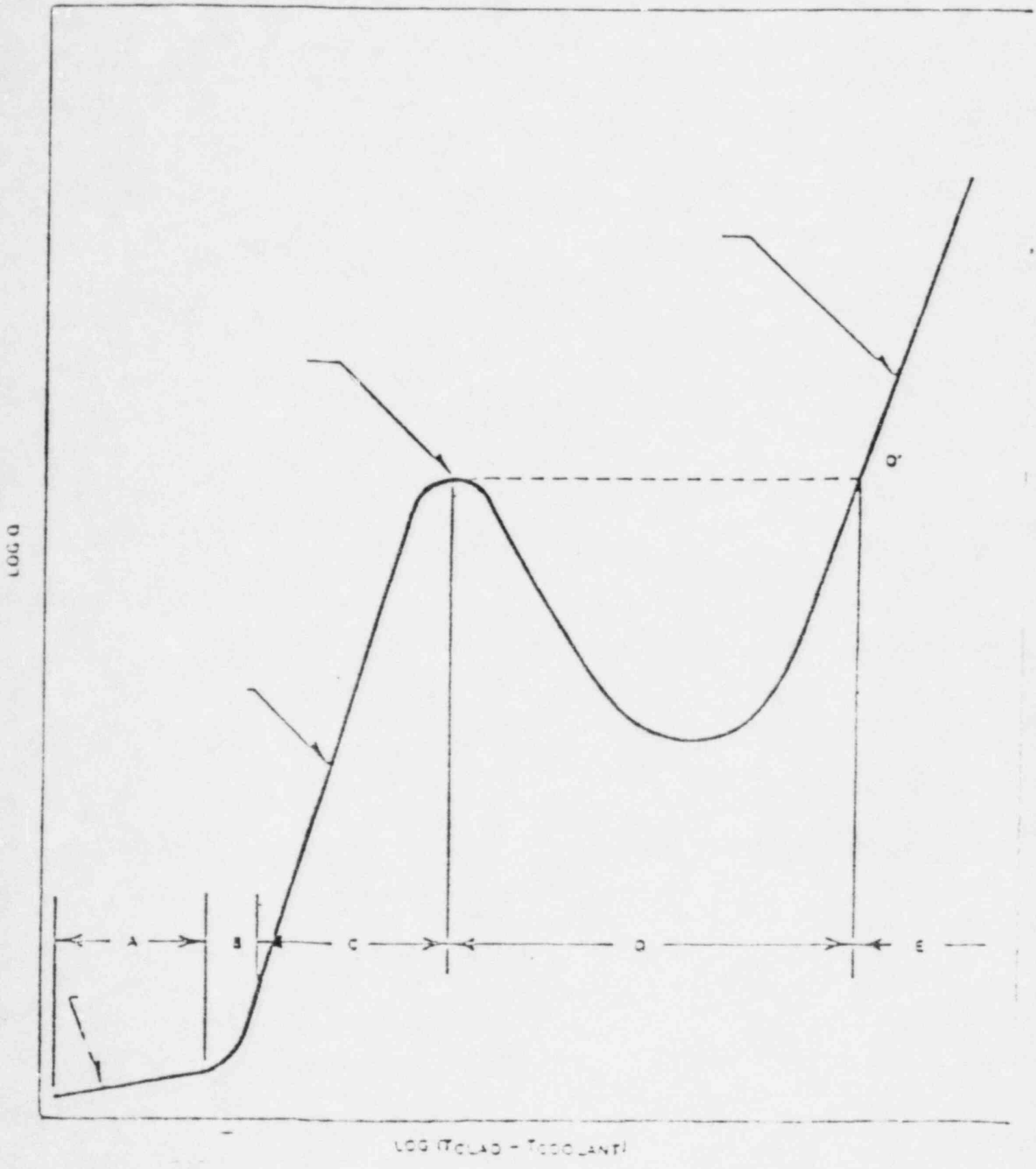

Figure 1. Heat Flux Versus Temperature Difference Between Cladding and Coolant

Category 6 Plant Systems Design, Control, and Instrumentation

6.01 The water level instrument causes several trips to occur at the level 8 condition. Explain the bases for the trip of the reactor feedpump. (Note protecting the turbine is not an answer) (1.0)

6.02 The reactor recirculation system has seals which could fail. Using figure (1) provided, draw in up arrows or down arrows in the appropriate spaces. (2.0)

6.03 What signals will start the diesel engines in Division I and II? (Four required for full credit) (2.0)

6.04 What signals will trip the diesel engine in Division three? (Six out of eight required for full credit) (3.0)

6.05 The recirculation pump system has three cavitation interlocks. What are the interlocks and the reasons for each one? (3.0)

6.06 What group isolations occur on a high drywell pressure trip? (Three required for full credit) (1.5)

6.07 State two reasons why it is important that jet pump integrity be verified. (2.0)

6.08 The EHC system has two pressure regulators. Explain what happens in the system when one of the regulators fails high (assume a gradual failure). (2.0)

6.09 Regarding the Control Rod Drives (CRDs) and CRD hydraulics:

a. Why is the hydraulic system Flow Control Valve mechanically blocked from going completely closed during a scram? (1.0)

b. Why are CRD scram times measured from fully withdrawn to notch position 13? (1.0)

c. What will result when scramming a CRD with the over piston flow path isolated (scram discharge valve closed or the area manual valve closed)? (1.0)

6.10 The SRMs provide rod blocks during plant startup (i.e., mode switch in startup). Name three rod block signals. (1.5)

6.02

FAILURE	#1 SEAL CAVITY PRESSURE	#2 SEAL CAVITY PRESSURE	STAGING FLOW	OUTER SEAL FLOW
#1 SEAL		↓	↓	
#2 SEAL		↓		
BOTH SEALS	↓	↓		↓
PRESS. BREAK DOWN ORIFICE CLOGGED		↓	↓	

Figure 1

6.11 The safety/relief valves have three modes of operation. (1.5)
List these three modes of operation.

6.12 Concerning APRM Gain Adjustment Factor:

a. Of the following APRM GAFs, which is the most conservative? (0.5)

APRM GAF 1.00 - 0.98 - 0.99

b. What does an APRM GAF of 1.00 mean? (1.0)

c. What is the APRM GAF limit for Clinton? (1.0)

END OF CATEGORY 6

Category 7 Procedures, Normal, Abnormal, Emergency, and Radiological Control

7.01 What four indications or alarms will tell you that you have a loss of feedwater heating? (2.0)

7.01 While operating at 100% power, an air leak develops in main condenser

A. Match the following automatic actions for the vacuum

a.	Approximately 21.6" Hg Vac	1.	Trip RFPTs	(0.5)
b.	Approximately 7.6" Hg Vac	2.	Close BPVs	(0.5)
c.	Approximately 19" Hg Vac	3.	Trip Main Turbine	(0.5)
d.	Approximately 13" Hg Vac	4.	Close MSIVs	(0.5)

B. Which of the following are included in the immediate operator actions for a loss of condenser vacuum per the Abnormal Operating Procedure? (Assume slow loss of vacuum) (1.0)

a. Initiate power reduction by decreasing recirculation pump flow.

b. Start the mechanical vacuum pump (if not the source of the air leak).

c. Scram the reactor and following the Reactor Scram Procedure.

d. Verify proper hotwell level.

7.03 Regarding the Residual Heat Removal (RHR) Procedure, CPS No. 3312.01, when operating in the SHUTDOWN cooling mode:

a. You are cautioned to NOT allow reactor vessel level to decrease below 44 inches on the shutdown range. Why is this level of concern? (0.5)

b. This procedure also cautions you to avoid opening the RHR test return line valve and the minimum flow bypass line valve. Why are these valves to remain closed? (0.5)

7.04 In reference to CPS No. 3002.01, HEATUP AND PRESSURIZATION, match the following startup activities with the pressures at which they should be performed. (Only one correct answer for each pressure).

a.	Start a turbine-driven feed pump	1.	60# _____	(0.5)
b.	Place RCIC in "standby"	2.	100# _____	(0.5)
c.	Place turbine sealing steam in service	3.	265# _____	(0.5)
d.	Start SJAEs	4.	920# _____	(0.5)

7.05 In procedure CPS No. 3107.01 turbine gland seal, a caution exists in the steam seal supply which states "Do not apply sealing steam to a stationary turbine." Choose the best reason for this caution from the following: (0.5)

a. Prevent overpressurizing the seals

b. Local heating of bearing surfaces and subsequent bearing damage

c. The steam seal evaporator will reach high level and isolate

d. Local heating of rotor surfaces and subsequent rotor bowing

7.06 A reactor water isotopic analysis for iodine is required when any of three (3) conditions occur. What are the three (3) conditions? (3.0)

7.07 Define or explain the following:

a. High radiation area (1.0)
b. Effective half-life (1.0)
c. Curie (1.0)
d. REM (1.0)

7.08 In accordance with emergency procedure #4100.01 Reactor Scram, your first step in immediate operator actions is to verify all appropriate automatic actions occur and manually perform any that do not occur. List the five automatic actions that occur. (4.0)

7.09 What actions are required if off-gas H_2 concentration reaches 1%? (1.0)

7.10 The procedure for the operational ALARA Program describes three simple concepts that station personnel should utilize to minimize their own exposure. What are these concepts? (1.5)

7.11 Assume that an SRV has spuriously actuated and stuck open.

a. One of the immediate actions listed in CPS No. 4009.01, INADVERTENT OPENING SAFETY/RELIEF VALVES, is to attempt to close the valve. Briefly explain how this is done. (1.0)

b. What are three (3) methods of determining if the valve was successfully closed? (1.5)

c. If it is determined in part B above that the relief valve is still stuck open, what action should be taken? Be specific. (0.5)

END OF CATEGORY 7

Category 8 Administrative Procedures, Conditions and Limitations

8.01 List the actions that shall be taken in the event of a T/S safety limit violation. (2.0)

8.02 Fill in the table provided with the minimum plant staff organization (licensed operators and others) required for each mode of reactor operation. (2.5)

8.03 What is required to make a temporary change to a procedure? (1.5)

8.04 Concerning Radiation Work Permits (RWP):

a. Whose permission is required to commence work covered by a RWP? (0.5)

b. What information is an individual required to enter on the RWP Access Log when entering/exiting the job site? (0.5)

8.05 List the conditions when the suppression pool is not required to be operable under operational condition 5 (per technical specification) (2.0)

8.06 What are the four safety limits per Technical Specification. (2.0)

8.07 What conditions must be met in order for drywell integrity to exist. (1.50)

8.08 What are six (6) actions that should be taken by the Control Room Operator upon receipt of notification of a fire? (3.0)

8.09 Arrange the following in the proper sequence of succession of station responsibility when the Power Plant Manager is not available. (2.5)

a. Assistant Power Plant Manager-Maintenance
b. Supervisor-Plant Operations
c. Supervisor-Technical
d. Assistant Power Plant Manager-Operations
e. Shift Supervisor on Duty

8.10 a. Under what two (2) circumstances may an individual, other than the person to whom a safety tagout was issued, release the tagout? (1.0)

b. Who is authorized to perform this release? (0.5)

c. Who must sign the release? (0.5)

8.02	Position	Condition 1, 2, or 3	Condition 4 or 5
	SS		
			None
	RO		
		2	
			None

8.11 Who has responsibility for the following steps in the Post-Scram Review process? (1.5)

a. Data collection
b. Scram investigation (primary and alternate)
c. Restart decision

8.12 What does "At the Controls" mean in reference to the Control Room Operator's responsibility during normal plant operation? (1.0)

8.13 The reactor at CPS has several power distribution limits. One of these is Linear Heat Generation Rate.

a. What is the limit for LHGR? (0.5)

b. When does this limit apply? (1.0)

c. What must be done if this limit is exceeded? (1.0)

END OF CATEGORY 8

$f = ma$

$w = mg$

$E = mc^2$

$KE = 1/2\ mv^2$

$PE = mgn$

$V_f = V_o + at$

$\frac{P}{\rho(g)} + \frac{V^2}{2g} + y = K$

$\Delta E = 931\ \Delta m$

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

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

$Pwr = W_f \Delta n$

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

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

$SUR = 26.06/T$

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

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

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

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

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

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

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

$\Sigma = \sigma N$

$v = s/t$

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

$a = (V_f - V_o)/t$

$\omega = \theta/t$

Cycle efficiency = (Network out)/(Energy in)

$A = N\sigma\phi(1-e^{-\lambda t_b})$

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

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

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

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

$I = I_o e^{-ux}$

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

$TVL = 1.3/u$

$HVL = -0.693/u$

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

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

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

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

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

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

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

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

$I_1 d_1 = I_2 d_2$

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

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

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.

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)

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U.S. NUCLEAR REGULATORY COMMISSION
REACTOR OPERATOR LICENSE EXAMINATION

FACILITY: Clinton
REACTOR TYPE: BWR - GE-6
DATE ADMINISTERED: April 30, 1985
EXAMINER: E. Plettner
APPLICANT: _____

INSTRUCTIONS TO APPLICANT:

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

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

FINAL GRADE _____%

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

_____
Applicant's Signature

CATEGORY 1

PRINCIPLES OF NUCLEAR POWER PLAN OPERATION, THERMODYNAMICS HEAT TRANSFER AND FLUID FLOW

1.1 Which of the following statements is correct regarding control rod worth? (1.0)

a. It is proportional to reactor power

b. It is proportional to rod speed

c. It is higher in regions of higher relative neutron flux

d. It is lower in regions of higher relative neutron flux.

1.2 Which of the following is NOT a characteristic of subcritical multiplications? (1.0)

a. If the reactor is shutdown long enough, the source range instruments will lose their ability to determine the subcritical multiplication level even though the core may still be at MOL

b. Doubling the indicated count rate by reactivity additions will reduce the margin to critical by approximately one half.

c. For equal reactivity additions, it takes longer for the equilibrium subcritical multiplication level to be reached as K eff approaches unity.

d. If two notches of rod withdrawal increases the subcritical multiplication level by 10 CPS, 4 notches of rod withdrawal will increase the subcritical multiplication level by approximately 20 cps.

1.3 Which of the following statements best describes the behavior of xenon and samarium? (1.0)

a. After a reactor scram occurs, xenon concentration initially increases and samarium decreases.

b. After a reactor scram occurs, xenon will eventually decay to a xenon free condition but a samarium free condition will not occur until after the next refueling outage.

c. The xenon and samarium peak concentration following a scram occurs at a time independent of the previous power level.

d. Xenon concentrations may increase or decrease when taking the plant from Hot Standby to full power but samarium will always decrease during this transient after the core's equilibrium samarium has been reached.

1.4 Which of the following radioactive isotopes found in the reactor coolant would not indicate a leak through the fuel cladding? (1.0)

a. I-131

b. Xe-133

c. Co-60

d. Kr-85

1.5 A moderator is necessary to slow neutrons down to thermal energies. Which of the following is the most correct reason for operating with thermal instead of fast neutrons. (1.0)

a. Increased neutron efficiency since thermal neutrons are less likely to leak out of the core than fast neutrons.

b. Reactors operating primarily on fast neutrons are inherently unstable and have a higher risk of going prompt critical.

c. The fission cross section of the fuel is much higher for thermal neutrons than for fast neutrons.

d. Doppler and moderator temperature coefficients become positive as neutron energy increases.

1.6 Which of the following is a true statement concerning radioactive decay? Remember the atomic number is the number of protons and the mass number is the number of neutrons plus protons. (1.0)

a. When an element decays by beta emission, the new element will have increased in atomic number by one and the mass number will remain the same as the original element.

b. When an element decays by alpha emission, the new element will have decreased in atomic number and mass number by two, from the original element.

c. When an element decays by neutron emission the new element will have increased in atomic number by one and decreased in mass number by one, from the original element.

d. When an element decays by gamma emission, the new element will have increased in atomic number by one and the mass number will remain the same as the original element.

1.7 Which of the following statements best describes the condition known as "condensate depression"? (1.0)

a. Can lead to condensate pump cavitation if condensate depression is too great.

b. Decreases as hotwell level rises.

c. Reduces Rankine cycle efficiency.

d. Increases as condensate temperature increases.

1.8 Which of the following statements most correctly completes the following sentence: Departure from nucleate boiling is the point where, (1.0)

a. Void fraction equals one.

b. The heat transfer mechanism changes from nucleate boiling to single phase convection.

c. Radiative heat transfer becomes insignificant.

d. The heat transfer rate sustainable with nucleate boiling reaches its maximum.

1.9 Which of the following statements is NOT correct concerning decay heat? (1.0)

a. Is the heat produced by the energy released from the radioactive decay of fission products.

b. Can be determined by the reading on the SRM's when the reactor is shutdown.

c. Is approximately 6% of the total energy released from fission.

d. Is still a significant contributor to the energy in the reactor core for approximately two hours after the reactor has been shutdown.

1.10 Referring to the attached curve (Fig. 1), which of the following regions on the curve is associated with the heat transfer mechanism knows as "transition boiling"? (1.0)

a. A ± B

b. D

c. E

d. C ± D

e. B ± C

1.11 Which of the following is NOT one of the four contributors or factors that establish equilibrium xenon? (1.0)

a. Direct production from fission

b. Decay of Iodine

c. Decay of Xenon to Sm

d. Decay of Xenon to Cs.

1.12 Figure 1.12 is a representation of how the resonance peaks of U-238 "flatten out" or Doppler broaden as fuel temperature increases. Which of the following are the correct labels for the x and y axes? (1.0)

a. X is neutron flux, Y is interaction rate.

b. X is neutron energy, Y is microscopic capture cross section.

c. X is atom density of U-238, Y is neutron flux.

d. X is interaction rate, Y is neutron density.

1.13 The ratio of Pu-239 and Pu-240 atoms to U-235 atoms changes over core life. Which of the pairs of parameters listed below are most affected by this change? (1.0)

a. Moderator temperature coefficient and doppler coefficient.

b. Doppler coefficient and beta.

c. Beta and moderator temperature coefficient.

d. Moderator temperature coefficient and neutron generation time.

1.14 Prior to startup (all rods in) the SRM count rate is 20 CPS and K effective is 0.96. If the control rods are pulled to give a delta K of +0.035 what count rate on the SRM's could be expected when the period becomes infinite? (1.0)

a. 40

b. 160

c. 80

d. 120

1.15 Assume the reactor is being started up from COLD SHUTDOWN and a ROD DROP ACCIDENT occurs. Which of the following statements best describes the way the rapid power rise would be limited. (1.0)

a. The moderator, doppler and void coefficients all act simultaneously.

b. The moderator temperature coefficient acts first since the temperature rise in the coolant will cause saturation conditions to be reached rapidly.

c. The void coefficient acts secondly, since the saturation conditions will cause more voids to form.

d. The doppler coefficient acts first due to the large number of neutrons being absorbed in the fuel.

1.16 Following an auto initiation of RCIC at a reactor pressure of 800 psig, reactor pressure decreases to 400 psig. Assume the RCIC is operating as designed, which of the following statements best describe the parameter changes in the RCIC. (1.0)

a. The RCIC flow to the reactor increases RCIC pump discharge head remains constant and RCIC turbine speed increases.

b. The RCIC flow to the reactor remains constant, RCIC pump discharge head decreases and the RCIC turbine speed decreases.

c. The RCIC flow to the reactor remains constant, RCIC pump discharge head remains constant and RCIC turbine speed remains constant.

d. The RCIC flow to the reactor decreases, RCIC pump discharge head increases and the turbine speed remains constant.

1.17 A motor driven centrifugal pump is operating at rated flow. You start closing down the discharge valve. Which of the following statements best describes the parameter changes that will occur with this action? (1.0)

a. Flow remains constant, discharge pressure remains constant, motor amps increase, net positive suction head increases.

b. Flow decreases, discharge pressure increases motor amps increase, net positive suction head increases.

c. Flow decreases discharge pressure increases motor amps decrease, net positive suction head decreases.

d. Flow decreases, discharge pressure increases, motor amps decrease; net positive suction head increases.

1.18 Boiling water reactors are designed to have "under moderated cores". Which statement best describes under moderated? (1.0)

a. The ratio of moderator to fuel is such that the temperature and void coefficient will both be the same (both positive or both negative).

b. The ratio of moderator/fuel is such that increasing moderator density increases K eff.

c. The ratio of moderator to fuel is such that the amount of under moderation increases during core life.

d. The ratio of fuel to moderator is such that increasing moderator density will decrease K eff.

1.19 How long does it take to increase power from 2 kw to 1 Mw on a 50 second period? (1.0)

a. 300 sec

b. 345 sec

c. 310 sec

d. 325 sec

1.20 Which of the thermal limits protects the fuel from clad rupture? (1.0)

a. MAPLHGR

b. MCPR

c. LHGR

d. DBA LOCA

1.21 If the recirculation pump speed remains constant, which of the following statements best describe why core flow will change if power is reduced below 100% by control rod insertion. (1.0)

a. Flow will increase because less 2 phase resistance and lower feedwater temperature.

b. Flow will increase because of higher differential pressure across the core and higher feedwater density.

c. Flow will decrease because the control rods are inserted thus reducing the total flow area.

d. Flow will decrease because more voids are formed thus less volume available for water in the core.

1.22 What reactivity is associated with a 40 second period? (Assume B is .0075) (1.0)

a. .0013

b. .0015

c. .0014

d. .0016

1.23 An ADS or Safety Relief Valve Leaking alarm is received in the control room. What temperature would you expect to see on the temperature recorder on H13-P614. (1.0)

a. between 210 and 220 degrees F

b. between 490-500 degrees F

c. between 550-560 degrees F

d. between 290-300 degrees F

1.24 Which of the following factors will hinder rather than assist natural circulation flow in the reactor vessel. (1.0)

a. Heat source

b. Increasing the coolant temperature

c. Lowering the water level in the down corner.

d. Flow resistance less than natural circulation lead.

1.25 A pressure gauge on the auxiliary boiler steam dome is reading improperly at 400 psig. A newly calibrated thermometer is reading 456°F at the same place. What is the proper reading for the pressure gauge. (1.0)

a. 434 psig

b. 415 psia

c. 385 psig

d. 449 psia

END OF CATAGORY 1

CATEGORY 2

PLANT DESIGN INCLUDING SAFETY AND EMERGENCY SYSTEMS

2.01 What signals are required to initiate the Automatic Depressurization System? Note five signals are required in one instance and three signals in other instance. (3.0)

2.02 How is the leakage rate minimized in the event of a reactor vessel level instrument sensing line break inside and outside of the Drywell? (2.0)

2.03 What three signals will automatically shift HPCS pump suction from RCIC tank to the suppression pool? (1.5)

2.04 What six signals will automatically start the standby gas treatment system. (3.0)

2.05 The turbine is running at 100% steam flow. The operator depresses the pressure setpoint DECREASE button and changes the pressure set point from 920 psig to 915 psig. What is the response of the EHC system, and what happens to reactor power? Assume MASTER MANUAL control for the Rx Recirculation system. (3.5)

2.06 What are SEVEN loads supplied by the Division I Diesel generator (3.5)

2.07 With regard to the Low Pressure Core Spray (LPCS) System:

a. INDICATE whether the following statements are True or False:

1. When a manual override is performed on a pump or valve, automatic pump restart or valve opening is disabled until the indications are reset. (0.5)

2. Manually starting the LPCS pump automatically establishes an adequate Standby Service Water flow path. (0.5)

b. On an AUTO initiation LIST 4 of the 5 actions that occur in the LPCS system (1.0)

2.08 An automatic RCIC initiation has occurred. Subsequently, RCIC injection was automatically terminated due to high reactor water level.

a. What component in the RCIC system functioned to automatically terminate the injection? (0.5)

b. Assuming no operator action, how will RCIC respond to a subsequent decreasing water level? (1.0)

c. If a RCIC "Turbine Test" had been in progress when the initial automatic initiation signal had been received, how would the system have responded? (1.0)

d. If, following the initiation, the RCIC turbine had tripped on overspeed, could it be reset from the Control Room? Explain. (1.0)

2.09 a. With the RHR Loop "A" in the standby service condition what maintains the suction and discharge piping full? (1.0)

b. What three conditions are required for automatic initiation of containment spray? (1.5)

c. Which LPCI Loops are used for containment spray? (1.0)

END OF CATAGORY 2

CATAGORY 3

INSTRUMENTS AND CONTROLS

3.01 What four signals in the source range monitor will provide rod blocks? (2.0)

3.02 What are the four different modes of operation for the recirculation flow control valves? (2.0)

3.03 a. What two conditions will cause an automatic main turbine runback? (Include setpoints) (1.0)

b. Two time delay relays are associated with the main turbine runback. What conditions, if NOT met, will cause these time delay relays to send a trip signal to the turbine? (1.0)

3.04 Answer the following concerning the Residual Heat Removal system.

a. Which RHR pump(s) can be controlled from the Remote Shutdown Panel? (0.5)

b. State the function of the Pressure Transmitter located in the discharge line on each RHR pump. (1.0)

c. State the interlock associated with the minimum flow valves (1E12-F064A[B] [C]). (1.5)

3.05 Assume the FEEDWATER LEVEL CONTROL SYSTEM is being operated in 3-ELEMENT control using reactor LEVEL DETECTOR CHANNEL 'A'. Reactor power is at 85%, STEADY STATE. For each of the instrument or control signal failures listed below, STATE HOW REACTOR LEVEL WILL INITIALLY RESPOND (increase, decrease, or remains constant) and BRIEFLY EXPLAIN WHY in terms of WHAT is happening in the Feedwater Control System IMMEDIATELY AFTER THE FAILURE.

(FOR EXAMPLE, your answers should include the following detail, "Causes reactor level to decrease due to a steam flow/feed flow error signal, steam flow < feed flow, resulting in a signal to increase the speed of the reactor feedpumps(s)," IF APPLICABLE.)

a. B FEEDWATER line FLOW signal fails HIGH (1.0)

b. Channel A REACTOR LEVEL detector signal fails LOW (1.0)

c. LOSS OF CONTROL SIGNAL to B Reactor Feed Pump Speed Controller (1.0)