January 16,2008

Mr. Terence Tehan, Director
Rhode Island Atomic Energy Commission
Rhode Island Nuclear Science Center
16 Reactor Road
Narragansett, RI 02882-1165

SUBJECT: INITIAL EXAMINATION REPORT NO. 50-193/OL-08-01, RHODE ISLAND ATOMIC ENERGY COMMISSION

Dear Mr. Tehan:

During the week of December 10, 2007, the U.S. Nuclear Regulatory Commission (NRC) administered operator licensing examination at your Rhode Island Atomic Energy Commission reactor. The examination was conducted according to NUREG-1478, "Operator Licensing Examiner Standards for Research and Test Reactors," Revision 2, published in June 2007. Examination questions and preliminary findings were discussed at the conclusion of the examination with those members of your staff identified in the enclosed report.

In accordance with Title 10, Section 2.390 of the Code of Federal Regulations, a copy of this letter and the enclosures will be available electronically for public inspection in the NRC Public Document Room or from the Publicly Available Records (PARS) component of NRC's Agencywide Documents Access and Management System (ADAMS). ADAMS is accessible from the NRC Web site at http://www.nrc.gov/reading-rm/adams.html (the Public Electronic Reading Room). The NRC is forwarding the individual grades to you in a separate letter which will not be released publicly. If you have any questions concerning this examination, please contact Patrick Isaac at 301-415-1019 or via email at pxi@nrc.gov.

Sincerely,

/RA/

Johnny Eads, Chief
Research and Test Reactors Branch B
Division of Policy and Rulemaking
Office of Nuclear Reactor Regulation

Docket No. 50-193

Enclosures:
1. Examination Report No. 50-193/OL-08-01
2. Facility Comments with NRC Resolution
3. Written Examination

cc: Mr. Michael Middleton, Rhode Island Atomic Energy Commission
cc w/o enclosures: See next page

January 16, 2008

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Rhode Island Atomic Energy Commission
Rhode Island Nuclear Science Center
16 Reactor Road
Narragansett, RI 02882-1165

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DISTRIBUTION w/ encls.:
PUBLIC PRTB r/f JEads Facility File CHart (O12-D19)

ADAMS ACCESSION #: ML080140238

OFFICE	PRTB:CE	IOLB:LA	PRTB:BC
NAME	PIsaac	CHart	JEads
DATE	01/14/2008	01/15/2008	01/16/2008

OFFICIAL RECORD COPY

cc:

Governor Donald Carcieri
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Test, Research, and Training Reactor Newsletter
University of Florida
202 Nuclear Sciences Center
Gainesville, FL 32611

EXAMINATION REPORT NO: 50-193/OL-08-01

FACILITY: Rhode Island Atomic Energy Commission

FACILITY DOCKET NO.: 50-193

FACILITY LICENSE NO.: R-95

SUBMITTED BY: ______________________________ ___________
Patrick J. Isaac, Chief Examiner Date

SUMMARY:

During the week of December 10, 2007, the NRC administered a retake of the written examinations to one Reactor Operator (RO) candidate. The candidate passed the examinations.

REPORT DETAILS

1. Examiner: Patrick J. Isaac, Chief Examiner

2. Results:

	RO PASS/FAIL	SRO PASS/FAIL	TOTAL PASS/FAIL
Written	1/0	N/A	1/0
Operating Tests	Waived	N/A	N/A
Overall	1/0	N/A	1/0

Facility Comments with NRC Resolution

Question (A.6)

Which statement illustrates a characteristic of Subcritical Multiplication?

a. As Keff approaches unity (1), for the same increase in Keff, a greater increase in neutron population occurs.

b. The number of neutrons gained per generation gets larger for each succeeding generation.

c. The number of fission neutrons remains constant for each generation.

d. The number of source neutrons decreases for each generation.

Answer: a

Facility Comment:

The question asked what illustrates a characteristic of subcritical multiplication.

The candidate chose answer c – The number of fission neutrons remains constant for each generation.

During training, the candidate learned about each of the factors in the six factor formula for Keff. Reproduction factor (η) represents the number of fission neutrons produced by thermal fission relative to the number of thermal neutrons absorbed in fuel. One of the points made during the training was that the value of the reproduction factor (η) is dependent on fuel type, and that it is independent of the value of Keff (see DOE Fundamentals Handbook Module 3 Reactor Theory, Table 1).

Consequently, this answer is a correct answer under conditions of subcritical multiplication.

NRC Resolution:

Comment not accepted. The Doe Fundamentals Handbook in discussing subcritical mltiplication (see DOE Fundamentals Handbook Module 4, Subcritical Multiplication Factor) clearly explains that in a subcritical reactor, the number of neutrons produced by fission, due to the introduction of a set number of source neutrons, decreases in subsequent generations. Therefore, answer “c” is wrong. The only correct answer for question A.6 is “a”.

Question (A.8)

Which one of the following statements describes Count Rate characteristics after a control rod withdrawal with the reactor subcritical? (Assume the Rx remains subcritical.)

a. Count Rate will rapidly increase (prompt jump) then gradually increase to a stable value.

b. Count Rate will rapidly increase (prompt jump) then gradually decrease to the previous value.

c. Count Rate will rapidly increase (prompt jump) to a stable value.

d. There will be no change in Count Rate until criticality is achieved.

Answer: a

Facility Comment:

The question asked what describes subcritical count rate after control rod withdrawal.

The candidate chose answer c – Prompt Jump to a stable value.

The exam answer was – Prompt Jump, then a gradual increase to a stable value. This is only partly true because the gradual increase to a stable value is relatively negligible when Keff <<1. It becomes more pronounced only when Keff approaches 1. Consider:

$CR_n = [S(1-K^N)] / (1-K)$

If we wanted to know the equilibrium count rate (CR_{eq}), we would determine the count rate when N = infinity (∞). As N goes to infinity with K<1, K^N goes to zero, and the equation above reduces to:

$CR_{eq} = S / (1-K)$

In theory it would take forever to reach the equilibrium count rate (CR_{eq}) because it would require N = infinity (∞) generations. Therefore if we approximate CR_{eq} to be 99% of the actual CR_{eq}, we could say that:

$S(1-K^N) / (1-K) = (0.99)[S / (1-K)]$

$(1-K^N) = 0.99$

$K^N = 0.01$

$\log(K^N) = \log(0.01)$

$N \log(K) = -2$

$N = -2 / \log(K)$

N represents the number of generations that it takes in order to reach 99% CR_{eq}.

From DOE Fundamentals Handbook Module 2 Nuclear Physics and Reactor Theory Page 30:

Average neutron generation time (l_{ave}) for a water moderated thermal reactor is = 0.0813 seconds / generation

Therefore, if Keff = 0.6, the number of generations that it would take to reach equilibrium is:

–2 / log(0.6) = 9 generations

The amount of time that it would take to reach CR_{eq} would be:

t = (N)(l_{ave}) = (9 generations)(0.813 seconds / generation = 0.7 seconds

Thus, the “gradual increase to a stable value” takes 0.7 seconds.

The reference for this question was Burn, R. Introduction to Nuclear Reactor Operations, 1982. Page 5-13 shows similar calculations for Keff = 0.5, 0.9, and 0.999 which have corresponding times to reach CR_{eq} of 1 second, 6.6 seconds, and 11.5 minutes assuming a generation time of 0.1 second. A gradual increase in counts only occurs when Keff is very close to one.

RINSC operators never really observe the effect of subcritical multiplication because the Start-Up Counter has a logarithmic scale, and the standard start-up for RINSC does not involve multiple control rod withdrawals while the reactor is being brought up to critical.

Consequently, the candidate’s answer is correct under conditions in which Keff << 1, and it reflects what is observed in the control room.

NRC Resolution:

Comment accepted. The answer key for A.8 will be modified to accept both “a” and “c” as correct.

Question (A.9)

Most nuclear text books list U-235 delayed neutron fraction (β_i) as being 0.0065Δρ. Most research reactors however have an effective delayed neutron fraction ($\beta_{effective}$) of 0.0070 Δρ. Which one of the following is the reason for this difference?

a. Delayed neutrons are born at higher energies than prompt neutrons resulting in a greater worth for the neutrons.

b. Delayed neutrons are born at lower energies than prompt neutrons resulting in a greater worth for the neutrons.

c. The fuel includes U^{238} which has a relatively large β for fast fission.

d. The fuel includes U^{238} which via neutron absorption becomes Pu^{239} which has a larger β for fission.

Answer: b

Facility Comment:

The question asked for the reason that β and βeff are different.

βeff was not discussed during training. RINSC management considers it to be important for reactor operators to understand the difference between prompt and delayed neutrons in terms of their respective origins and lifetimes, and the effect that delayed neutrons have on controlling the fission reaction. As part of this, operators should be aware that β represents the delayed neutron fraction. However, understanding βeff is beyond the scope of what an operator needs to know because the difference between β and βeff is negligible.

Consequently, the facility requests that this question be deleted.

NRC Resolution:

Comment accepted. Question A.9 will be deleted from the examination

Question (A.11)

You perform two initial startups a week apart. Each of the startups has the same starting conditions, (core burnup, pool and fuel temperature, and count rate are the same). The only difference between the two startups is that during the **SECOND** one you stop for 10 minutes to answer the phone. For the second startup compare the critical rod height and count rate to the first startup.

	Rod Height	Count Rate
a.	Higher	Same
b.	Lower	Same
c.	Same	Lower
d.	Same	Higher

Answer: d

Facility Comment:

The question asked the candidate to compare two start-ups that are under identical conditions, the second of which is interrupted with a ten minute delay during rod pulls. The reference for this question was Burn, R. Introduction to Nuclear Reactor Operations, 1982, Sect 5.7.

This reference was not used for training. Furthermore, upon review of this reference, I was unable to find any discussion or explanation about what the impact of subcritical multiplication is on critical rod height or count rate when Keff reaches 1. The DOE Fundamentals Handbook that was used for training discusses subcritical multiplication in Module 4 Nuclear Physics and Reactor Theory. That discussion, just as Reed Burns's discussion, is limited to the effect of source neutrons on count rate under conditions in which Keff < 1, the derivation of CR_0 / CR_1 = (1-K_1) / (1-K_0), and the use of 1/M plots. Neither reference indicates that a ten minute delay during rod withdrawal would lead to a higher count rate with control rods at the same height that they would have been if there had been no delay in rod withdrawal. The magnitude of the difference in count rate would be dependent on what Keff was when the interruption occurred. If the interruption occurred early in the start-up, then the critical count rate would be approximately the same as if there had been no interruption. If it occurs late in the start-up, then the difference will be significant.

Since the training materials that were used, as well as the question reference do not provide this information, the facility requests that this question be deleted.

NRC Resolution:

Comment accepted. Question A.11, as written, will be deleted from this examination.

U. S. NUCLEAR REGULATORY COMMISSION
NON-POWER INITIAL REACTOR LICENSE EXAMINATION

FACILITY:	RINSC
REACTOR TYPE:	Pool
DATE ADMINISTERED:	2007/12/11
REGION:	I
CANDIDATE:	

INSTRUCTIONS TO CANDIDATE:
Answers are to be written on the answer sheet provided. Attach the answer sheets to the examination. Points for each question are indicated in parentheses for each question. A 70% in each section is required to pass the examination. Examinations will be picked up three (3) hours after the examination starts.

CATEGORY VALUE	% OF TOTAL	CANDIDATE'S SCORE	% OF CATEGORY VALUE		CATEGORY
20.00	33.3	______	____	A.	REACTOR THEORY, THERMODYNAMICS AND FACILITY OPERATING CHARACTERISTICS
20.00	33.3	______	____	B.	NORMAL AND EMERGENCY OPERATING PROCEDURES AND RADIOLOGICAL CONTROLS
20.00	33.3	______	____	C.	FACILITY AND RADIATION MONITORING SYSTEMS
60.00		______ FINAL GRADE	____%		TOTALS

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

Candidate's Signature

ENCLOSURE 3

Section A Theory & Fac. Operating Characteristics

A N S W E R   S H E E T

Multiple Choice   (Circle or X your choice)
If you change your answer, write your selection in the blank.

MULTIPLE CHOICE

001 a b c d ___

002 a b c d ___

003 a b c d ___

004 a b c d ___

005 a b c d ___

006 a b c d ___

007 a b c d ___

008 a b c d ___

009 a b c d ___

010 a b c d ___

011 a b c d ___

012 a b c d ___

013 a b c d ___

014 a b c d ___

015 a b c d ___

016 a b c d ___

017 a b c d ___

018 a b c d ___

019 a b c d ___

(***** END OF CATEGORY A *****)

A N S W E R S H E E T

Multiple Choice (Circle or X your choice)
If you change your answer, write your selection in the blank.

001 a b c d ___

002 a b c d ___

003 a b c d ___

004 a b c d ___

005 a ___ b ___ c ___ d ___

006 a ___ b ___ c ___ d ___

007 a b c d ___

008 a b c d ___

009 a b c d ___

010 1 ___ 2 ___ 3 ___ 4 ___

~~011 a b c d~~ ___

012 a b c d ___

013 a b c d ___

014 a b c d ___

015 a b c d ___

016 a b c d ___

017 a b c d ___

(***** END OF CATEGORY B *****)

C. PLANT AND RAD MONITORING SYSTEMS

A N S W E R   S H E E T

Multiple Choice (Circle or X your choice)
If you change your answer, write your selection in the blank.

001 a b c d ___

002 a b c d ___

003 a b c d ___

004 a b c d ___

005 a b c d ___

006 a b c d ___

007 a b c d ___

008 a b c d ___

009 a b c d ___

010 a b c d ___

011 a b c d ___

012 a b c d ___

013 a b c d ___

014 a ___ b ___ c ___ d ___

015 a b c d ___

016 a b c d ___

~~017 a b c d~~ ___

018 a b c d ___

019 a b c d ___

(***** END OF CATEGORY C *****)
(********** END OF EXAMINATION **********)

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. After the examination has been completed, you must sign the statement on the cover sheet indicating that the work is your own and you have neither received nor given assistance in completing the examination. This must be done after you complete the examination.

3. 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.

4. Use black ink or dark pencil <u>only</u> to facilitate legible reproductions.

5. Print your name in the blank provided in the upper right-hand corner of the examination cover sheet and each answer sheet.

6. Mark your answers on the answer sheet provided. USE ONLY THE PAPER PROVIDED AND DO NOT WRITE ON THE BACK SIDE OF THE PAGE.

7. The point value for each question is indicated in [brackets] after the question.

8. If the intent of a question is unclear, ask questions of the examiner only.

9. When turning in your examination, assemble the completed examination with examination questions, examination aids and answer sheets. In addition turn in all scrap paper.

10. Ensure all information you wish to have evaluated as part of your answer is on your answer sheet. Scrap paper will be disposed of immediately following the examination.

11. To pass the examination you must achieve a grade of 70 percent or greater in each category.

12. There is a time limit of three (3) hours for completion of the examination.

EQUATION SHEET

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

$P_{max} = \dfrac{(\rho - \beta)^2}{2\alpha(k)\ell}$

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

$SCR = S/(1\text{-Keff})$

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

$CR_1 (1\text{-Keff})_1 = CR_2 (1\text{-Keff})_2$

$SUR = \dfrac{26.06 (\lambda_{eff}\rho)}{(\beta - \rho)}$

$M = \dfrac{(1\text{-Keff})_0}{(1\text{-Keff})_1}$

$SUR = 26.06/\tau$

$M = 1/(1\text{-Keff}) = CR_1/CR_0$

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

$SDM = (1\text{-Keff})/\text{Keff}$

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

$Pwr = W_f \dot{m}$

$P = \dfrac{\beta(1-\rho)}{\beta-\rho} P_o$

$\ell^* = 1 \times 10^{-5}$ seconds

$\tau = (\ell^*/\rho) + [(\bar{\beta}-\rho)/\lambda_{eff}\rho]$

$\tau = \ell^*/(\rho-\bar{\beta})$

$\rho = (\text{Keff}-1)/\text{Keff}$

$\lambda_{eff} = 0.1$ seconds^{-1}

$\rho = \Delta\text{Keff}/\text{Keff}$

$T_{1/2} = \dfrac{0.693}{\lambda}$

$\bar{\beta} = 0.0070$

$DR_1 D_1^2 = DR_2 D_2^2$

$DR = DR_o e^{-\lambda t}$

$DR = \dfrac{6CiE(n)}{R^2}$

$DR \equiv$ R/hr, $Ci \equiv$ Curies, $E \equiv$ Mev, $R \equiv$ feet

1 Curie = $3.7\text{x}10^{10}$ dps

1 kg = 2.21 lbm

1 hp = $2.54\text{x}10^3$ BTU/hr

1 Mw = $3.41\text{x}10^6$ BTU/hr

1 BTU = 778 ft-lbf

°F = 9/5°C + 32

1 gal $H_2O \approx$ 8 lbm

°C = 5/9 (°F - 32)

Question A.1 [1.0 point]

A reactor scram has resulted in the instantaneous insertion of .006 ΔK/K of negative reactivity. Which one of the following is the stable negative reactor period resulting from the scram?

a. 45 seconds

b. 56 seconds

c. 80 seconds

d. 112 seconds

Question A.2 [1.0 point]

The count rate is 50 cps. An experimenter inserts an experiment into the core, and the count rate decreases to 25 cps. Given the initial K_{eff} of the reactor was 0.8, what is the worth of the experiment?

a. $\Delta\rho$ = - 0.42

b. $\Delta\rho$ = + 0.42

c. $\Delta\rho$ = - 0.21

d. $\Delta\rho$ = + 0.21

Question A.3 [1.0 point]

Given the lowest of the high power scrams is 110%, and the scram delay time is 0.5 sec. If the reactor is operating at 100% power prior to the scram, approximately how high will reactor power get with a positive 20 second period?

a. 113%

b. 116%

c. 124%

d. 225%

Question A.4 [1.0 point]

Excess reactivity is the amount of reactivity:

a. associated with samples.

b. needed to achieve prompt criticality.

c. available above that which is required to make the reactor subcritical.

d. available above that which is required to keep the reactor critical.

Question A.5 [1.0 point]

Which one of the following is the MAJOR source of energy recovered from the fission process?

a. Kinetic energy of the fission neutrons

b. Kinetic energy of the fission fragments

c. Decay of the fission fragments

d. Prompt gamma rays

Question A.6 [1.0 point]

Which statement illustrates a characteristic of Subcritical Multiplication?

a. As Keff approaches unity (1), for the same increase in Keff, a greater increase in neutron population occurs.

b. The number of neutrons gained per generation gets larger for each succeeding generation.

c. The number of fission neutrons remains constant for each generation.

d. The number of source neutrons decreases for each generation.

Question A.7 [1.0 point]

If reactor power is increasing by a decade every minute, it has a period of:

a. 13 sec

b. 26 sec

c. 52 sec

d. 65 sec

Question A.8 [1.0 point]

Which one of the following statements describes Count Rate characteristics after a control rod withdrawal with the reactor subcritical? (Assume the Rx remains subcritical.)

a. Count Rate will rapidly increase (prompt jump) then gradually increase to a stable value.

b. Count Rate will rapidly increase (prompt jump) then gradually decrease to the previous value.

c. Count Rate will rapidly increase (prompt jump) to a stable value.

d. There will be no change in Count Rate until criticality is achieved.

Question A.9 [1.0 point]

Most nuclear text books list U-235 delayed neutron fraction (β_i) as being 0.0065$\Delta\rho$. Most research reactors however have an effective delayed neutron fraction ($\beta_{effective}$) of 0.0070 $\Delta\rho$. Which one of the following is the reason for this difference?

a. Delayed neutrons are born at higher energies than prompt neutrons resulting in a greater worth for the neutrons.

b. Delayed neutrons are born at lower energies than prompt neutrons resulting in a greater worth for the neutrons.

c. The fuel includes U^{238} which has a relatively large β for fast fission.

d. The fuel includes U^{238} which via neutron absorption becomes Pu^{239} which has a larger β for fission.

Question A.10 [1.0 point]

Select the condition NOT assumed when calculating shutdown margin.

a. The highest worth shim safety rod is fully withdrawn.

b. The regulating rod fully withdrawn.

c. The reactor is in the cold condition without Xe.

d. The reactor has been shutdown for greater than 48 hours.

Question A.11 [1.0 point]

You perform two initial startups a week apart. Each of the startups has the same starting conditions, (core burnup, pool and fuel temperature, and count rate are the same). The only difference between the two startups is that during the **SECOND** one you stop for 10 minutes to answer the phone. For the second startup compare the critical rod height and count rate to the first startup.

	Rod Height	Count Rate
a.	Higher	Same
b.	Lower	Same
c.	Same	Lower
d.	Same	Higher

Question A.12 [1.0 point]

An element decays at a rate of 20% per day. Determine its half-life.

a. 3 hr.

b. 75 hr.

c. 108 hr.

d. 158 hr.

Question A.13 [1.0 point]

Which ONE of the following is the reason for the -80 second period following a reactor scram?

a. The negative reactivity added during a scram is greater than á-effective

b. The half-life of the longest-lived group of delayed neutron precursors is approximately 55 seconds

c. The fuel temperature coefficient adds positive reactivity as the fuel cools down, thus retarding the rate at which power drops

d. The amount of negative reactivity added is greater than the Shutdown Margin

Question A.14 [1.0 point]

Which One of the following is the time period in which the maximum amount of XE^{135} will be present in the core?

a. 8 to 10 hours after a startup to 100% power.

b. 4 to 6 hours after a power increase from 50% to 100%.

c. 4 to 6 hours after a power decrease from 100% to 50%.

d. 8 to 10 hours after a scram from 100%.

Question A.15 [1.0 point]

Which ONE of the following describes the difference between reflectors and moderators?

a. Reflectors decrease core leakage while moderators thermalize neutrons

b. Reflectors shield against neutrons while moderators decrease core leakage

c. Reflectors decrease thermal leakage while moderators decrease fast leakage

d. Reflectors thermalize neutrons while moderators decrease core leakage

Question A.16 [1.0 point]

Experimenters are attempting to determine the critical mass of a new fuel material. As more fuel was added the following fuel to count rate data was taken:

Fuel	Counts/Sec
1.00 kg	500
1.50 kg	800
2.00 kg	1142
2.25 kg	1330
2.50 kg	4000
2.75 kg	15875

Which one of the following is the amount of fuel needed for a critical mass?

a. 2.60 kg

b. 2.75 kg

c. 2.80 kg

d. 2.95 kg

Question A.17 [1.0 point]

With the reactor on a constant period, which transient requires the LONGEST time to occur?

A reactor power change of:

a. 5% power going from 1% to 6% power

b. 10% power going from 10% to 20% power

c. 15% power going from 20% to 35% power

d. 20% power going from 40% to 60% power

Question A.18 [1.0 point]

The reactor has scrammed following an extended period of operation at full power.
Which one of the following accounts for generation of a majority of the heat one (1) hour after the scram?

a. Spontaneous fissions

b. Delayed neutron fissions

c. Alpha fission product decay

d. Beta fission product decay

Question A.19 [1.0 point]

The term "reactivity" is described as:

a. a measure of the core's fuel depletion.

b. negative when Keff is greater than 1.0.

c. a measure of the core's deviation from criticality.

d. being equal to $0.66 when the reactor is prompt critical.

Question B.1 [1.0 point]

In order to ensure the health and safety of the public, in an emergency, 10CFR50 allows the operator to deviate from Technical Specifications. What is the minimum level of authorization needed to deviate from Tech. Specs?

a. USNRC

b. Reactor Supervisor

c. Licensed Senior Reactor Operator.

d. Licensed Reactor Operator.

Question B.2 [1.0 point]

In Natural Convection Flow Mode, the reactor thermal power setpoint of 115 kw is an example of a:

a. safety limit.

b. limiting safety system setting.

c. limiting condition for operation.

d. surveillance requirement.

Question B.3 [1.0 point]

Which one of the following statements defines the Technical Specifications term "Channel Test?"

a. The adjustment of a channel such that its output corresponds with acceptable accuracy to known values of the parameter which the channel measures

b. The qualitative verification of acceptable performance by observation of channel behavior

c. The introduction of a signal into a channel for verification of the operability of the channel

d. The combination of sensors, electronic circuits and output devices connected to measure and display the value of a parameter

Question B.4 [1.0 point]

Which one of the following instruments should you use to survey a gamma source?

a. Thin window ion chamber.

a. GM tube.

b. Ion chamber (open window).

c. Neutron ball.

Question B.5 [2.0 points, 0.5 each]

Match the type of radiation in column A with its associated Quality Factor (10CFR20) from column B.

Column A	Column B
a. alpha	1
b. beta	2
c. gamma	5
d. neutron (unknown energy)	10
	20

Question B.6 [2.0 points, 0.5 each]

Match the radiation reading from column A with its corresponding radiation area classification (per 10 CFR 20) listed in column B.

COLUMN A	COLUMN B
a. 10 mRem/hr	1. Unrestricted Area
b. 150 mRem/hr	2. Radiation Area
c. 10 Rem/hr	3. High Radiation Area
d. 550 Rem/hr	4. Very High Radiation Area

Question B.7 [1.0 point]

A radioactive source generates a dose of 100 mr/hr at a distance of 10 feet. Using a two inch thick sheet of lead for shielding the reading drops to 50 mr/hr at a distance of 10 feet. What is the minimum number of sheets of the same lead shielding needed to drop the reading to less than 5 mr/hr at a distance of 10 ft?

a. 1

b. 3

c. 5

d. 7

Question B.8 [1.0 point]

Which one of the following is the 10 CFR 20 definition of **TOTAL EFFECTIVE DOSE EQUIVALENT (TEDE)**?

a. The sum of the deep dose equivalent and the committed effective dose equivalent.

b. The dose that your whole body receives from sources outside the body.

c. The sum of the external deep dose and the organ dose.

d. The dose to a specific organ or tissue resulting from an intake of radioactive material

Question B.9 [1.0 point]

A room contains a source which, when exposed, results in a general area dose rate of 175 millirem per hour. This source is scheduled to be exposed continuously for 25 days. Select an acceptable method for controlling radiation exposure from the source within this room.

a. Post the area with words “Danger-Radiation Area”.

b. Equip the room with a device to visually display the current dose rate within the room.

c. Equip the room with a motion detector that will alarm in the control room.

d. Lock the room to prevent inadvertent entry into the room.

Question B.10 [2.0 points, 0.5 each]

Match the requirements (10 CFR 55) for maintaining an active operator license in column A with the correct time period from column B.

Column A	Column B
1. Renewal of license	a. 4 months
2. Medical examination	b. 1 year
3. Console manipulation evaluation	c. 2 years
4. Requalification exam (written)	d. 6 years

~~Question B.11~~ Deleted Prior to Administration of Examinations

Question B.12 [1.0 point]

Which one of the following is NOT a guidance/recommendation under “Planned Occupational Exposure under Emergency Conditions” for *Life Saving Actions*?

a. Planned whole body dose not to exceed 100 rems.

b. Persons receiving exposures under the planned actions should avoid procreation for a few months.

c. Planned dose to hands and forearms not to exceed 300 rems.

d. The younger volunteers should perform the rescue.

Question B.13 [1.0 point]

At the RINSC the Emergency Support Center (ESC) is ...

a. the control room

b. the South County Hospital in Wakefield, RI.

c. the Coastal Institute Building.

d. the reactor building and the basement area beneath the reactor building.

Question B.14 [1.0 point]

Which one of the following does NOT require NRC approval for changes?

a. Facility License

b. Requalification plan

c. Emergency Implementation Procedures

d. Emergency Plan

Question B.15 [1.0 point]

Which one of the following is a duty of the Reactor Operator (RO) during an emergency which requires a facility evacuation?

a. Leave building taking Log Book.

b. Verify all persons are accounted for.

c. Assure that reactor is secured.

d. Verify all doors to the reactor building are closed.

Question B.16 [1.0 point]

The reactor is in steady-state power at 90% when you, the operator, notice that the Emergency Generator is inoperable. Which one of the following describes the correct action you should take?

a. Shutdown the reactor. Technical Specifications (T.S.) do not allow operations of the reactor without it.

b. Continue operation. T.S. allow the unit to be out of service for up to 7 days.

c. Continue operation. Within 24 hours of recognition of failure, replace the unit with a portable generator.

d. Continue operation as long as a minimum of two licensed operators are in the control room at all times.

Question   B.17   [1.0 point]

It is April 1, 2007. You have stood watch for the following hours during the last quarter:
Jan. 11, 2007 0.5 hours
Feb. 24, 2007   1.5 hours
Mar. 16, 2007   1.0 hours

What requirements must you meet in order to stand an RO watch today?

a. None. You've met the minimum requirements of 10 CFR 55.

b. You must perform 4 hours of shift functions under the direction of a licensed operator or licensed senior operator as appropriate.

c. You must perform 6 hours of shift functions under the direction of a licensed operator or licensed senior operator as appropriate.

d. You must submit a new application form to the NRC requesting a waiver to reactivate your license.

(*** End of Section B ***)

Question C.1 [1.0 point]

While operating in the Natural Convection Flow Mode which one of the following will result in a reactor scram?

a. Primary Coolant Flow = 40 gpm

b. Coolant Outlet Temperature = 123°F

c. Log N amplifier high voltage at 40 volts

d. Reactor Power = 110 kw

Question C.2 [1.0 point]

Which one of the following actions may stop a leak from a beam port vent line ?

a. Installing the cover flange on the tube end.

b. Plugging the outer tube instrument leads hole.

c. Installing the outer tube concrete filled plugs.

d. Closing the beam port shutter.

Question C.3 [1.0 point]

The "TEST" position of the Master Switch allows:

a. insertion of scram signals without de-energizing the scram magnets.

b. control power and lamp indication operability testing.

c. control blade drive motion without energizing the scram magnets.

d. control blade drive motion with energized scram magnets.

Question C.4 [1.0 point]

The thermal column design prevents radiation streaming by:

a. a movable lead shutter that is normally closed.

b. installation of portable shielding around the experiment.

c. alternately stacked graphite logs and a stepped closure door.

d. concrete filler plugs.

Question C.5 [1.0 point]

Which one of the following actions should NOT automatically occur when the evacuation button is depressed?

a. The air conditioning and normal ventilation fans turn off.

b. All dampers on ventilating ducts leading outside close.

c. The building cleanup system air scrubber and fresh air blower turn off.

d. The off-gas blower and rabbit system blower turn off.

Question C.6 [1.0 point]

Based upon the LOCA analysis, which one of the following is NOT assumed in order to conclude that the loss of coolant event would not cause core damage?

a. All beamport fixed experiments are designed to withstand a minimum of 25.09 feet of water pressure.

b. No beamport experiment will be installed with a barrier having an opening greater than the equivalent area of a 1/2 inch diameter hole.

c. The capacity of the normal pool make-up system shall exceed the loss of coolant flow rate.

d. The maximum loss of coolant flow rate is 20 gallons.

Question C.7 [1.0 point]

Which one of the listed tanks is the normal collection point for non-sanitary liquid waste from the reactor building?

a. Delay Tank

b. Radiation Waste Tank

c. Retention Tank

d. Resin Tank

Question C.8 [1.0 point]

Which ONE of the following scrams is an 'electric' scram?

a. Gate

b. Seismic

c. High Voltage failure

d. Reactor Period

Question C.9 [1.0 point]

What is the maximum acceptable time between the initiation of a scram signal, and the time that any shim safety rod is fully inserted in the core?

a. 1sec.

b. 0.8 sec.

c. 10 sec.

d. 100 msec.

Question C.10 [1.0 point]

Which one of the following will limit the size of the leakage area in the event of a coolant leak due to failure of the Through Tube?

a. Fixed experiment barriers.

b. Flanges at each end of through tube.

c. Anti-siphon valves.

d. Through tube shutter.

Question C.11 [1.0 point]

Which of the following electrical loads is POWERED by the Nuclear Center Generator when normal power is lost?

a. Sump Pump

b. Stack Monitor (CAM)

c. Primary Coolant Pump

d. Console Power

Question C.12 [1.0 point]

Which one of the following conditions will generate an alarm when the Power Level Selector switch is in the "0.1 MW" position?

a. Thermal Column flow sensor reads zero.

b. Bridge movement is detected by sensor.

c. Secondary coolant flow rate is 750 gpm

d. Core outlet temperature is 122°F

Question C.13 [1.0 point]

Which one of the following nuclear instrumentation amplifiers sends a signal to the servo system?

a. Start-up preamplifier 10AR1

b. Log-N Period Amplifier 11AR1

c. Stable Picoammeter 12AR1

d. Stable Picoammeter 12AR2

Question C.14 [2.0 point]

For each of the parameters listed in column A, list the correct plant response from column B.

COLUMN A	**COLUMN B**
a. Bridge movement	1. Alarm only
b. One safety blade disengaged from magnet	2. Scram only
c. High conductivity (primary)	3. Alarm and Scram
d. High Voltage failure	4. No response

Question C.15 [1.0 point]

Which one of the following is the approximate flow rate of the automatic pool water make-up system?

a. 2 gallons/minute

b. 5 gallons/minute

c. 20 gallons/minute

d. 31 gallons/minute

Question C.16 [1.0 point]

Which of the following safety system scrams is NOT bypassed when the Power Level Selector Switch is in the 0.1 Mwatt position?

a. High Temperature Primary Coolant leaving Core

b. Primary Coolant Low Flow Rate

c. Bridge Low Power Position

d. Low Pool Water Level

~~Question C.17~~ Deleted Prior to Administration of Examinations

Question C.18 [1.0 point]

The cladding material for the LEU fuel element is...?

a. 6061 Al

b. B_4C clad with AL

c. U_3Si_2-Al

d. Type 304 Stainless Steel

Question C.19 [1.0 point]

Identify the control blade assembly component that provides the “Stop” signal to the drive assembly at either end of blade travel.

a. Drive shaft worm gear.

b. Helical potentiometer

c. Motor limit switch

d. Electromagnetic clutch

(*** End of Examinatiuon ***)

A.1 c
REF: Burn, R., *Introduction to Nuclear Reactor Operations,* © 1982, § 4.6, p. 4-16.

A.2 a
REF:
$CR_1 / CR_2 = (1 – Keff_2) / (1 – Keff_1) \rightarrow 50 / 25 = (1 – Keff_2) / (1 – 0.8)$
Therefore $Keff_2 = 0.6$
$\Delta\rho = Keff_2 – Keff_1 / Keff_2 \cdot Keff_1 = (0.6 – 0.8) / (0.6 \cdot 0.8) = - 0.41667$/CR2=(1-Keff2)/(1-Keff1)

A.3 a
REF: $P = P_0 e^{t/\tau}$ $P_o = 110\%$ $\tau = 20$ sec. t = 0.5 $P = 110 e^{0.5/20} = 112.78\%$

A.4 d
REF: Glasstone and Sesonske, *Nuclear Reactor Engineering*, Chapter 5, Section 5.114

A.5 b
REF: Standard NRC Reactor Theory Question

A.6 a
REF: Standard NRC Reactor Theory Question

A.7 b
REF: Glasstone, S. and Sesonske, A, *Nuclear Reactor Engineering,* Kreiger Publishing, Malabar, Florida, 1991,
$P = P_o e^{t/T}$ $10 = 1e^{60/T}$ ln 10 = 60/T 2.3 = 60/T T = 60/2.3 T = 26 seconds

A.8 a
REF: Burn, R., *Introduction to Nuclear Reactor Operations,* © 1982, § 5.7, pp. 5-28 — 5-38

A.9 b
REF: Standard NRC Reactor Theory Question

A.10 d
REF: NSC Tech Spec 3.1.3

A.11 d
REF: Burn, R. Introduction to Nuclear Reactor Operations, 1982, Sect. 5.7

A.12 b
REF: $A = A_o e^{-\lambda t}$ $\lambda = .693 / T2 \rightarrow \ln A/A_o = - .693\, t / T2$
$T2 = - .693 \cdot 24hr / \ln 0.8 = 75$ hr

A.13 b
REF: Introduction to Nuclear Reactor Operations, Reed Robert Brown, Section 3.2.2, Delayed Neutrons.

A.14 d
REF: Burn, R., *Introduction to Nuclear Reactor Operations,* © 1988

A.15 a
REF: Introduction to Nuclear Reactor Operations, Reed Robert Brown, Section 5.4, Inverse Multiplication, p. 5-14.

A.16 c
REF: Glasstone, S. and Sesonske, A, *Nuclear Reactor Engineering,* Kreiger Publishing, Malabar, Florida, 1991, §§ 3.161 — 3.163, pp. 190 & 191.

A.17 a
REF: Introduction to Nuclear Reactor Operations, Reed Robert Brown, Section 4.3, Reactor Period and Reactor Power

A.18 d
REF: Burn, R., *Introduction to Nuclear Reactor Operations,* © 1988 pg. 3-4~~.~~

A.19 c
REF: Lamarsh, J.R., *Introduction to Nuclear Engineering,* Addison-Wesley Publishing, Reading, Massachusetts, 1983. § , p. 282.

B.1 c
REF: 10CFR50.54(y)

B.2 b
REF: TS 2.2.2

B.3 c
REF: TS 1.5.1

B.4 b
REF: Nuclear Power Plant Health Physics and Radiation Protection, Ch. 10

B.5 a, 20; b, 1; c, 1; d, 10
REF: 10CFR20.100x

B.6 a, 2; b, 3; c, 3; d, 4
REF: 10 CFR 20.1003, Definitions

B.7 c
REF: Two inches = one-half thickness ($T_{½}$). Using 5 half-thickness will drop the dose by a factor of $(½)^5 = 1/32$ □ $100/32 = 3.13$

B.8 a
REF: 10 CFR 20.1003 *Definitions*

B.9 d
REF: 10 CFR 20.1601

B.10 1 d 2 c 3 b 4 c
REF: 10CFR55

~~B.11~~ Deleted Prior to Administration of Examinations

B.12 d
REF: Emergency Plan §7.5.1 Life Saving Actions

B.13 c
REF: EPIP

B.14 c
REF: 10 CFR 50.54 q; 10 CFR 50.59; 10 CFR 55.59

B.15 a
REF: EPIP

B.16 a
REF: T.S. 3.6

B.17 c
REF: 10CFR55.53(e) & (f)

(*** End of Section B ***)

C.1 c
REF: T.S. Table 2.1.2g. 22

C.2 d
REF: SAR LEU Conversion - Beamport Description

C.3 c
REF: General Electric Operation and Maintenance Manual

C.4 c
REF: SAR

C.5 c
REF: Facility provided Question

C.6 c
REF: SAR (HEU to LEU Conv.); Loss of Coolant Analysis pg. 17-18

C.7 c
REF: 1993 NRC Exam

C.8 d
REF: General Electric Operation Manual

C.9 a
REF: T.S. 3.2.3

C.10 b
REF: SAR (HEU to LEU Conv.); Loss of Coolant Analysis pg. 17

C.11 a
REF: Facility supplied Question

C.12 b
REF: SAR (HEU - LEU) Table F.1

C.13 c
REF: Operation and Maintenance Manual Table 1-2 pg. 1-47

C.14 a. 3; b. 1; c 4; d 3
REF: Facility supplied Question

C.15 b
REF: SAR Section 13.2.3

C.16 d
REF: Facility supplied Question

~~C.17~~ Deleted Prior to Administration of Examinations

C.18 a
REF: Fig. 3 - SAR for the LEU fuel conversion.

C.19 c
REF: SAR for HEU to LEU Conversion; Appendix F pg. 43

(*** End of Section C ***)
(***** End of Examination *****)