April 18, 2017

Dr. Cameron Goodwin, Director
Rhode Island Nuclear Science Center
Rhode Island Atomic Energy Commission
16 Reactor Road
Narragansett, RI 02882-1165

SUBJECT: EXAMINATION REPORT NO. 50-193/OL-17-01, RHODE ISLAND ATOMIC ENERGY COMMISSION

Dear Dr. Goodwin:

During the week of March 20, 2017, the U.S. Nuclear Regulatory Commission (NRC) administered operator licensing examinations at your Rhode Island Nuclear Science Center Reactor. The examinations were conducted according to NUREG-1478, "Operator Licensing Examiner Standards for Research and Test Reactors," Revision 2. 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 Mr. John T. Nguyen at (301) 415-4007 or via e-mail at John.Nguyen@nrc.gov.

Sincerely,

/RA/

Anthony J. Mendiola, Chief
Research and Test Reactors Oversight Branch
Division of Policy and Rulemaking
Office of Nuclear Reactor Regulation

Docket No. 50-193

Enclosures:
1. Examination Report No. 50-193/OL-17-01
2. Written Examination

cc: Jeff Davis, Assistant Director, Operations
cc w/o enclosures: See next page

SUBJECT: EXAMINATION REPORT NO. 50-193/OL-17-01, RHODE ISLAND ATOMIC ENERGY COMMISSION DATED APRIL 18, 2017

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NAME	JNguyen	ABaxter	AMendiola
DATE	3/28/2017	4/04/2017	4/18/2017

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cc:

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U. S. NUCLEAR REGULATORY COMMISSION
OPERATOR LICENSING INITIAL EXAMINATION REPORT

REPORT NO.: 50-193/OL-17-01

FACILITY DOCKET NO.: 50-193

FACILITY LICENSE NO.: R-95

FACILITY: RHODE ISLAND ATOMIC ENERGY COMMISSION

EXAMINATION DATES: March 20 – March 22, 2017

SUBMITTED BY: _______/RA/_______________ _03/28/2017_
John T. Nguyen, Chief Examiner Date

SUMMARY:

During the week of March 20, 2017, the NRC administered operator licensing examination to two Reactor Operator (RO) candidates. The candidates passed all portions of the operating examination.

REPORT DETAILS

1. Examiner: John T. Nguyen, Chief Examiner

2. Results:

	RO PASS/FAIL	SRO PASS/FAIL	TOTAL PASS/FAIL
Written	2/0	N/A	2/0
Operating Tests	2/0	N/A	2/0
Overall	2/0	N/A	2/0

3. Exit Meeting:

Jeff Davis, RINSC, Associate Director
Paul Martin, RINSC, Training Supervisor
John Nguyen, NRC, Chief Examiner

The NRC examiners thanked the facility for their support in the administration of the examinations. Mr. Nguyen discussed with the facility management the generic weaknesses observed during their operating tests to include occupational dose limits for adults specified in 10 CFR Part 20.

ENCLOSURE 1

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

FACILITY:	RINSC
REACTOR TYPE:	Pool
DATE ADMINISTERED:	03/21/2017
CANDIDATE:	_______________________

INSTRUCTIONS TO CANDIDATE:
Answers are to be written on the Answer sheet provided. Attach all Answer sheets to the examination. Point values are indicated in parentheses for each question. A 70% in each category 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 2

A. RX THEORY, THERMO & FAC OP CHARS

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.

A01 a ___ b ___ c ___ (0.33 each)

A02 a b c d ___

A03 a b c d ___

A04 a b c d ___

A05 a b c d ___

A06 a b c d ___

A07 a b c d ___

A08 a b c d ___

A09 a b c d ___

A10 a b c d ___

A11 a b c d ___

A12 a b c d ___

A13 a b c d ___

A14 a b c d ___

A15 a b c d ___

A16 a b c d ___

A17 a b c d ___

A18 a b c d ___

A19 a b c d ___

A20 a b c d ___

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

B. NORMAL/EMERG PROCEDURES & RAD CON

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.

B01 a ______ b ______ c ______ (0.33 each)

B02 a b c d ___

B03 a b c d ___

B04 a b c d ___

B05 a b c d ___

B06 a ___ b ___ c ___ d ___ (0.25 each)

B07 a b c d ___

B08 a b c d ___

B09 a b c d ___

B10 a b c d ___

B11 a b c d ___

B12 a b c d ___

B13 a b c d ___

B14 a ___ b ___ c ___ d ___ (0.25 each)

B15 a b c d ___

B16 a b c d ___

B17 a b c d ___

B18 a b c d ___

B19 a b c d ___

B20 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.

C01 a ___ b ___ c ___ d ___ (0.25 each)

C02 a b c d ___

C03 a b c d ___

C04 a b c d ___

C05 a b c d ___

C06 a b c d ___

C07 a b c d ___

C08 a b c d ___

C09 a ___ b ___ c ___ d ___ (0.5 each)

C10 a b c d ___

C11 a b c d ___

C12 a b c d ___

C13 a b c d ___

C14 a b c d ___

C15 a b c d ___

C16 a b c d ___

C17 a b c d ___

C18 a b c d ___

C19 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 only 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

X X
$Q = m\, c_p\, \Delta T$

X X
$Q = m\, \Delta h$

X
$Q = UA\, \Delta T$

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

$SUR = 26.06/\tau$

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

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

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

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

$\rho = (Keff-1)/Keff$

$\rho = \Delta Keff/Keff$

$\bar{\beta} = 0.007$

$DR_1 D_1^2 = DR_2 D_2^2$

$Cp\ (H20) = 0.146\ \frac{kw}{gpm\ \cong EF}$

$\lambda_{eff} = 0.1/sec$

$SCR = S/(1-Keff)$

$CR_1\, (1-Keff)_1 = CR_2\, (1-Keff)_2$

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

$M = 1/(1-Keff) = CR_1/CR_0$

$SDM = (1-Keff)/Keff$

$I = I_o\, e^{-ux}$

$P^* = 1 \times 10^{-4}$ seconds

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

$R = 6\, C\, E\, n/r^2$

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

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

$P = S\, /\, (1 - Keff)$

$$\Delta\rho = \frac{K_{eff_2} - K_{eff_1}}{K_{eff_1} K_{eff_2}}$$

---

1 Curie = 3.7×10^{10} dps

1 hp = 2.54×10^{3} BTU/hr

1 BTU = 778 ft-lbf

931 Mev = 1 amu

1 kg = 2.21 lbm

1 Mw = 3.41×10^{6} BTU/hr

EF = 9/5EC + 32

EC = 5/9 (EF - 32)

QUESTION A.01 [1.0 point, 0.33 each]
Match the term listed in Column A with its corresponding unit listed in column B.

	Column A	Column B
a.	1 barn	1. cm^{-1}
b.	Macroscopic Cross Section	2. $10^{-24}\ cm^2$
c.	Neutron Flux	3. Neutrons / cm^2/sec

QUESTION A.02 [1.0 point]
For the alpha decay of a nuclide, the number of protons will ___________ and its atomic mass number will __________.

a. increase by 2 / increase by 2

b. decrease by 2 /decrease by 4

c. decrease by 4 / decrease by 2

d. increase by 4 / increase by 2

QUESTION A.03 [1.0 point]
The FAST FISSION FACTOR is defined as a ratio of:

a. the number of neutrons that reach thermal energy over the number of fast neutrons that start to slow down.

b. the number of fast neutrons produced from fission in a generation over the number of fast neutrons produced from fission in the previous generation.

c. the number of fast neutrons produced from U-238 over the number of thermal neutrons produced from U-235.

d. the number of fast neutrons produced from all fission over the number of fast neutrons produced from thermal fission.

QUESTION A.04 [1.0 points]
Which ONE of the following is the stable reactor period which will result in a power rise from 1% to 100% power in 2 minutes?

a. 0.5 second

b. 13 seconds

c. 26 seconds

d. 43 seconds

QUESTION A.05 [1.0 point]
Given a source strength of 1000 neutrons per second (N/sec) and a multiplication factor of 0.8, which ONE of the following is the expected stable neutron count rate?

a. 700 N/sec

b. 5000 N/sec

c. 10000 N/sec

d. 20000 N/sec

QUESTION A.06 [1.0 point]
The reactor is SHUTDOWN by 5 %Δk/k with the count rate of 1000 counts per second (cps). The control rods are withdrawn until the count rate is quadrupled. What is the value of K_{eff}?

a. 0.952

b. 0.976

c. 0.988

d. 1.002

QUESTION A.07 [1.0 point]
Inelastic scattering can be described as a process whereby a neutron collides with a nucleus and leaves the nucleus in an excited state. The nucleus later:

a. emits a gamma ray and a neutron with lower energy.

b. emits a gamma ray and a neutron with higher energy.

c. emits a beta particle and a neutron with lower energy.

d. emits an alpha particle ONLY.

QUESTION A.08 [1.0 point]
While a reactor is at 5 watts, the reactor operator is withdrawing a control rod to insert a positive reactivity of 0.156 %Δk/k. Which ONE of the following will be the stable reactor period as a result of this withdrawal? Given beta-effective = 0.0073 and λ_{eff}= 0.1.

a. 17 seconds

b. 27 seconds

c. 37 seconds

d. 47 seconds

QUESTION A.09 [1.0 point]
Which term is described by the following?
"Depart from criticality."

a. 1/M

b. K-effective

c. Reactor period

d. Reactivity

QUESTION A.10 [1.0 point]
A reactor is subcritical with a K_{eff} of 0.927. If you add 7.875% Δk/k into the core, the reactor will be:

a. subcritical

b. critical

c. supercritical

d. prompt critical

QUESTION A.11 [1.0 point]
A reactor is slightly supercritical with the following values for each of the factors in the six-factor formula:

Fast fission factor	1.05
Fast non-leakage probability	0.80
Resonance escape probability	0.90
Thermal non-leakage probability	0.92
Thermal utilization factor	0.80
Reproduction factor	1.86

A control rod is inserted to bring the reactor back to critical. Assuming all other factors remain unchanged, the new value for the thermal utilization factor is:

a. 0.698

b. 0.702

c. 0.743

d. 0.773

QUESTION A.12 [1.0 point]
The following data was obtained during a reactor fuel load.

Step	No. of Elements	Detector A (count/sec)
1	0	100
2	4	120
3	8	140
4	12	200
5	15	400

The estimated number of **additional** elements required to achieve criticality is between:

a. 2 to 3

b. 4 to 5

c. 6 to 8

d. 8 to 10

QUESTION A.13 [1.0 point]
Which term is described by the following?
"The increase in neutron population by providing a positive additional reactivity while the reactor is subcritical"

a. Inverse Multiplication

b. Subcritical Multiplication

c. Neutron Production

d. Source Strength

QUESTION A.14 [1.0 point]
On the average, how many neutrons are produced for each fission of U-235?

a. 2.00 neutrons

b. 2.09 neutrons

c. 2.43 neutrons

d. 2.93 neutrons

QUESTION A.15 [1.0 point]
Which ONE of the following most correctly describes the SIX- FACTOR FORMULA?

a. $K_{eff} = K_{\infty}$ * the total non-leakage probability

b. $K_{\infty} = K_{eff}$ * the total non-leakage probability

c. $K_{eff} = K_{\infty}$ * the total leakage probability

d. $K_{\infty} = K_{eff}$ * the utilization factor

QUESTION A.16 [1.0 point]
Which ONE of the following types of neutrons has a mean neutron generation lifetime of 12.5 seconds?

a. Prompt

b. Delayed

c. Fast

d. Thermal

QUESTION A.17 [1.0 point]
The reactor is at 5 watts. The reactor operator accidentally inserts a fuel element worth of 0.8 $\%\Delta k/k$ into the core. With this insertion, the reactor will be:

a. subcritical

b. critical

c. supercritical

d. prompt critical

QUESTION A.18 [1.0 point]
A mechanism by which a nucleus can gain stability by converting a neutron to a proton or vice versa is called:

a. gamma decay

b. beta decay

c. alpha decay

d. photoelectric effect

QUESTION A.19 [1.0 point]
During a reactor scram from full power, which ONE of the following best describes the values of K-effective and ρ?

a. $K_{eff} = 1$ and $\rho = 0$

b. $K_{eff} < 1$ and $0 < \rho < \beta\text{-eff}$

c. $K_{eff} < 1$ and $\rho < 0$

d. $K_{eff} < 1$ and $1 < \rho <$ infinity (∞)

QUESTION A.20 [1.0 point]
Which ONE of the following is a correct statement of why delayed neutrons enhance the ability to control reactor power than prompt neutrons?

a. Delayed neutrons are born at higher energy levels than prompt neutrons, so delayed neutron can easily cause fission in U-235 with their high energies.

b. Delayed neutrons increase the average neutron lifetime that allows the reactor control rods control the population of delayed neutrons.

c. Prompt neutrons can cause fissions in both U-235 and U-238; whereas delayed neutrons can only cause fissions in U-235.

d. The absorption cross section of delayed neutrons is lower than the absorption cross section of prompt neutrons with U-235.

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

<u>Section B Normal/Emergency Procedures and Radiological Controls</u>

QUESTION B.01 [1.0 point, 0.33 each]
Fill out a blank with appropriate data provided in the bracket. During the Natural Convection Mode, the Limiting Safety System Settings:

a. for reactor thermal power shall be ______. (115 kW/125 kW/2.5 MW)

b. for the height of coolant above the top of the uranium silicide fuel shall be ______. (21'7''/22'7''/23'7")

c. for the bulk pool temperature shall be _______. (122 °F/125 °F/127 °F)

QUESTION B.02 [1.0 point]
Reactor Operator works in a high radiation area for eight (8) hours a day. The dose rate in the area is 100 mR/hour. Which ONE of the following is the <u>MAXIMUM number of days</u> in which Reactor Operator may perform his duties WITHOUT exceeding 10 CFR 20 limits?

a. 5 days

b. 6 days

c. 7 days

d. 12 days

QUESTION B.03 [1.0 point]
You receive a quarterly dosimetry report stating that you have received whole body occupational exposures of:
1 mrem of beta
1 mrem of alphas
1 mrem of neutrons of unknown energy
What would be the total effective dose equivalent?

a. 3 mrem

b. 12 mrem

c. 22 mrem

d. 31 mrem

QUESTION B.04 [1.0 point]
Which ONE of the following correctly describes the limitations of experiment? The experiment with _____ shall NOT be irradiated in the reactor.

a. total non-secured reactivity worth exceeding 0.06 %Δk/k

b. total secured reactivity worth exceeding 0.4 %Δk/k

c. explosive materials

d. fissionable materials

QUESTION B.05 [1.0 point]
A radioactive source reads 5 Rem/hr on contact. Five hours later, the same source reads 1.25 Rem/hr. How long is the time for the source to decay from a reading of 5 Rem/hr to 625 mRem/hr?

a. 6.5 hours

b. 7.5 hours

c. 8.5 hours

d. 9.5 hours

QUESTION B.06 [1.0 point, 0.25 each]
Match the events listed in column A with its emergency classification listed in column B. Values in Column B can be used once, more than once or not at all.

	Column A	Column B
a.	Loss of building electricity	1. Unusual Event
b.	Fire in the reactor control room	2. Alert
c.	Hurricane causing damage to the reactor building and reactor pool resulting in major coolant leakage	3. Site Area Emergency
d.	Receipt of a bomb threat directly to the reactor facility	4. General Emergency

QUESTION B.07 [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. Persons receiving exposures under the planned actions should avoid procreation for a few months.

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

c. Persons receiving exposures can receive multiple times in a future until exceeding 5 Rem TEDE.

d. Persons receiving exposures shall receive medical attention as soon as possible after their exposure.

QUESTION B.08 [1.0 point]
An annual test of the nuclear instrument was performed. Which ONE of the following is the latest the test that must be performed again without violation of the Technical Specifications?

a. Not to exceed 13 months

b. Not to exceed 14 months

c. Not to exceed 15 months

d. Not to exceed 16 months

QUESTION B.09 [1.0 point]
A radioactive material is decayed 30% after one hour. Determine its half-life?

a. 2 hours

b. 3 hours

c. 4 hours

d. 5 hours

QUESTION B.10 [1.0 point]
A system or component is defined as "OPERABLE" by Technical Specifications when:

a. a system is operational when reactor is in the unsecured condition.

b. a system is operational when reactor is in the shutdown condition.

c. operating whenever it is not unsecured or shutdown.

d. it is capable of performing its intended function.

QUESTION B.11 [1.0 point]
The reactivity worth of the regulating rod shall not exceed ________.

a. 0.08 %Δk/k

b. 0.6 %Δk/k

c. 1.0 %Δk/k

d. 3.0 %Δk/k

QUESTION B.12 [1.0 point]
A two-curie source emits 80% of a 500 K-ev gamma, what is its dose rate at 1 foot?

a. 0.8 R/hr at 1 ft

b. 4.8 R/hr at 1 ft

c. 80 R/hr at 1 ft

d. 480 R/hr at 1 ft

QUESTION B.13 [1.0 point]
Per Procedure SP-01, Facility Access for Visitors, the area that includes the reactor building and the reactor building basement is considered to be the _________.

a. Controlled Access Area

b. Vital Area

c. Unescorted Area

d. Reconvening Area

QUESTION B.14 [1.0 point, 0.25 each]
Match each of the Technical Specification Limits in column A with its corresponding value in column B. (Each limit has only one answer, values in Column B may be used once, more than once or not at all.)

Column A	Column B
a. Worth of single secured experiment	1. 0.08 %Δk/k
b. Non-Secured experiment	2. 0.1 %Δk/k
c. Excess reactivity	3. 0.6 %Δk/k
d. Shutdown margin	4. 1.00 %Δk/k
	5. 3.00 %Δk/k
	6. 4.7 %Δk/k

QUESTION B.15 [1.0 point]
Which ONE of the following hospitals has agreed to accept contaminated victims for medical treatments?

a. Rhode Island Hospital in Providence

b. Kent County Hospital in Warwick

c. South County Hospital in Wakefield

d. Newport Hospital in Newport

QUESTION B.16 [1.0 point]
The ventilation flow through the Emergency Filter Bank shall be verified to be less than or equal to 1500 SCFM. The verification shall be performed at least:

a. quarterly

b. semi-annually

c. annually

d. biennially

QUESTION B.17 [1.0 point]
The below items are listed as a reportable occurrence, EXCEPT:

a. Fuel cladding failure.

b. An uncontrolled reactivity change of 0.7 %ΔK/K.

c. Reactor operation at 2.0 MW with primary pump OFF.

d. Performance of Reactor operation without a completion of the startup checklist.

QUESTION B.18 [1.0 point]
The principal barrier to be used for specification of the safety limit is the:

a. Reactor fuel cladding temperature.

b. Reactor thermal power.

c. Bulk pool temperature.

d. Coolant height.

QUESTION B.19 [1.0 point]
Which ONE of the following changes must be submitted to NRC for approval prior to implementation?

a. Replace a primary cooling pump with an identical pump

b. Add new limitation to the Pre-Startup Checklist Procedure

c. Add more responsibilities to the Radiation Protection Officer listed in the health physics procedure

d. Delete a definition of Channel Test listed in the RINSC Technical Specifications

QUESTION B.20 [1.0 point]
Per RINSC Technical Specifications, the insertion rates of individual control rod and Reg rod simultaneously shall not exceed _____.

a. 0.02 $\Delta k/k$ per second

b. 0.005 $\Delta k/k$ per second

c. 0.0002 $\Delta k/k$ per second

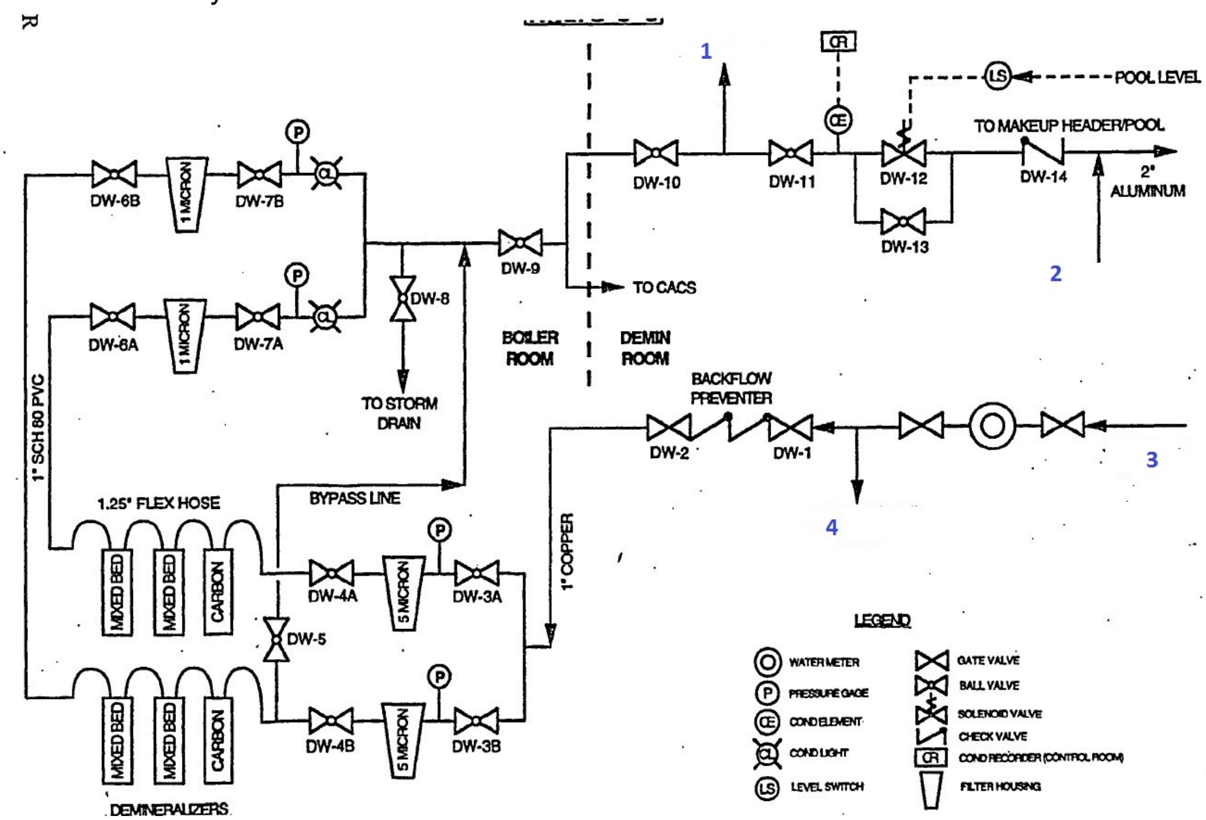
d. 0.0005 $\Delta k/k$ per second

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

Section C Facility and Radiation Monitoring Systems

QUESTION C.01 [1.0 point, 0.25 each]
The figure below depicts the RINSC water make-up system. Match the water flowing location (to/from) listed in Column A to the appropriate numeral label in Column B?

Column A		Column B
a.	Clean up system	1
b.	City water supply	2
c.	RINSC labs	3
d.	potable water supply to the facility	4



QUESTION C.02 [1.0 point]
Which ONE of the following will convert the 480 VAC to 220/110 VAC in the RINSC electrical distribution system?

a. Line Transfer Switch

b. 15-kW Power Generator

c. Electrical Inverter

d. Electrical Transformer

QUESTION C.03 [1.0 point]
During emergency conditions, the MAIN purpose of the activated charcoal section in the filter bank is to remove 99% of any airborne radioactive _______ present in the reactor room air.

a. Argon-41

b. Nitrogen -16

c. Iodine

d. Xenon

QUESTION C.04 [1.0 point]
Which ONE of the following statement correctly describes the automatic servo control interlock? An interlock will prevent auto servo control if:

a. the inlet coolant gate opens.

b. the servo blade is fully withdrawn.

c. Inserted two control blades simultaneously.

d. the reactor period is less than 30 seconds.

QUESTION C.05 [1.0 point]
The "TEST" position of the Master Switch allows to:

a. exercise the control blade drive motion without energizing the scram magnets.

b. calibrate the period less than 30 second without energizing the interlock system.

c. exceed the Wide Range Linear Power limit without energizing the scram.

d. exercise the control blade drive motion with energizing the scram magnets

QUESTION C.06 [1.0 point]
When a SIGNIFICANT loss of water from the reactor pool (low pool water alarm initiated), which ONE of the following is an appropriate system for adding the make-up water to the pool?

a. The Emergency Core Cooling System (ECCS) will automatically add water to the reactor pool when low pool water alarm initiated.

b. The ECCS will be turned on manually through a series of manual valves.

c. The delay tank will automatically add water to the reactor pool when low pool water alarm initiated.

d. The RINSC does NOT have any ECCS.

QUESTION C.07 [1.0 point]
You perform a High-Voltage (HV) Loss-Scram check for the Log Power Channel. The output of voltage meter reads 4.28 Volts. A High Voltage applied to the Log Power chamber is set at _______ Volts.

a. 726

b. 856

c. 876

d. 896

QUESTION C.08 [1.0 point]
Which ONE of the following best describes how the Uncompensated Ion Chamber (UIC) and Compensated Ion Chamber (CIC) operate?

a. The CIC has only one chamber coated with U-235 for fission reaction, whereas the UIC has two chambers, both can sense gamma rays but only one is coated with boron-10 for (n,α) reaction.

b. The CIC has two chambers, one is coated with U-235 for fission reaction and the other is coated with boron-10 for (n,α) reaction; whereas the UIC has only one chamber coated with U-235 for fission reaction.

c. The CIC has only one chamber coated with boron-10 for (n,α) reaction; whereas the UIC has two chambers, one is coated with U-235 for fission reaction and the other is coated with boron-10 for (n,α) reaction.

d. The CIC has two chambers, both can sense gamma rays but only one is coated with boron-10 for (n,α) reaction; whereas the UIC has only one chamber coated with boron-10 for (n,α) reaction.

QUESTION C.09 [2.0 point, 0.5 each]
Match the following actions used in Column A with their respective definitions in Column B:

COLUMN A		COLUMN B
a.	You compare readings of Safety Channel with Linear Channel during reactor operations	1. Channel Check
		2. Channel Test
b.	During startup, you verify the reactor scram at 115 % power	
		3. Channel Calibration
c.	During startup, you verify the reactor scram due to a loss of Watchdog communication	
d.	You adjust a safety channel reading after conducting a thermal power calibration	

QUESTION C.10 [1.0 point]
Which ONE of the following is currently the source of neutrons for INITIAL startup and low power operation of the RINSC reactor?

a. Americium-Beryllium (Am-Be)

b. Plutonium-Beryllium (Pu-Be)

c. Radon-Beryllium (Ra-Be)

d. Beryllium Reflector

QUESTION C.11 [1 point]
During a reactor operation, you discover the Stack Particulate Monitor (SPM) pump has been turned OFF since yesterday. Which ONE of the following actions should you take?

a. Immediately secure reactor. This event is a Technical Specification (TS) violation.

b. Immediately secure reactor, but this event is NOT a TS violation because the SPM is still operable.

c. Continue with reactor operation. Up to 24 hours is allowed to run reactor before replacing the Stack Particulate Monitor.

d. Continue with reactor operation. The Technical Specifications require only RAMs and Stack Gas monitors during reactor operation.

QUESTION C.12 [1.0 point]
The Main purpose for setting a conductivity limit of the pool water is to:

a. Maintain the departure of nucleate boiling ratio (DNBR) greater than the unity

b. Minimize the possibility of corrosion of the cladding on the fuel elements

c. Extend integrity of resin bed on the demineralizer

d. Minimize Ar-41 released to the public

QUESTION C.13 [1.0 point]
Which ONE of the following provides a reactor scram in any mode of operations?

a. Pool Temperature = 122 °F

b. Seismic Disturbance

c. No Flow Thermal Column

d. Primary Coolant Flow Rate = 1600 gpm

QUESTION C.14 [1.0 point]
In order to test the Watchdog Scram, you should:

a. Disconnect the building internet server that supports the internet for the RINSC computers.

b. Withdraw the Regulating blades at full out position and hold the manual scram for 10 secconds.

c. Turn the Watchdog Scram Test and the Master Switches to “TEST” simultaneously.

d. Turn the Watchdog Scram Test Switch to “TEST”.

QUESTION C.15 [1.0 point]
Which ONE of the following is the material used for the fission chamber?

a. BF_3 fill gas

b. B-10

c. U-235

d. Pu-233

Section C Facility and Radiation Monitoring Systems

QUESTION C.16 [1.0 point]
Which ONE of the following is NOT required to be determined for core shutdown margin?

a. Annually surveillance is required

b. Core reflection is changed

c. Following control blade is changed

d. The reactivity worth of experiments is changed

QUESTION C.17 [1.0 point]
Which ONE of the following can be determined if there is a leak in the heat exchanger?

a. Present of a sodium-24 nuclide in the secondary coolant system.

b. Pool level will increase due to leakage into the secondary.

c. Decrease a flow rate in the secondary makeup system.

d. Present of an argon-41 nuclide in the secondary coolant system.

QUESTION C.18 [1.0 point]
The design basis for the thermal column is to provide:

a. the biological shield from the reactor core.

b. a fast neutron flux for experiments.

c. a thermal neutron flux for experiments

d. a shield of fast neutrons entered to the experiments.

QUESTION C.19 [1.0 point]
Which ONE of the following best describes how the Emergency Core Cooling System (ECCS) operates? In the event of a loss of coolant accident, the ECCS water is provided from ________ up to the top of the pool.

a. the delay tank

b. the 3000 gallon holding tank

c. the public water supply through a backflow-preventer

d. the fire sprinkler system supply, through a series of manual valves

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

Section A L Theory, Thermo & Fac. Operating Characteristics

A.01
Answer: a(2) b(1) c(3) (0.33 each)
Reference: Burn, R., *Introduction to Nuclear Reactor Operations,* © 1988, Sec 2.6

A.02
Answer: b
Reference: Chart of the Nuclides

A.03
Answer: d
Reference: Burn, R., *Introduction of Nuclear Reactor Operations*, © 1982, Sec 3.3.1, page 3-16.

A.04
Answer: c
Reference: $P = P_0 e^{t/T}$ —> $T= t/Ln(P/ P_0)$
T= 120/Ln(100); T = 26 sec.

A.05
Answer: b
Reference: CR = S/(1-K) → CR = 1000/(1 - 0.8) = 5000 N/sec

A.06
Answer: c
Reference:
Keff1=1/1- ρ1
Keff1 =1/(1-(-.05)) —>Keff1= 0.952,
Count1*(1-Keff1) = Count2*(1-Keff2)
Count1*(1-0.952) = Count2*(1-Keff2)
1000*(1-0.952) = 4000(1- Keff2); Keff2 = 0.988

A.07
Answer: a
Reference: Burn, R., *Introduction of Nuclear Reactor Operations*, © 1988, Sec 2.4.5, page 2-29.

A.08
Answer: c
Reference: Reactivity added = 0.156 %Δk/k = 0.00156 Δk/k
$\tau = (\beta-\rho)/\lambda_{eff}\rho =$ (0.0073 - 0.00156)/ ((0.1)*(0.00156))
= 37 seconds

A.09
Answer: d
Reference: Burn, R., Introduction of Nuclear Reactor Operations, © 1988, Sec 3.3.4

A.10
Answer: b
Reference: SDM = (1- keff)/keff = (1-0.927)/0.927 = 0.07875 Δk/k. So if you add the same amount of SDM, the reactor is critical.
Another method: you can find the new value of Keff when adding 0.07875 Δk/k to reactor.
Δp = (k2 –k1)/ k1*k2
0.07875 = (k2- 0.927)/(0.927* k2), solve for k2
K2 = 1, hence the reactor is critical

A.11
Answer: d
Reference: K eff = 1.05*0.80*0.90*0.92*1.86*x
X= 1/1.294 = 0.773

A.12
Answer: a
Reference: Burn, R., Introduction to Nuclear Reactor Operations, © 1982, Sec 5.5, page 5-18-5-25.

A.13
Answer: b
Reference: Burn, R., *Introduction to Nuclear Reactor Operations,* © 1988, Section 5.1, Subcritical Multiplication

A.14
Answer: c
Reference: Burn, R., *Introduction of Nuclear Reactor Operations*, © 1988, Section 3.2, Table 3.1

A.15
Answer: a
Reference: Burn, R., *Introduction of Nuclear Reactor Operations*, © 1988, Sec 3.3.1

A.16
Answer: b
Reference: DOE Handbook Vol. 1 Module 2, Section 3.0

A.17
Answer: d
Reference: Burn, R., Introduction of Nuclear Reactor Operations, © 1988, Sec 4.2

A.18
Answer: b
Reference: NRC Standard Question

A.19
Answer: c
Reference: Burn, R., *Introduction of Nuclear Reactor Operations*, © 1988, Sec 4.2

A.20
Answer: b
Reference: Burn, R., *Introduction of Nuclear Reactor Operations*, © 1982, Section 3.3.7, page 3-37

Section B Normal/Emergency Procedures and Radiological Controls

B.01
Answer: a (115 kW) b (23' 7 ") c (127 degree F) (0.33 each)
Reference: TS 2.2.1

B.02
Answer: b
Reference: 10CFR20.1201(a)(1) [5000 mr x $\frac{1 \text{ hr}}{100 \text{ mr}}$ x $\frac{\text{day}}{8 \text{ hr}}$ = 6.25 days

B.03
Answer: a
Reference: The report already provides a conversion in mrem, so you just add them up.

B.04
Answer: c
Reference: TS 3.8.1 & 3.1.1

B.05
Answer: b
Reference: $DR = DR_{\circ} * e^{-\lambda t}$
1.25 rem/hr $= 5$ rem/hr$* e^{-\lambda(5hr)}$
$Ln(1.25/5) = -\lambda*5$ --> $\lambda=0.277$; solve for t: $Ln(.625/5)=-0.277*t$
t=7.5 hours

B.06
Answer: a(1) b(2) c(3) d(1) (0.25 each)
Reference: EP 4.1, EP 4.2, and EP 4.3

B.07
Answer: c
Reference: EP 7.5.1

B.08
Answer: c
Reference: TS Definition 1.43 (annual: interval NOT to exceed 15 months)

B.09
Answer: a
Reference: $DR = DR_{\circ} * e^{-\lambda t}$
30% is decayed, so 70% is still there 70% =100%$* e^{-\lambda(3hrs)}$
$Ln(70/100) = -\lambda*1$ -->$\lambda=0.357$ $t_{1/2}=Ln(2)/\lambda$ -->.693/.357 t=1.94 hours

B.10
Answer: d
Reference: TS 1.18

B.11
Answer: b
Reference: TS 3.1.1

B.12
Answer: b
Reference: 6CEN = R/hr @ 1 ft. -> 6 x 2 x .8 x .5 = 4.8 R/hr at 1ft.

B.13
Answer: b
Reference: SOP, SP-01

B.14
Answer: a, 3 b,1 c,6 d,4 (0.25 each)
Reference: TS 3.1.1

B.15
Answer: a
Reference: Emergency Plan 3.2.4

B.16
Answer: c
Reference: TS 4.5.5

B.17
Answer: b
Reference: TS 1.31

B.18
Answer: a
Reference: TS 2.1

B.19
Answer: d
Reference: 10 CFR 50.59

B.20
Answer: c
Reference: TS 3.2

Section C Facility and Radiation Monitoring Systems

C.1
Answer: a,2 b,3 c,1 d,4 (0.25 each)
Reference: SAR, Figure 5.7

C.02
Answer: d
Reference: SAR 8.2

C.03
Answer: c
Reference: SOP, MP-02

C.04
Answer: d
Reference: SAR 7.2.8

C.05
Answer: a
Reference: SAR 7.2.3

C.06
Answer: b
Reference: SAR 5.7.1

C.07
Answer: b
Reference: Operational Procedures, CP-04
4.28 V * 200 = 856 V

C.08
Answer: d
Reference: NRC Standard Question

C.09
Answer: a(1) b(2) c(2) d(3) (0.5 each)
Reference: TS 1.2, 1.3 and 1.4

C.10
Answer: d
Reference: SAR 4.2.4

C.11
Answer: a
Reference: TS 3.7.1.2.2

C.12
Answer: b
Reference: TS 4.3.1.1

Section C Facility and Radiation Monitoring Systems

C.13
Answer: b
Reference: TS 3.2

C.14
Answer: d
Reference: Pre-Startup Procedures OP-02

C.15
Answer: c
Reference: NRC Standard Question

C.16
Answer: d
Reference: TS 4.1.1.1

C.17
Answer: a
Reference: TS 4.3.2.1

C.18
Answer: c
Reference: SAR 10.2.4

C.19
Answer: d
Reference: SAR 5.7.1