December 26, 2017

Peter F. Caracappa, Ph.D, CHP
Department of Mechanical, Aerospace and Nuclear Engineering,
Building JEC- Room 2032,
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110 8th Street
Troy, NY 12180-3590

SUBJECT: EXAMINATION REPORT NO. 50-225/OL-18-01, RENSSELAER POLYTECHNIC INSTITUTE

Dear Dr. Cacacappa:

During the week of November 6, 2017, the U.S. Nuclear Regulatory Commission (NRC) administered an operator licensing examination at your Rensselaer Polytechnic Institute reactor. The written examination and operating test were conducted according to NUREG-1478, "Operator Licensing Examiner Standards for Research and Test Reactors," Revision 2. Examination questions and preliminary findings were discussed with those members of your staff identified in the enclosed report at the conclusion of the examination.

In accordance with Title 10 of the *Code of Federal Regulations,* Section 2.390, 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 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 NRC is forwarding the individual grades to you in a separate letter which will not be released publicly.

Should 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 Mendiola, Chief
Research and Test Reactors Oversight Branch
Division of Licensing Projects
Office of Nuclear Reactor Regulation

Docket No. 50-225

Enclosures:
1. Examination Report No. 50-225/OL-18-01
2. Written Examination

cc w/enclosures: Mr. Glenn Winters, Rensselaer Polytechnic Institute
cc w/o enclosures: See next page

SUBJECT: EXAMINATION REPORT NO. 50-225/OL-18-01, RENSSELAER POLYTECHNIC INSTITUTE DATED DECEMBER 26, 2017.

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OFFICE	NRR/DLP/PROB:CE	NRR/DIRS/IOLB:OLA	NRR/DLP/PROB:CE
NAME	JNguyen	ABaxter	AMendiola
DATE	12/13/2017	12/20/2017	12/26/2017

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cc:

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

EXAMINATION REPORT NO: 50-225/OL-18-01

FACILITY: Rensselaer Polytechnic Institute

FACILITY DOCKET NO.: 50-225

FACILITY LICENSE NO.: CX-22

SUBMITTED BY: /RA/ 11/22/2017
John T. Nguyen, Chief Examiner Date

SUMMARY:

During the week of November 6, 2017, the NRC administered operator licensing examinations to one Senior Reactor Operator – Instant (SRO-I) license candidate. The license candidate passed all applicable portions of their examinations.

REPORT DETAILS

1. Examiner: John T. Nguyen, Chief Examiner

2. Results:

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

3. Exit Meeting:

Glenn Winters, RPI, Reactor Supervisor
John T. Nguyen, NRC, Chief Examiner

The NRC examiner thanked the facility for their support in the administration of the examinations.

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

FACILITY: RPI

REACTOR TYPE: Critical Experimental

DATE ADMINISTERED: 11/7/2017

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
17.00	33.3	_____	_____	A. REACTOR THEORY, THERMODYNAMICS AND FACILITY OPERATING CHARACTERISTICS
16.00 ~~17.00~~	33.3	_____	_____	B. NORMAL AND EMERGENCY OPERATING PROCEDURES AND RADIOLOGICAL CONTROLS
16.00 ~~17.00~~	33.3	_____	_____	C. FACILITY AND RADIATION MONITORING SYSTEMS
49.00 ~~51.00~~		_____ FINAL GRADE	_____ %	TOTALS

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

_____
Candidate's Signature

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 d ___

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 ___ (0.25 each)

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 ___

(***** 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 d ___

B02 a ___ b ___ c ___ d ___ (0.25 each)

B03 a b c d ___

B04 a ___ b ___ c ___ d ___ (0.25 each)

B05 a b c d ___

B06 a b c d ___

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 ___

B15 a b c d ___

B16 a b c d ___

B17 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 ___ (0.25 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 ___

(***** 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

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

$Q = m\, \Delta h$

$Q = UA\, \Delta T$

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

$SUR = 26.06/\tau$

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

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

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

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

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

$\rho = \Delta Keff/Keff$

$\bar{\beta} = 0.007$

$DR_1D_1^2 = DR_2D_2^2$

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

$\lambda_{eff} = 0.1/\sec$

$SCR = S/(1-Keff)$

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

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

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

$SDM = (1-Keff)/Keff$

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

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

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

$R = 6\ C\ E\ n$

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

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

$P = S / (1 - Keff)$

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

---

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)

Section A L Theory, Thermo & Fac. Operating Characteristics

QUESTION A.01 [1.0 point]
Which ONE of the following correctly describes the SIX- FACTOR FORMULA?

a. $K_\infty = K_{eff}$ * the reproduction factor

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

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

d. $K_{eff} = K_\infty$ * (the resonance escape probability * the reproduction factor)

QUESTION A.02 [1.0 point]
Few minutes following a reactor scram of 90 watts, the reactor period has stabilized and the power level is decreasing at a **CONSTANT** rate. What is the power level one minute later from 5 watts?

a. 0.24 W

b. 2.40 W

c. 4.20 W

d. 10.1 W

QUESTION A.03 [1.0 point]
Which ONE of the following is the MAIN reason for operating reactor with thermal neutrons instead of fast neutrons?

a. The fission cross section of the fuel is much higher for fast neutrons than thermal energy neutrons. Since fast neutrons are easier to cause fission, a reactor cannot control with fast neutrons.

b. The neutron lifetime of thermal neutrons is longer than fast neutrons, so the fuel has enough time to capture thermal neutrons.

c. The fission cross section of the fuel is much higher for thermal energy neutrons than fast neutrons, so thermal neutrons are easier to cause fission.

d. The atomic weight of thermal neutrons is larger than fast neutrons, so thermal neutrons are easily to slow down and be captured by the fuel.

Section A L Theory, Thermo & Fac. Operating Characteristics

QUESTION A.04 [1.0 point]
Which ONE of the following is a number of protons in the Uranium-235 nucleus ($_{92}U^{235}$)?

a. 92

b. 143

c. 235

d. The U-235 doesn't have a constant number of photons, it fluctuates between 92 and 143.

QUESTION A.05 [1.0 point]
Reactor is at full power. The operator immediately scrams all control rods into the core. This insertion will cause:
Given:
T: reactor period, ℓ^*: Prompt neutron lifetime; ρ: reactivity insertion; β: beta fraction

a. The delayed period to be equal to +80 seconds.

b. A number of prompt neutrons equals to a number of delayed neutrons.

c. The immediate period to be a function of the prompt neutron lifetime ($T=\ell^*/\rho$).

d. A sudden change of power that equals to the initial power multiplied by $\beta(1-\rho)/(\beta-\rho)$.

QUESTION A.06 [1.0 point]
A reactor is subcritical with K_{eff} of 0.955. Which ONE of the following is the MINIMUM reactivity ($) that must be added to produce PROMPT criticality? Given $\beta_{eff}=0.0073$

a. $1.000

b. $1.045

c. $6.400

d. $7.400

Section A L Theory, Thermo & Fac. Operating Characteristics

QUESTION A.07 [1.0 point]
The effective target area in cm^2 presented by a single nucleus to an incident neutron beam is defined as:

a. a macroscopic cross section

b. a microscopic cross section

c. a mean free path

d. a neutron flux

QUESTION A.08 [1.0 point]
Delayed neutrons are produced by:

a. decay of N-16.

b. Photoelectric Effect.

c. decay of fission fragments.

d. come directly from fission.

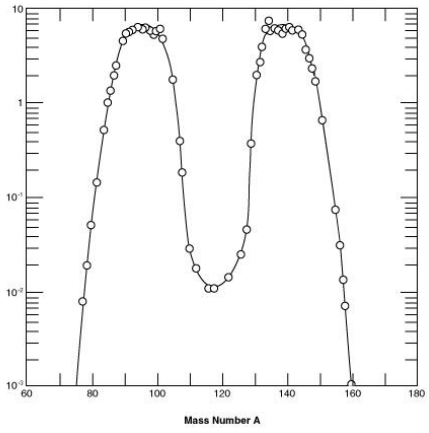
QUESTION A.09 [1.0 point]
The following graph for U-235 depicts……

a. axial flux distribution in the core

b. fission product yield distribution

c. radial flux distribution in the core

d. neutron energy distribution in the moderator



QUESTION A.10 [1.0 point]
Which ONE of the following atoms will cause a neutron to lose the most energy in an elastic collision?

a. U-238

b. Ar-40

c. O-16

d. H-1

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	1.03
Fast non-leakage probability	0.84
Resonance escape probability	0.96
Thermal non-leakage probability	0.88
Thermal utilization factor	0.70
Reproduction factor	1.96

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. 0.074

d. 0.076

QUESTION A.12 [1.0 point, 0.25 each]
Match the following Neutron Interactions in Column A with the appropriate definition in Column B (each used only once)

Column A		Column B
a.	Fission	1. Neutron enters nucleus, forms a compound nucleus, then decays by gamma emission.
b.	Radiative capture	2. Particle enters nucleus, forms a compound nucleus and is excited enough to eject a new particle with incident neutron remaining in nucleus.
c.	Scattering	3. Nucleus absorbs neutron and splits into two similarly sized parts.
d.	Particle ejection	4. Nucleus is struck by a neutron and emits a single neutron.

QUESTION A.13 [1.0 point]
A reactor contains a neutron source that produces 1,000 neutrons/second. The reactor has a k_{eff} = 0.80. What is the stable total neutron production rate in the reactor?

a. 2,000 neutrons/sec

b. 5,000 neutrons/sec

c. 8,000 neutrons/sec

d. 20,000 neutrons/sec

QUESTION A.14 [1.0 point]
Which ONE of the following changes will increase the core excess?

a. Insertion of an experiment containing cadmium.

b. Adding of a fuel experiment (U-235) into the core.

c. Pool water temperature increase.

d. Buildup of xenon in the core.

QUESTION A.15 [1.0 point]
Which ONE is true about "subcritical multiplication"? As the reactor approaches criticality, the parameter

a. k_{eff} approaches zero.

b. ρ approaches infinity.

c. M approaches one.

d. 1/M approaches zero.

QUESTION A.16 [1.0 point]
Which ONE of the following is the stable reactor period which will result in a power rise from 1% to 100% power in 1 minute?

a. 0.2 seconds

b. 5 seconds

c. 13 seconds

d. 80 seconds

QUESTION A.17 [1.0 point]
When the reactor is at critical, what effect does Doppler Broadening for U-238 have on neutrons?

a. More absorption

b. More scattering

c. Increasing the resonance escape probability

d. Increasing the Reproduction factor

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

Section B Normal/Emergency Procedures and Radiological Controls

QUESTION B.01 [1.0 point]
Which ONE of the following radionuclide causes a severe damage to thyroid gland from an intake?

a. I^{131}

b. N^{16}

c. Ar^{41}

d. Co^{60}

QUESTION B.02 [1.0 points, 0.25 each]
Match the radiation reading from Column A with its corresponding radiation area classification (per 10 CFR 20) listed in Column B. Answer in Column B can be used more than once, or not at all. Conversion may be needed to meet the definition. QF = 10

	Column A	Column B
a.	1 mrem/hr at 1 m	1. Public Area
b.	10 mrem/hr at 1 m	2. Radiation Area
c.	500 rem/hr at 1 m	3. High Radiation Area
d.	5.5 grays/hr at 1 m	4. Very High Radiation Area

QUESTION B.03 [1.0 point]
All applicants for an RO or SRO license must take the NRC examination according to the requirement of 10 CFR:

a. Part 19

b. Part 20

c. Part 50

d. Part 55

QUESTION B.04 [1.0 point, 0.25 each]
Match the appropriate radiation unit in Column A with its definition in Column B.

Column A		Column B
a.	Curie	1. Equal to absorbed dose of 100 ergs/gram
b.	Roentgen	2. Amount of radioactive material decaying at a rate of 3.7×10^{10}
c.	RAD	3. Amount of x-ray or gamma ray leading to the absorption of 88 ergs/gram in air
d.	Dose Equivalent	4. Equal to absorbed dose in RAD times quality factor

QUESTION B.05 [1.0 point]
A room contains a source which, when exposed, results in a general area dose rate of 1 rem per hour. This source is scheduled to be exposed continuously for 20 days. Which ONE of the following statements correctly describes an acceptable method for controlling radiation exposure from the source within this room?

a. Monitor the current dose rate in the reactor control room.

b. Post the area with “Caution – Restricted Area”.

c. Control is not required because the presence of radioactive source is less than 30 days.

d. Equip the room with an electronic surveillance that is capable of preventing unauthorized entry.

Section B Normal/Emergency Procedures and Radiological Controls

QUESTION B.06 [1.0 point]
After a long period of reactor operation, the staffs perform a normal shutdown checklist and find that only three out of four control rods are fully inserted. Which ONE of the following is the MINIMUM staffing requirement for this condition? Assume that the console keys are removed during a shutdown checklist.

a. All staffs may go home after the shutdown checklist is completed because the reactor meets a shutdown definition.

b. Require only one licensed reactor operator (RO) present in the control room.

c. Require one SRO on call, one RO in the control room, and one person on duty.

d. Require one SRO in the control room and one SRO on call.

QUESTION B.07 [1.0 point]
A radiation from an unshielded source is 200 mrem/hr. What is a radiation level when shielding it with a lead sheet of 30 mm thickness? Given the half-value-layer (HVL) of lead = 10 mm.

a. 10 mem/hr

b. 25 mrem/hr

c. 50 mrem/hr

d. 75 mrem/hr

QUESTION B.08 [1.0 point]
Which ONE of the following surveillances is a channel check?

a. Push the Manual Scram button to verify a reactor scram.

b. Comparing the readings of the Linear and Log-N Power Channels during reactor operation.

c. Exposing a check source to the area gamma monitor to verify its operation.

d. Adjusting a power level after a power calibration.

Section B Normal/Emergency Procedures and Radiological Controls

QUESTION B.09 [1.0 point]
When a bomb threat is received at the RCF, all of the following procedures are correct, EXCEPT:

a. The reactor will be placed in Secured Shutdown.

b. All RCF staff and other personel will be present in the reactor room for emergency supports.

c. The Operations Superivor and Facility Director will be notified.

d. The RPI Public Safety will be notified.

QUESTION B.10 [1.0 point]
Consider two point sources, each having the SAME curie strength. Source A's gammas have an energy of 1 MeV, while Source B's gammas have an energy of 4.0 MeV. Using a Geiger-Müller detector, the reading from source B will be: (NOTE: Ignore detector efficiency.)

a. the same.

b. twice that of source A.

c. half that of source A.

d. four times that of source A.

QUESTION B.11 [1.0 point]
Annual limit on intake (ALI) means the derived limit for the amount of radioactive material taken into the body of an adult worker by inhalation or ingestion in a year. What is the regulatory limit on the committed effective dose equivalent for an individual in one year?

a. 50 mRem

b. 500 mRem

c. 5 Rem

d. 50 Rem

Section B Normal/Emergency Procedures and Radiological Controls

QUESTION B.12 [1.0 point]
According to the Pre-Startup Procedures, which ONE of the following is the material used as a source check for the area gamma monitors?

a. N-16

b. Pu-240

c. Cs-137

d. Ar-41

QUESTION B.13 [1.0 point]
Which ONE of the following changes must be submitted to NRC for approval prior to implementation?

a. Replace a control rod with an identical one.

b. Add a new section to the Operation Procedure.

c. Adjust an alarm set point from the control room area gamma monitor from 10 mrem/hr to 5 mrem/hr.

d. Adjust an interlock set point from the Log Count Rate channel listed in Tech Spec from 2 cps to 1 cps.

QUESTION B.14 [1.0 point]
During the performance of a Pre-Startup Procedure, a Water Dump Valve Bypass is required. Select the MINIMUM level of personnel required to approve this bypass. Assume that all reactor shutdown conditions are met.

a. Any RCF staff.

b. A licensed Reactor Operator on duty.

c. A licensed Senior Reactor Operator on duty

d. The Duty Shift Supervisor

Section B Normal/Emergency Procedures and Radiological Controls

QUESTION B.15 [1.0 point] Question was deleted during the administration of the examination. There is no correct answer in the distractors.
~~You are about transferring fuel to the reactor core. Which ONE of the following is the maximum excess reactivity (with or without experimental material in the core) that you will NOT allow to transfer?~~

~~a. $0.20~~

~~b. $0.40~~

~~c. $0.60~~

~~d. $0.80~~

QUESTION B.16 [1.0 point]
The limit for maximum water level at no greater than 10 inches above the top grid of the core is based on:

a. providing adequate neutron shielding during operation.

b. limiting moderator mass to maximize negative temperature coefficient effects during transients.

c. avoiding hydraulic restrictions to control rod insertion during a scram.

d. ensuring that negative reactivity will be added within 1 minute of activation of the water dump.

QUESTION B.17 [1.0 point]
According to the Emergency Plan, the decision to perform preliminary decontamination on site will be made by:

a. The Reactor Operator on duty

b. The Senior Reactor Operator on duty

c. The Radiation Safety Officer

d. The Fire Department Team

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

Section C Facility and Radiation Monitoring Systems

QUESTION C.01 [1.0 point, 0.25 each]
Match each monitor listed in column A with a specific purpose in column B. Items in column B is to be used only once.

	Column A		Column B
a.	Continuous air monitor	1.	Monitor radiation level in the reactor room
b.	Area radiation monitor	2.	Operating below minimum allowable temperature
c.	Portable monitor	3.	Detect radioisotopes released due to fuel failure
d.	moderator water temperature	4.	Survey of laboratory

QUESTION C.02 [1.0 point]
The RCF Safety Limit is on:

a. the excess reactivity of $0.60.

b. the maximum power level of 100 watts.

c. the temperature of fuel of 1000 °F.

d. the temperature of fuel of 1000 °C.

QUESTION C.03 [1.0 point]
The Uncompensated Ion Chambers is powered from:

a. 120 volt AC outlets.

b. 120 volt DC power supply.

c. 300 volt DC battery.

d. 480 volt, three-phase power from the utility grid.

Section C Facility and Radiation Monitoring Systems

QUESTION C.04 [1.0 point]
Which ONE of the following has bypass provisions?

a. Door scram and the Water Dump Valve scram.

b. Log-N period scram and the Water Dump Valve scram.

c. Door scram and the Linear Power high level scram.

d. Log-N scram and the Linear Power high level scram.

QUESTION C.05 [1.0 point]
Which ONE of the following is the RCF neutron startup source?

a. Americium-Beryllium (Am-Be)

b. Uranium-Beryllium (U-Be)

c. Radon-Beryllium (Ra-Be)

d. Plutonium-Beryllium (Pu-Be)

QUESTION C.06 [1.0 point]
It will take approximately _____ to fill the 2000-gallon reactor water tank.

a. 2 hours

b. 1 hour

c. 30 minutes

d. 15 minutes

Section C Facility and Radiation Monitoring Systems

QUESTION C.07 [1.0 point]
Which ONE of the following conditions will cause the reactor interlock?

a. Reactor period exceeds 25 seconds

b. Source range reading is 10 cps

c. Fill pump "ON"

d. Chart recorder power "ON"

QUESTION C.08 [1.0 point]
One of the amplifier functions in the Startup channel is to:

a. Count a total number of neutron and gamma pulses.

b. Separate gamma pulses from neutron pulses.

c. Convert a number of pulses to a current in amps.

d. Convert a number of pulse to a reactor period in seconds.

QUESTION C.09 [1.0 point, 0.25 each]
Match the readings listed in column A with the automatic response listed in column B. Assume the reactor is in operation. (Items in column B is to be used more than once or not at all.)

	Column A	Column B
a.	Reactor period exceeding 25 sec.	1. Indication only
b.	Open reactor door without by passed	2. Control rod withdrawal prohibit
c.	Line voltage to recorders exceeding 80 V	3. Reactor scram
d.	Area gamma monitor in the control room exceeding 45 mrem/hr	

Section C Facility and Radiation Monitoring Systems

QUESTION C.10 [1.0 point]
Following a loss of building electrical power, which ONE of the following best describes on how the reactor tank water is quickly drained to the storage tank?

a. The reactor pump will turn “ON” and pumping water from the reactor tank to the storage tank.

b. Reactor tank water can be quickly drained through the fill line by deenergizing of the air-operated drain valve.

c. Reactor tank water can be quickly drained by energizing of the quick drain valve that are operated by motor control.

d. The filled drain valve and the quick dump valve will both de-energize, allowing water flow from reactor tank to the storage tank.

QUESTION C.11 [1.0 point]
Which ONE of the following is a correct set point for the area gamma monitor located in the control room?

a. 10 mr/hr

b. 20 mr/hr

c. 40 mr/hr

d. 50 mr/hr

QUESTION C.12 [1.0 point]
A signal for the Period > 15 Sec Interlock comes from the:

a. Log Power Channel (PP2)

b. Linear Power Channel 1 (LP1)

c. Linear Power Channel 2 (LP2)

d. Startup Channel B (SUB)

Section C Facility and Radiation Monitoring Systems

QUESTION C.13 [1.0 point] Question was deleted during the administration of the examination. There is no correct answer in the distractors.

~~If control rod sensitivity is known from previous measurement, withdrawal of the rods as a bank is permitted as long as:~~

~~a. reactor period is between 20 seconds to 40 seconds.~~

~~b. the source level channel has increased by less than one decade.~~

~~c. the reactivity addition does not exceed $0.10 per second at all higher levels (>10 watts).~~

~~d. the reactivity addition does not exceed $0.12 per second up to 10 times the source level.~~

QUESTION C.14 [1.0 point]

Which ONE of the following types of detector is utilized in the area gamma radiation monitoring system?

a. Geiger-Mueller tube

b. Scintillation detector

c. Ionization chamber

d. Proportional counter

QUESTION C.15 [1.0 point]

The reactor room ventilation system:

a. shares a vent with the control room ventilation system.

b. exhaust vent closes in response to high radiation alarms.

c. exhaust fan opens in response to high radiation alarms.

d. operates by natural circulation, with its own vent to the outside stack.

Section C Facility and Radiation Monitoring Systems

QUESTION C.16 [1 point]
The potentially most severe accident at the RCF is due to:

a. Loss of coolant.

b. Loss of normal electrical power.

c. Terrorist bomb destroyed the facility.

d. Unsecured experimental insertion of greater than $0.60.

QUESTION C.17 [1.0 point]
Which ONE of the following best describes the temperature thermocouple?

a. A thermocouple is an electrical device consisting of two dissimilar electrical conductors forming electrical junctions at differing temperatures. Thermocouple voltage is converted to Fahrenheit degrees by circuitry in the video-graphic recorders.

b. A thermocouple is an electrical device consisting of two dissimilar electrical conductors forming electrical junctions at differing temperatures. Thermocouple current is converted to Fahrenheit degrees by circuitry in the video-graphic recorders.

c. A thermocouple is an electrical device consisting of variable resistor that value changes are dependent to the temperatures. Thermocouple resistor is converted to Fahrenheit degrees by circuitry in the video-graphic recorders.

d. A thermocouple is an electrical device consisting of two dissimilar electrical conductors forming electrical junctions at differing temperatures. Thermocouple conductivity is converted to Fahrenheit degrees by circuitry in the video-graphic recorders.

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

Section A L Theory, Thermo & Fac. Operating Characteristics

A.01
Answer: c
Reference: Burn, R., *Introduction of Nuclear Reactor Operations*, © 1988, Sec 3.3

A.02
Answer: b
Reference: $P = P_0 e^{-t/T} = 5 * e^{(60sec/-80sec)} = 5 * e^{-0.75} = 0.472 * 5 = 2.36$ watts

A.03
Answer: c
Reference: Burn, R., *Introduction of Nuclear Reactor Operations*, © 1982, Figure 2.6, page 2-39

A.04
Answer: a
Reference: Chart of Nuclides and Isotopes
N (neutrons) = 143; A = 235; Z = 92

A.05
Answer d
Reference: Burn, R., *Introduction to Nuclear Reactor Operations,* © 1988, Sec 4.6, page 4-17

A.06
Answer: d
Reference: from subcritical with k=0.955 to criticality (k=1), $\Delta\rho = (k-1)/k = -0.047\ \Delta k/k$ or $\Delta\rho = 0.047\ \Delta k/k$ ($0.047/0.0073=$6.4) needed for criticality. From criticality to JUST prompt (minimum), you need to add extra $1.00, so minimum reactivity needed is $6.4 +$1 = $7.4

A.07
Answer: b
Reference: Burn, R., Introduction to Nuclear Reactor Operations, © 1988, Section 8.2

A.08
Answer: c
Reference: Burn, R., *Introduction to Nuclear Reactor Operations,* © 1982, Sec 3.2.

A.09
Answer: b
Reference: DOE Manual Vol. 1, pg. 57

A.10
Answer: d
Reference: Burn, R., *Introduction of Nuclear Reactor Operations*, © 1988, Sec 2.5.3

A.11
Answer: a
Reference: Keff = 1.03*0.84*0.96*0.88*1.96*x
X= 1/1.4326 = 0.698

Section A L Theory, Thermo & Fac. Operating Characteristics

A.12
Answer: a (3) b (1) c (4) d (2)
Reference: DOE Fundamentals Handbook Nuclear Physics and Reactor Theory, Volume 1, Module 1, Page 43-46

A.13
Answer: b
Reference: SCR = (S)/ (1-K_{eff})
N = (1,000)/(1-0.8) = 5,000 neutrons/second
DOE Fundamentals Handbook, NPRT, Vol. 2, Module 4, EO 1.2, p 4

A.14
Answer: b
Reference: NRC Standard Question

A.15
Answer: d
Reference: Burn, R., *Introduction to Nuclear Reactor Operations,* 1988, Table 5.5

A.16
Answer: c
Reference: $P = P_0 e^{t/T}$ —> T= t/Ln(P/ P_0)
T= 60/Ln(100); T = 13 sec.

A.17
Answer: a
Reference: Burn, R., *Introduction of Nuclear Reactor Operations*, © 1988, Sec 3.3.1

Section B Normal/Emergency Procedures and Radiological Controls

B.01
Answer: a
Reference: Basic Health Physics

B.02
Answer: a(2); b(3); c(3); d(4)
Reference: 10 CFR 20.1003 Definitions
1 mrem/hr at 1 m = 11.1 mrem/hr at 30 cm => Radiation area
10 mrem/hr at 1m = 111 rem/hr at 30 cm => high radiation area
500 rem/hr at 1m = 50 rad/hr at 1 m < 500 Rad/hr at 1 m :=> high radiation area
5.5 grays→ 550 rad/hr at 1 m =>very high radiation area

B.03
Answer: d
Reference: 10 CFR 55

B.04
Answer: a (2) b(3) c(1) d(4)
Reference: NRC Standard Question

B.05
Answer: d
Reference: 10 CFR 20.1601(b)

B.06
Answer: c
Reference: TS 6.1 and TS 1.3
Since a reactor is not shutdown nor secured, correct answer is c, not d.

B.07
Answer: b
Reference:
From 200mrem to 100 mrem required 10 mm of lead sheet
From 100 mrem to 50 mrem required another 10 mm of lead sheet
From 50 mrem to 25 mrem required another 10 mm of lead sheet
So 30mm of lead sheet will reduce a radiation from 200 mrem/hr to 25 mrem/hr

B.08
Answer: b
Reference: TS 1.3

B.09
Answer: b
Reference: EP Procedures 6.4

B.10
Answer: a
Reference: Standard NRC Health Physics Question. G-M detector is not sensitive to incident energy levels.

Section B Normal/Emergency Procedures and Radiological Controls

B.11
Answer: c
Reference: 10 CFR 20.1003

B.12
Answer: c
Reference: Pre-Startup Procedures, Section I

B.13
Answer: d
Reference: 10 CFR 50.59
Tech Spec change

B.14
Answer: c
Reference: RCF Operating Procedure, Section F

~~**B.15**~~
~~Answer: c~~
~~Reference: RCF Operating Procedures, Section G~~

B.16
Answer: d
Reference: TS 3.2, Bases

B.17
Answer: c
Reference: Emergency Plan, Decontamination

Section C Facility and Radiation Monitoring Systems

C.01
Answer: a(3) b(1) c(4) d(2)
Reference: TS 3.7 & TS 3.1, Bases

C.02
Answer: d
Reference: TS 2.1

C.03
Answer: c
Reference: RCF SAR, Section 7.2.3

C.04
Answer: a
Reference: Operating Procedure, Section F

C.05
Answer: d
Reference: RCF SAR 4.1

C.06
Answer: b
Reference: Operating Procedures, Section J

C.07
Answer: c
Reference: RCF SAR, Section 7.3

C.08
Answer: b
Reference: SAR 7.2.3

C.09
Answer: a,1 b,3 c,1 d,1
Reference: TS 3.2

C.10
Answer: d
Reference: SAR, Figure 5.1

C.11
Answer: a
Reference: SAR, Section 7.7

C.12
Answer: a
Reference: SAR 7.2.3

~~**C.13**~~
~~Answer: d~~
~~Reference: Operating Procedures, Section A.~~

Section C Facility and Radiation Monitoring Systems

C.14
Answer: a
Reference: SAR 7.7

C.15
Answer: d
Reference: SAR, Section 9.1

C.16
Answer: d
Reference: SAR, 13.1

C.17
Answer: a
Reference: SAR, Section 7.3