February 24, 2016

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

SUBJECT: EXAMINATION REPORT NO. 50-225/OL-16-01, RENSSELAER POLYTECHNIC INSTITUTE

Dear Dr. Caracappa:

During the week of January 11, 2016, the NRC administered operator licensing examinations at your Rensselaer Polytechnic Institute 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 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 (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 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. Phillip T. Young at (301) 415-4094 or via e-mail phillip.young@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. 50-225

Enclosures: 1. Examination Report No. 50-225/OL-16-01
2. Written examination with comments

cc w/o enclosures: See next page

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ADAMS ACCESSION #: ML16050A272 **TEMPLATE #: NRR-079**

Office	PROB/CE	IOLB/OLA	PROB/BC
Name	PYoung/Gary Morlang For	CRevelle	AMendiola
Date	2/12/2016	2/18/2016	2/24/2016

OFFICIAL RECORD COPY

Rensselaer Polytechnic Institute

Docket No. 50-225

cc:

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

OPERATOR LICENSING INITIAL EXAMINATION REPORT

REPORT NO: 50-225/OL-16-01

FACILITY DOCKET NO.: 50-225

FACILITY LICENSE NO.: CX-22

FACILITY: Rensselaer Polytechnic Institute

EXAMINATION DATES: January 12-13, 2016

SUBMITTED BY: **P.Isaac for** **01/23/2016**
Phillip T. Young, Chief Examiner Date

SUMMARY:

During the week of January 11, 2016 the NRC administered licensing examinations to three Senior Operator Instant (SROI) applicants. The applicants passed all portions of the examination

REPORT DETAILS

1. Examiner: Phillip T. Young, Chief Examiner, NRC

2. Results:

	RO PASS/FAIL	SRO PASS/FAIL	TOTAL PASS/FAIL
Written	0/0	3/0	3/0
Operating Tests	0/0	3/0	3/0
Overall	0/0	3/0	3/0

3. Exit Meeting:

   Phillip T. Young
   Glenn Winters, RPI, Reactor Supervisor

   The examiner thanked the facility for their assistance ensuring the exam administration went smoothly and their feedback on the written examination. The examiner also noted that none of the three applicants demonstrated any knowledge of the 10 CFR 50.59 process for making changes to facility equipment or procedures.

ENCLOSURE 1

FACILITY COMMENTS:

Dear Mr. Young,

I have the following exam comments.

COMMENT: Question B.004:
All of the following are interlocks that prevent control rod withdrawal during reactor operations EXCEPT:
a. water level in reactor tank 12 inches above core top grid.
b. neutron flux = 60 counts per minute.
c. failure of line voltage to recorders.
d. fill pump running.
Answer: B.04 a.
Reference: Technical Specifications, Table 2.

Delete the question since there are two correct answers, (a) and (b). The Technical Specifications, June 2011, Table 2, lists Neutron Flux > 2 cps as an interlock, therefore, (b) neutron flux=60 cpm is also not an interlock. Technical Specifications were included in reference material submitted October 29, 2015.

NRC Resolution:
After reviewing the comment the staff agrees that there are two correct answers. Applicant answer a. or b. will be accepted as correct.

COMMENT: Question B.006:
Following an unintentional scram, the reactor may be prepared for startup only after the cause of the scram has been determined by the:
a. Reactor Operator
b. Senior Reactor Operator
c. Operations Supervisor
d. Facility Director
Answer: B.06 b.
Reference: Emergency Procedure 7.3.1.

Delete the question due to confusion between the Operating Procedures, J.1.a, where permission to restart must be obtained from the Operations Supervisor, except in one specified situation in the procedure, and the Emergency Procedures where the SRO determines cause and prepares to restart. With both positions available as an answer, the question could be misread. Both documents were included in reference material submitted October 29 and December 12, 2015.

NRC Resolution:
After reviewing the question in light of your comment the NRC agrees. Nothing in the stem of the question clearly implies a situation that would cause using the Emergency Procedures for the decision to restart. Applicant answer b. or c. will be accepted as correct.

FACILITY COMMENTS:

COMMENT: Question B.011:
You are transferring fuel to the storage vault from the core. What is the maximum SPERT (F1) fuel pins which can be placed in a storage tube within the Fuel Vault?

a. 5
b. 15
c. 24
d. 30

Answer: B.11 b.
Reference: RCF Operating Procedures, G "Fuel Handling", Version 2.1, 9/2006

Revise the reference to Operating Procedures, Version 3.0, July 2013. The document was included in the reference material submitted December 12, 2015. The question need not be deleted since it has only one correct answer, (b).

NRC Resolution:
After reviewing the question in light of your comment the NRC agrees. Revised the reference to Operating Procedures, Version 3.0, July 2013.

COMMENT: Question B.012:
For a known core arrangement, the addition, movement, or removal of fuel will be limited to…..

a. $0.10 of reactivity or 4 fuel pins, whichever is greater
b. $0.20 of reactivity or 4 fuel pins, whichever is smaller
c. $0.30 of reactivity or 2 fuel pins, whichever is smaller
d. ½ the difference between the current number of fuel pins and the linearly extrapolated critical number from the 1/M plot or 50 fuel pins, whichever is smaller

Answer: B.12 b.
Reference: RCF Operating Procedures, G "Fuel Handling", Version 2.1, 9/2006

Delete the question since there is no correct answer. Operating Procedures, Version 3.0, July 2013, Paragraph K.15, only limits the reactivity worth of the rods being moved for a known core. There is no limit on number of rods. The document was included in the reference material submitted December 12, 2015.

NRC Resolution:
After reviewing the question in light of your comment the NRC agrees. The question is deleted from the examination.

Regards, Glenn Winters

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

FACILITY: RPI
REACTOR TYPE: Critical Experimental
DATE ADMINISTERED: 01/12/2015
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
16.00	33.3	_____	____	A. REACTOR THEORY, THERMODYNAMICS AND FACILITY OPERATING CHARACTERISTICS
15.00	33.3	_____	____	B. NORMAL AND EMERGENCY OPERATING PROCEDURES AND RADIOLOGICAL CONTROLS
16.00	33.3	_____	____	C. FACILITY AND RADIATION MONITORING SYSTEMS
47.00		_____	____%	TOTALS
		FINAL GRADE		

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

_____
Candidate's Signature

NRC RULES AND GUIDELINES FOR LICENSE EXAMINATIONS

During the administration of this examination the following rules apply:

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

2. 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

$Q = m\, c_p\, \Delta T$ $\qquad$ $CR_1 (1-K_{eff})_1 = CR_2 (1-K_{eff})_2$

$SUR = 26.06/\tau$ $\qquad$ $P = P_0\, 10^{SUR(t)}$

$P = P_0\, e^{(t/\tau)}$ $\qquad$ $\tau = (\ell^*/\rho) + [(\beta-\rho)/\lambda_{eff}\rho]$

$\lambda_{eff} = 0.1 \text{ seconds}^{-1}$ $\qquad$ $DR_1 D_1^2 = DR_2 D_2^2$

$DR = DR_o e^{-\lambda t}$ $\qquad$ $DR = 6CiE/D^2$

$\rho = (K_{eff} - 1)/K_{eff}$ $\qquad$ $1 \text{ eV} = 1.6\text{x}10^{-19}$ watt-sec.

1 Curie = $3.7\text{x}10^{10}$ dps $\qquad$ 1 gallon water = 8.34 pounds

1 Btu = 778 ft-lbf $\qquad$ $°F = 9/5\,°C + 32$

1 Mw = $3.41\text{x}10^6$ BTU/hr $\qquad$ $°C = 5/9\,(°F - 32)$

DR – Rem, Ci – curies, E – Mev, R – feet

1 Curie = 3.7×10^{10} dis/sec $\qquad$ 1 kg = 2.21 lbm

1 Horsepower = 2.54×10^3 BTU/hr $\qquad$ 1 Mw = 3.41×10^6 BTU/hr

1 BTU = 778 ft-lbf $\qquad$ $°F = 9/5\,°C + 32$

1 gal (H_2O) . 8 lbm $\qquad$ $°C = 5/9\,(°F - 32)$

$c_P = 1.0$ BTU/hr/lbm/°F $\qquad$ $c_p = 1$ cal/sec/gm/°C

Question A.001 [1.0 point] (1.0)

A reactor is operating at a steady-state power level of 1.000 kW. Reactor power is increased to a new steady-state power level of 1.004 kW. At the higher power level, K_{eff} is:

a. 1.004

b. 1.000

c. 0.004

d. 0.000

Answer: A.01 b.
Reference: Lamarsh, Introduction to Nuclear Engineering, 2nd Edition, page 287

Question A.002 [1.0 point] (2.0)

Which ONE of the following is true concerning the differences between prompt and delayed neutrons?

a. Prompt neutrons account for less than one percent of the neutron population while delayed neutrons account for approximately ninety-nine percent of the neutron population.

b. Prompt neutrons are released during fast fissions while delayed neutrons are released during thermal fissions.

c. Prompt neutrons are released during the fission process while delayed neutrons are released during the decay process.

d. Prompt neutrons are the dominating factor in determining the reactor period while delayed neutrons have little effect on the reactor period.

Answer: A.02 c.
Reference: Lamarsh, Introduction to Nuclear Engineering, 3rd Edition, Section 7.2,

Question A.003 [1.0 point] (3.0)

Thermalization of neutrons is accomplished most efficiently when the moderator has a:

a. LOW atomic mass number and HIGH scattering cross-section

b. HIGH atomic mass number and HIGH scattering cross-section

c. LOW neutron absorption cross-section and LOW scattering cross-section

d. LOW neutron absorption cross-section and HIGH atomic mass number

Answer: A.03 a.
Reference: Burn, R., *Introduction to Nuclear Reactor Operations,* © 1982

Question A.004 [1.0 point] (4.0)

A reactor is critical at 18.1 inches on a controlling rod. The controlling rod is withdrawn to 18.4 inches. The reactivity inserted is 14.4 cents. What is the differential rod worth?

a. 14.4 cents/inch at 18.25 inches.
b. 14.4 cents/inch only between 18.1 and 18.4 inches.
c. 48 cents/inch at 18.4 inches.
d. 48 cents/inch at 18.25 inches.

Answer: A.04 d.
Reference: Burn, Introduction to Nuclear Reactor Operations, page 7-2.
$\Delta\rho$ = 14.4 cents; Δx = 18.4 - 18.1 = 0.3 inches; $\Delta\rho/\Delta x$ = 48 cents/inch at the midpoint (18.25 inches).

Question A.005 [1.0 point] (5.0)

Two critical reactors at low power are identical except that Reactor 1 has a beta fraction of 0.0072 and Reactor 2 has a beta fraction of 0.0060. An equal amount of positive reactivity is inserted into both reactors. Which ONE of the following will be the response of Reactor 2 compared to Reactor 1?

a. The resulting power level will be lower.
b. The resulting power level will be higher.
c. The resulting period will be longer.
d. The resulting period will be shorter.

Answer: A.05 d.
Reference: Burn, Introduction to Nuclear Reactor Operations, page 3-33.

Question A.006 [1.0 point] (6.0)

Which ONE of the following does NOT affect the Effective Multiplication Factor $K_{eff?}$

a. The moderator-to-fuel ratio.
b. The moderator temperature.
c. The physical dimensions of the core.
d. The strength of an installed neutron source.

Answer: A.06 d.

Reference: DOE Fundamentals Handbook, Module 3, pages 2-9.

Question A.007 [1.0 point] (7.0)
Delayed neutron precursors decay by beta decay. Which ONE reaction below is an example of beta decay?

a. $_{35}Br^{87}$ -> $_{36}Kr^{87}$

b. $_{35}Br^{87}$ -> $_{35}Kr^{86}$

c. $_{35}Br^{87}$ -> $_{34}Kr^{86}$

d. $_{35}Br^{87}$ -> $_{33}Kr^{83}$

Answer: A.07 a.
Reference: Lamarsh, Introduction to Nuclear Engineering, 2nd Edition, page 71.

Question A.008 [1.0 point] (8.0)
Which ONE of the following elements will slow down fast neutrons most quickly, i.e. produces the greatest energy loss per collision?

a. Boron-10

b. Oxygen-16

c. Hydrogen-1

d. Uranium-238

Answer: A.08 c.
Reference: Lamarsh, Introduction to Nuclear Engineering, 3rd Edition, Section 5.9, page 254.

Question A.009 [1.0 point] (9.0)
Which ONE of the reactions below is an example of a photoneutron source?

a. $_{1}H^{2} + \gamma$ -> $_{1}H^{1} + n$

b. $_{4}Be^{9} + \alpha$ -> $_{6}C^{12} + n$

c. $_{51}Sb^{123} + n$ -> $_{51}Sb^{124} + \gamma$

d. $_{92}U^{238}$ -> $_{35}Br^{87} + _{57}La^{148} + 3n + \gamma$

Answer: A.09 a.
Reference: Burn, Introduction to Nuclear Reactor Operations, page 5-3.

Question A.010 [1.0 point] (10.0)

Which ONE of the following describes the term prompt jump?

a. The instantaneous change in power level due to withdrawing a control rod.

b. A reactor which has attained criticality on prompt neutrons alone.

c. A reactor which is critical using both prompt and delayed neutrons.

d. A positive reactivity insertion which is less than βeff.

Answer: A.10 a.
Reference: Lamarsh, Introduction to Nuclear Engineering, 2nd Edition, page 287

Question A.011 [1.0 point] (11.0)

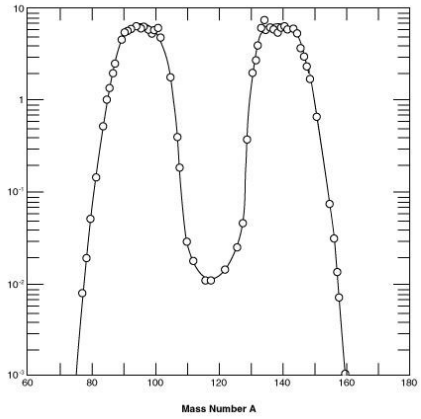
The graph depicted in **Figure-1** for U-235 depicts……

a. neutron energy distribution in the moderator

b. axial flux distribution in the core

c. radial flux distribution in the core

d. fission product yield distribution



Answer: A.11 d.
Reference: DOE Manual Vol. 1, pg. 57, NEEP 234 “Reactor Physics Part I”, pg.2

Question A.012 [1.0 point] (12.0)

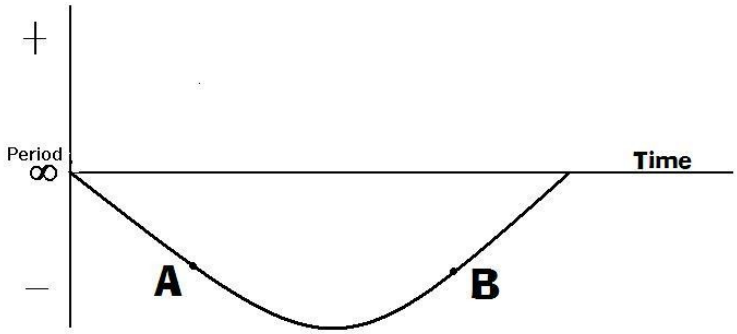
The figure depicts a plot of reactor period as a function of time. What best describes the behavior of
REACTOR POWER between points A and B:

a. Constant

b. Decreasing then increasing

c. Continually increasing

d. Continually decreasing



Answer: A.12 d.
Reference: DOE Manual Vol. 1, Section 2 - From point A to B, reactor period is negative, and power will continue to decrease.

Question A.013 [1.0 point] (13.0)
During the time following a reactor scram, reactor power decreases on an 80 second period, which of the following corresponds to the half-life of the longest-lived delayed neutron precursors?

a. 80 seconds
b. 55 seconds
c. 40 seconds
d. 20 seconds

Answer: A.13 b.
Reference: Lamarsh, J. "Introduction to Nuclear Engineering" p. 88
Group 1 is the longest-lived delayed neutron precursor for thermal fission in U-235, with a half-life of 55.72 sec.

Question A.014 [1.0 point] (14.0)
Inelastic scattering can be described as a process whereby a neutron collides with a nucleus and:

a. recoils with a lower kinetic energy, with the nucleus emitting a gamma ray.
b. recoils with the same kinetic energy it had prior to the collision.
c. is absorbed by the nucleus, with the nucleus emitting a gamma ray.
d. recoils with a higher kinetic energy, with the nucleus absorbing a gamma ray.

Answer: A.14 a.
Reference: DOE Handbook Vol I, pg. 45

Question A.015 [1.0 point] (15.0)
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.

Answer: A.15 d.
Reference: Glasstone and Sesonske, *Nuclear Reactor Engineering*, Chapter 5, Section 5.114

Question A.016 [1.0 point] (16.0)
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

Answer: A.16 b.
Reference: Standard NRC Reactor Theory Question

(*** End of Section A ***)

Question B.001 [1.0 point] (1.0)

The Total Effective Dose Equivalent (TEDE) is defined as the sum of the deep-dose equivalent and the committed effective dose equivalent. The deep-dose equivalent is related to:

a. the dose to organs or tissues.
b. the external exposure to the skin or an extremity.
c. the external exposure to the lens of the eye.
d. the external whole-body exposure.

Answer: B.01 d.
Reference: 10CFR20.

Question B.002 [1.0 point] (2.0)

A temporary procedure change may be made with the approval of the Operations Supervisor without prior approval from the NSRB if it is a change:

a. required for safe reactor shutdown.
b. that does not change the original intent of the procedure.
c. required for safe operation of experiments and experiment facilities.
d. that specifies corrective actions to be taken for specific foreseen malfunctions.

Answer: B.02 b.
Reference: Technical Specifications, 6.4.

Question B.003 [1.0 point] (3.0)

The maximum reactivity change allowed for withdrawal and insertion of an experiment with an absolute worth of $0.35 is:

a. $0.40/second.
b. $0.35/second.
c. $0.20/second.
d. $0.15/second.

Answer: B.03 c.
Reference: Technical Specifications, Section 3.8.5

Question B.004 [1.0 point] (4.0)
All of the following are interlocks that prevent control rod withdrawal during reactor operations EXCEPT:

a. water level in reactor tank 12 inches above core top grid.
b. neutron flux = 60 counts per minute.
c. failure of line voltage to recorders.
d. fill pump running.

Answer: B.04 a. or b. per facility comment
Reference: Technical Specifications, Table 2.

Question B.005 [1.0 point] (5.0)
A radioactive sample is reading 25 R/hour. Four hours later, the sample reads 2.5 R/hour. The approximate time required for the sample to decay to 100 mR/hour from the 2.5 R/hour point is:

a. 1.9 hours
b. 3.8 hours
c. 5.6 hours
d. 7.8 hours

Answer: B.05 c.
Reference: Equation Sheet. $DR = DR_o e^{-\lambda t}$; $(2.5/25) = e^{-4\lambda}$; $\lambda = 0.575\ hr^{-1}$; therefore, $(0.1/2.5) = e^{-0.575t}$; t = 5.6 hours.

Question B.006 [1.0 point] (6.0)
Following an unintentional scram, the reactor may be prepared for startup only after the cause of the scram has been determined by the:

a. Reactor Operator
b. Senior Reactor Operator
c. Operations Supervisor
d. Facility Director

Answer: B.06 b. or c. per facility comment accepted.
Reference: Emergency Procedure 7.3.1. or Operating Procedure, J.1.a

Question B.007 [1.0 point] (7.0)
In accordance with the technical specifications, the safety limit set for the fuel pellet temperature, resulting from normal operation or transient effects, is limited to _____.

a. 300 °C
b. 500 °C
c. 1000 °C
d. 1700 °C

Answer: B.07 c.
Reference: Technical Specification (2.1 specifications).

Question B.008 [1.0 point] (8.0)
To ensure that there is adequate shutdown capability even with a stuck rod, requirements are established for the:

a. insertion time for each control rod.
b. minimum number of operable control rods.
c. maximum moderator-reflector water level.
d. actuation time for the auxiliary reactor scram.

Answer: B.08 b.
Reference: Technical Specifications, Section 3.2.2, Bases.

Question B.009 [1.0 point] (9.0)
According to the Emergency Plan, the decision to perform preliminary decontamination on site will be made by

a. By the individual
b. Senior Operator
c. The Radiation Safety Officer
d. The radiation treatment team at the hospital.

Answer: B.09 c.
Reference: Emergency Plan, Decontamination

Question B.010 [1.0 point] (10.0)

What is the Emergency Classification for a sustained fire at the RPI critical reactor facility?

a. Personnel Emergency

b. Unusual Event (Class I)

c. Emergency Alert

d. General Emergency

Answer: B.10 c.
Reference: Emergency Plan

Question B.011 [1.0 point] (11.0)

You are transferring fuel to the storage vault from the core. What is the maximum SPERT (F1) fuel pins which can be placed in a storage tube within the Fuel Vault?

a. 5

b. 15

c. 24

d. 30

Answer: B.11 b.
Reference: ~~RCF Operating Procedures, G "Fuel Handling", Version 2.1, 9/2006~~
Operating Procedures, Version 3.0, July 2013. Reference revised per facility comment.

Question B.012 [1.0 point] (12.0)

Question deleted per facility comment.

~~For a known core arrangement, the addition, movement, or removal of fuel will be limited to…..~~
~~a. $0.10 of reactivity or 4 fuel pins, whichever is greater~~
~~b. $0.20 of reactivity or 4 fuel pins, whichever is smaller~~
~~c. $0.30 of reactivity or 2 fuel pins, whichever is smaller~~
~~d. ½ the difference between the current number of fuel pins and the linearly extrapolated critical number from the 1/M plot or 50 fuel pins, whichever is smaller~~

~~Answer: B.12 b.~~
~~Reference: RCF Operating Procedures, G "Fuel Handling", Version 2.1, 9/2006~~

Question B.013 [1.0 point] (13.0)
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. U-235
b. Pu-240
c. Cs-137
d. N-16

Answer: B.13 c
Reference: Pre-Startup Procedures, Section I

Question B.014 [1.0 point] (14.0)
In accordance with the Technical Specifications, which ONE situation below is NOT permissible?

a. A moderator temperature minimum of 50 degrees F.
b. A clean fuel pin with a reactivity worth of $0.20.
c. A water level of not greater than 10 inches above the top grid of the core.
d. A total control rod drop time (full out to full in) of 1.1 second.

Answer: B.14 d.
Reference: RCF Technical Specifications 3.1 and 3.2

Question B.015 [1.0 point] (15.0)
The special unit for absorbed dose “Rem” is defined in 10 CFR Part 20 in terms of a dose equivalent. What does the term dose equivalent relate to?

a. It is derived by accounting for the amount of radioactive material taken into the body of an adult worker by inhalation or ingestion in one year.

b. It is equal to the absorbed dose (rad) multiplied by the quality factor (Q) of the radiation

c. It is the equivalent radiation required to produce 1 electrostatic unit of charge in 1 cc of dry air at Standard Temperature Pressure (STP).

d. It is the equivalent dose one would receive during the 50-year period following intake

Answer: B.15 b.
Reference: 10 CFR Part 20.1003

Question B.016 [1.0 point] (160)

"Experiments containing known explosives or highly flammable materials shall not be installed in the reactor." This is an example of a:

a. safety limit.
b. surveillance requirement.
c. limiting safety system setting.
d. limiting condition for operation.

Answer: B.16 d.
Reference: RCF Technical Specifications, Section 3.8.8.

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

Question C.001 [1.0 point] (1.0)
During Pre-Startup, you expose a known check source to the area gamma monitors to verify whether it is operable. This action is considered to be:

a. a channel test
b. a channel check
c. a channel calibration
d. a channel verification

Answer: C.01 a.
Reference: Technical Specifications, 1.3

Question C.002 [1.0 point] (2.0)
What is the scram setpoint for reactor period?

a. 2 seconds
b. 5 seconds
c. 15 seconds
d. 90% of on the highest scale of either of the two Linear Power Channels (LP1, LP2)

Answer: C.02 b.
Reference: Technical Specifications, 2.2

Question C.003 [1.0 point] (3.0)
Which ONE of the following best describes the reason for the high sensitivity of Geiger-Mueller tube detector?

a. BF_3 fill gas
b. Coating with U-235
c. Lower voltage applied to the detector helps to amplify all incident events.
d. Any incident radiation event causing primary ionization results in ionization of entire detector.

Answer: C.03 d.
Reference: RCF Manual of Experiments 2015, Section 1.2, page 1

Question C.004 [1.0 point] (4.0)
Which ONE of the following is the best description on how the Uncompensated Ion Chamber (UIC) operates?

	Material used in UIC	Interact with	Results
a.	Pu-239 +	neutron	B-10 + alpha -> N-14 + gamma
b.	B-10 +	neutron	B-11 -> Li-7 + alpha
c.	U-235 +	neutron	Fission fragments + gamma
d.	Am-239 +	neutron	Be-9 + gamma -> Li-8 + beta

Answer: C.04 b.
Reference: RCF Manual of Experiments 2015, Section 1.2, page 3

Question C.005 [1.0 point] (5.0)
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

Answer: C.05 a.
Reference: SAR page 7-7

Question C.006 [1.0 point] (6.0)
The "worst case" single instrument malfunction for a reactivity insertion accident is a(n):

a. loss of voltage to the detector for linear power channel 1(LP1).
b. open circuit on the ion chamber for log power channel 2(PP2).
c. interruption of output current to the Water Dump Valve solenoid.
d. grounded input signal to the short period module of the Solenoid Interrupt Circuit.

Answer: C.06 b.
Reference: SAR page 13-1

Question C.007 [1.0 point] (7.0)
Which ONE of the following descriptions of interlock features will allow control rod motion?

a. fill pump on, period greater than 15 seconds.
b. fill pump off, period less than 15 seconds.
c. fill pump off, period greater than 15 seconds.
d. fill pump on, period less than 15 seconds.

Answer: C.07 c.
Reference: SAR, Figure 7.2.

Question C.008 [1.0 point] (8.0)
Attached is the Figure 5.1: RCF Piping Diagram. Match the indicated valve number listed in column A with their intended function listed in column B. (Item in column B is to be used more than once or not at all.)

Column A	Column B
a. Valve # 5	1. Normally CLOSE/ Remote Fail OPEN
b. Valve # 2	2. Normally OPEN/ Remote Fail CLOSE
c. Valve # 4	3. Normally CLOSE/ Remote Fail CLOSE
d. Valve # 6	4. Normally CLOSE/ Hand valve
	5. Normally OPEN/ Hand valve

Answer: C.08 a. = 1; b. = 5; c. = 2; d. = 4
Reference: RCF SAR, Section 4.3 and Section 5.1

Question C.009 [1.0 point] (9.0)
Which ONE of the following is the neutron startup source currently used at the RCF reactor?

a. Americium-Beryllium (Am-Be)
b. Plutonium-Beryllium (Pu-Be)
c. Radon-Beryllium (Ra-Be)
d. Uranium-Beryllium (U-Be)

Answer: C.09 b.
Reference: RCF SAR 4.2.4, page 4-14

Question C.010 [1.0 point] (10.0)
Fuel pellet expansion in the SPERT fuel pins is most likely accommodated by ____.

a. the He fill gas around the fuel pellets
b. the BF_3 fill gas around the fuel pellets
c. the chromium nickel spring in the upper plenum region
d. the small dowel on the lower end cap which inserts into the lower grid plate

Answer: C.10 a.
Reference: RCF SAR 4.2.

Question C.011 [1.0 point] (11.0)
Per Surveillance Procedures-Section C, the reactor operator will use __ foils for the absolute power measurement.

a. copper
b. nickel
c. gold
d. aluminum

Answer: C.11 c.
Reference: RCF Surveillance Procedures-Section C, page 5

Question C.012 [1.0 point] (12.0)
The water dump valve operation may be by-passed by:

a. locking closed the water dump valve operator locally.
b. depressing the bypass pushbutton on the main control panel.
c. placing key switch located on CP-2 to the "By-pass" position.
d. disconnecting the DC current output at the Solenoid Interrupt Circuit module.

Answer: C.12 c.
Reference: RCF Prestart Procedures

Question C.013 [1.0 point] (13.0)
Differentiation between gamma and neutron induced signals in the startup channel is accomplished by:

a. amplifying only neutron signals coming from the detector.
b. counting only signals at strengths greater than the gamma signals.
c. adjusting the amplifier gain.
d. adjusting the compensating voltage applied to the detector.

Answer: C.13 b.
Reference: RCF Laboratory Procedure 1

Question C.014 [1.0 point] (14.0)
The “Reactor Tank Fill and Drain Control” switch is turned to “Fill.” When the “Fill” light next to the switch comes on:

a. the reactor tank is filled to 68 inches with water.
b. the fill pump stops.
c. the return valve to the fill pump suction is fully closed.
d. the fill valve is completely opened.

Answer: C.14 d.
Reference: RCF Prestart Procedures

Question C.015 [1.0 point] (15.0)
During a normal operation, which ONE of the following conditions will scram the reactor?

a. Reactor period exceeds 15 seconds
b. Neutron flux is less than 2 cps
c. Reactor door is opened
d. Line voltage to recorder is less than 100 V

Answer: C.15 c.
Reference: RCF Prestart Procedures

Question C.016 [1.0 point] (16.0)

When a failure of fuel pins occurs, the Continuous Air Monitor (CAM) alarms due to the release of:

a. N-16

b. Ar-41

c. Na-24

d. Xe-135

Answer: C.16 d.
Reference: NRC Standard Question

(*** End of Examination ***)