UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

February 7, 2019

Dr. Wei Ji, Director
Reactor Critical Facility
Rensselaer Polytechnic Institute
110 8th Street
Troy, NY 12180-3590

SUBJECT: EXAMINATION REPORT NO. 50-225/OL-19-02, RENSSELAER POLYTECHNIC INSTITUTE

Dear Dr. Ji:

On January 29, 2019, the U.S. Nuclear Regulatory Commission (NRC) administered an operator licensing examination at your Rensselaer Polytechnic Institute Research 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 Mrs. Paulette Torres at (301) 415-5656 or via internet e-mail Paulette.Torres@nrc.gov.

Sincerely,

/RA/

Anthony J. 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-19-02
2. Written examination

cc: Glenn Winters, RPI

cc: w/o enclosures: See next page

SUBJECT: EXAMINATION REPORT NO. 50-225/OL-19-02, RENSSELAER POLYTECHNIC INSTITUTE DATED FEBRUARY 7, 2019

DISTRIBUTION:
PUBLIC
RidsNrrDlpPrlb Resource
RidsNrrDlpProb Resource
Facility File (QLChen)

ADAMS Accession No. ML19037A297 **NRR-079**

OFFICE	NRR/DLP/PROB/CE	NRR/DLP/IOLB/OLA	NRR/DLP/PROB/BC
NAME	PTorres	QLChen	AMendiola
DATE	02/04/2019	02/06/2019	02/07/2019

OFFICIAL RECORD COPY

cc:

Mayor of the City of Schenectady
Schenectady City Hall
105 Jay St.
Schenectady, NY 12305

Dr. Shekhar Garde
Dean, School of Engineering
Rensselaer Polytechnic Institute
110 8th Street
Troy, NY 12181-3590

Reactor Operations Supervisor
JEC Room 2049
Department of Mechanical Aerospace
and Nuclear Engineering
Rensselaer Polytechnic Institute
110 8th Street
Troy, NY 12180-3590

Chief, Radiation Section
Division of Environmental Remediation
NY State Dept. of Environmental
Conservation
625 Broadway
Albany, NY 12233-7255

Radiation Safety Officer
NES Building, Room 1-10,
MANE Department
Rensselaer Polytechnic Institute
110 8th St.
Troy, NY 12180-3590

RCF Supervisor
NES Building, Room 1-10,
MANE Department
Rensselaer Polytechnic Institute
110 8th St.
Troy, NY 12180

Annette Chism, Director EH&S
Rensselaer Polytechnic Institute
21 Union Street
Gurley Building 2nd Floor
Troy, NY 12180

State Liaison Officer Designee
Senior Project Manager
Radioactive Waste Policy and Nuclear
Coordination
New York State Energy Research &
Development Authority
17 Columbia Circle
Albany, NY 12203-6399

Test, Research and Training
Reactor Newsletter
P.O. Box 118300
University of Florida
Gainesville, FL 32611
Troy, NY 12180-3590

U.S. NUCLEAR REGULATORY COMMISSION
OPERATOR LICENSING EXAMINATION REPORT

REPORT NO.: 50-225/OL-19-02

FACILITY DOCKET NO.: 50-225

FACILITY LICENSE NO.: CX-22

FACILITY: Critical

EXAMINATION DATES: January 29, 2019

SUBMITTED BY: ***/RA/*** 02/04/2019
Paulette Torres, Chief Examiner Date

SUMMARY:
On January 29, 2019, the NRC administered an operator licensing examination to one Senior Reactor Operator Instant (SROI) candidate. The candidate failed Part B of the written exam. The candidate passed all portions of the operating exam.

REPORT DETAILS

1. Examiner: Paulette Torres, Chief Examiner, NRC

2. Results:

	RO PASS/FAIL	SRO PASS/FAIL	TOTAL PASS/FAIL
Written	N/A	0/1	01
Operating Tests	N/A	1/0	1/0
Overall	N/A	0/1	0/1

3. Exit Meeting:
Paulette Torres, Chief Examiner, NRC
Ashley D. Ferguson, Examiner Trainee, NRC
Glenn Winters, Operations Supervisor, RPI

Upon completion of the examination, the NRC Examiner and Trainee met with the facility Operations Supervisor to discuss overall results. At the conclusion of the meeting, the NRC examiner thanked the facility for their support in the administration of the examination.

ENCLOSURE 1

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

FACILITY:	Rensselaer Polytechnic Institute
REACTOR TYPE:	Critical Facility
DATE ADMINISTERED:	1/29/2019
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
18.00	33.3	_____	_____	B. NORMAL AND EMERGENCY OPERATING PROCEDURES AND RADIOLOGICAL CONTROLS
18.00	33.3	_____	_____	C. FACILITY AND RADIATION MONITORING SYSTEMS
56.00		_____ 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. Reactor Theory, Thermohydraulics & Facility Operating Characteristics

A N S W E R S H E E T

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

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 ___

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 SECTION A *****)

B. Normal/Emergency Procedures and Radiological Controls

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 ___

B03 a b c d ___

B04 a b c d ___

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 ___

B18 a b c d ___

(***** END OF SECTION B *****)

C. Facility and Radiation 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 ___

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 ___

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 ___

(***** END OF SECTION 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

$$\dot{Q} = \dot{m}C_p\Delta T = \dot{m}\Delta H = UA\Delta T$$

$$P_{\max} = \frac{(\beta-\rho)^2}{(2\alpha\lambda)}$$

$$\lambda_{eff} = 0.1\,\text{sec}^{-1}$$

$$P = P_0\ e^{t/\mathrm{T}}$$

$$SCR = \frac{S}{-\rho} \cong \frac{S}{1-K_{eff}}$$

$$\lambda^* = 1\times10^{-4}\ \text{sec}$$

$$CR_1(-\rho_1) = CR_2(-\rho_2)$$

$$SUR = 26.06\left[\frac{\lambda_{eff}\rho + \rho\&}{\overline{\beta}-\rho}\right]$$

$$CR_1(1-K_{eff_1}) = CR_2(1-K_{eff_2})$$

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

$$M = \frac{1-K_{eff_1}}{1-K_{eff\,2}}$$

$$SDM = \frac{1-K_{eff}}{K_{eff}}$$

$$\mathrm{T} = \frac{\lambda^*}{\rho-\overline{\beta}}$$

$$\mathrm{T} = \frac{\lambda^*}{\rho} + \left[\frac{\overline{\beta}-\rho}{\lambda_{eff}\rho + \rho\&}\right]$$

$$T_{\frac{1}{2}} = \frac{0.693}{\lambda} \qquad \Delta\rho = \frac{K_{eff_2}-K_{eff_1}}{K_{eff_1}K_{eff_2}}$$

$$M = \frac{1}{1-K_{eff}} = \frac{CR_2}{CR_1}$$

$$\rho = \frac{K_{eff}-1}{K_{eff}}$$

$$DR = DR_0\,e^{-\lambda t}$$

$$DR_1\,d_1^{\,2} = DR_2 d_2^{\,2}$$

$$DR = \frac{6\,Ci\,E(n)}{R^2}$$

$$\frac{(\rho_2-\beta)^2}{Peak_2} = \frac{(\rho_1-\beta)^2}{Peak_1}$$

$$P = \frac{\beta(1-\rho)}{\beta-\rho}P_0$$

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

1 Curie = 3.7 x 10^{10} dis/sec
1 Horsepower = 2.54 x 10^3 BTU/hr
1 BTU = 778 ft-lbf
1 gal (H_2O) ≈ 8 lbm
c_P = 1.0 BTU/hr/lbm/°F
1ft = 30.48 cm

1 kg = 2.21 lbm
1 Mw = 3.41 x 10^6 BTU/hr
°F = 9/5 °C + 32
°C = 5/9 (°F - 32)
c_p = 1 cal/sec/gm/°C

QUESTION A.01 [1.0 point]
Which ONE of the following is defined as the balance between production of neutrons and their absorption in the core for which core leakage can be neglected?

a. Utilization Factor

b. Reproduction Factor

c. Infinite Multiplication Factor

d. Effective Multiplication Factor

QUESTION A.02 [1.0 point]
Delayed neutrons contribute more to reactor stability than prompt neutrons because they _____ the average neutron generation time and are born at a _____ kinetic energy.

a. Increase, lower

b. Decrease, lower

c Increase, higher

d. Decrease, higher

QUESTION A.03 [1.0 point]
Which ONE of the following most accurately describes the reason that fission products such as Xenon-135 and Samarium-19 have the most substantial impact in reactor design and operation?

a. Xenon-135 and Samarium-19 cause excess positive reactivity in the core.

b. Xenon-135 and Samarium-19 burn up causes an increase in the thermal flux.

c. Xenon-135 and Samarium-19 have large absorption cross sections resulting in a large removal of neutrons from the reactor.

d. Xenon-135 and Samarium-19 produce fast fission neutrons, resulting in the net increase in the fast neutron population of the reactor core.

QUESTION A.04 [1.0 point]
Which ONE of the following parameters is MOST significant in determining the differential rod worth of a control rod?

a. Rod speed

b. Flux shape

c. Reactor power

d. Fuel temperature

QUESTION A.05 [1.0 point]
Delayed neutrons are produced by:

a. Decay of N-16

b. Directly from the fission

c. Pair Production process

d. Decay of fission fragments

QUESTION A.06 [1.0 point]
Which ONE of the following best describes the effects of an increase in moderator temperature on neutron multiplication?

a. Reactor period doubles.

b. An increase in the moderator temperature has negligible effect on neutron multiplication.

c. An immediate decrease in the prompt neutron fraction due to leakage, absorption, and reduction in the fission rate.

d. The meanfree path between scattering collisions increases causing the average neutron to travel further and rod worth increases.

QUESTION A.07 [1.0 point]
What is the average number of neutrons produced from every fission of Uranium-235 with thermal neutrons?

a. 2.42 neutrons

b. 2.66 neutrons

c. 2.81 neutrons

d. 2.93 neutrons

QUESTION A.08 [1.0 point]
Which ONE of the following statement best defines the reactor excess reactivity?

a. A measure of the additional fuel loaded to overcome fission product poisoning.

b. A measure of remaining control rod worth when the reactor is exactly critical.

c. A measure of remaining control rod worth when the reactor is sub-critical.

d. The combined control rod negative reactivity worth required to keep the reactor shutdown.

QUESTION A.09 [1.0 point]
Which ONE of the following conditions would INCREASE the shutdown margin of a reactor?

a. Depletion of Uranium fuel.

b. Depletion of a burnable poison.

c. Inserting an experiment adding positive reactivity.

d. Lowering moderator temperature if the moderator temperature coefficient is negative.

QUESTION A.10 [1.0 point]
Which ONE of the following methods is used at the RCF to simulate a VOID?

a. Increase boron concentration

b. Add additional fuel to the core

c. Add helium gas to the moderator

d. Wrap a polystyrene sheet around the center fuel pin

QUESTION A.11 [1.0 point]
Fuel is being loaded into the core. The operator is using a 1/M plot to monitor core loading. Which ONE of the following conditions would result in a non-conservative prediction of core critical mass, i.e., the reactor would reach criticality prior to the predicted critical mass?

a. The detector is too close to the source and the fuel.

b. The detector is too far away from the source and the fuel.

c. A fuel element is placed between the source and the detector.

d. Excessive time is allowed between fuel elements being loaded.

QUESTION A.12 [1.0 point]
What is the result in a potential elastic scattering reaction between a neutron and a target nucleus?

a. Energy is transferred into nuclear excitation, and then emitted via a gamma emissions.

b. The target nucleus gains the amount of kinetic energy that the neutron loses.

c. The neutron is absorbed by the target nucleus and then emitted with lower kinetic energy.

d. The neutron conserves its initial kinetic energy if the target nucleus is large.

QUESTION A.13 [1.0 point]
Which ONE of the following is the definition of the effective neutron multiplication factor (k-eff)?

a. Absorption / (Production + Leakage)

b. (Production + Leakage) / Absorption

c. Production / (Absorption + Leakage)

d. (Absorption + Leakage) / Production

QUESTION A.14 [1.0 point]
A reactor is critical at 0.1 mW, you are raising reactor power, and doubling time is 30 seconds. What is the reactor power 2 minutes later?

a. 1.0 mW

b. 1.2 mW

c. 1.6 mW

d. 1.8 mW

QUESTION A.15 [1.0 point]
Given a source strength of 150 neutrons per second (N/sec) and a multiplication factor of 0.85. Which ONE of the following is the expected stable neutron count rate?

a. 500 N/sec

b. 750 N/sec

c. 1000 N/sec

d. 1250 N/sec

QUESTION A.16 [1.0 point]
What effect does Doppler Broadening for U-238 have on neutrons in a critical core?

a. More Scattering

b. More Absorption

c. Increase the Reproduction Factor

d. Increase the Resonance Escape Probability

QUESTION A.17 [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 2 / Decrease by 2

d. Increase by 2 / Increase by 4

QUESTION A.18 [1.0 point]
If the multiplication factor, k, is increased from 0.795 to 0.990, the amount of reactivity added is:

a. 0.197 Δk/k

b. 0.248 Δk/k

c. 0.319 Δk/k

d. 0.400 Δk/k

QUESTION A.19 [1.0 point]
Which ONE of the following is the stable reactor period which will result in a power rise from 50% to 100% power in 5 seconds?

a. 5 seconds

b. 7 seconds

c. 9 seconds

d. 10 seconds

QUESTION A.20 [1.0 point]
The number of neutrons passing through a one square centimeter of target material per second is described as:

a. Fission Rate

b. Neutron Flux

c. Macroscopic Cross Section

d. Microscopic Cross Section

********** End of Section A **********

QUESTION B.01 [1.0 point]
What is the HALF LIFE of the isotope contained in a sample which produces the following count rates?

Time (Minutes)	Counts per Minute (cpm)
Initial count	840
30	740
60	615
90	512
180	270

a. 310 minutes

b. 210 minutes

c. 110 minutes

d. 60 minutes

QUESTION B.02 [1.0 point]
In an emergency in order to protect the public health and safety, 10 CFR 50 allows the operator to depart from a license condition or a technical specification. What is the minimum level of authorization needed to deviate from this action?

a. Facility Director

b. Operations Supervisor

c. Licensed Reactor Operator

d. Licensed Senior Reactor Operator

QUESTION B.03 [1.0 point]
The exposure rate for a point source is 100 mR/hr at a distance of 4 m. What is the exposure rate at a distance of 2 m?

a. 200 mR/hr

b. 400 mR/hr

c. 600 mR/hr

d. 800 mR/hr

QUESTION B.04 [1.0 point]
Given the following instruments, which ONE is the best to check your hands and clothing for beta-gamma contamination upon leaving a contamination zone?

a. GM Pancake

b. Ionization chamber survey instrument

c. Portable sodium Iodide (NaI) detector

d. Zinc Sulfide (ZnS) detector

QUESTION B.05 [1.0 point]
As a research reactor licensed operator, you were unable to perform the functions of an operator for the minimum number of hours during the previous calendar quarter. What are the minimum number of hours you must complete before resumption of functions authorized by your license?

a. 4

b. 6

c. 8

d. 12

QUESTION B.06 [1.0 point]
Which ONE of the following Safety System Channels requires a minimum number of 2?

a. Log Count Rate

b. Linear Power

c. Log-N; Period

d. Control Panel 1 Power

QUESTION B.07 [1.0 point]
Which ONE of the following emergencies is categorized as an ALERT?

a. Loss of off-site electrical power.

b. Detection of smoke or flames within the RCF Building or Boiler House.

c. Area Monitor exceeds Alarm Levels when the reactor is shutdown or secured.

d. Phone or other message threatening damage to the facility with an explosive device.

QUESTION B.08 [1.0 point]
Which ONE of the following areas is the primary assembly point during an emergency?

a. Inside reactor room

b. Inside reactor building

c. Inside shielding counting room

d. RCF parking lot

QUESTION B.09 [1.0 point]
A channel _____of the safety system channels and visual inspection of the reactor shall be performed daily prior to reactor startup.

a. Check

b. Test

c. Calibration

d. Maintenance

QUESTION B.10 [1.0 point]
All equipment controlled by CP-1 include all of the following EXCEPT:

a. High Voltage power supplies

b. NIM bins

c. Compressor

d. Air Particulate Detector (APD) pump

QUESTION B.11 [1.0 point]
Which ONE of the following materials hazards has a encapsulation requirement?

a. Corrosive

b. Explosive

c. Flammable

d. Volatile

QUESTION B.12 [1.0 point]
Per Technical Specifications, the moderator-reflector water dump time shall be measured:

a. Annual

b. Semiannual

c. Quarterly

d. Monthly

QUESTION B.13 [1.0 point]
Per procedure, all of the following are necessary steps of the Pre-Startup Checklist EXCEPT:

a. Reactor tank fill

b. Fast dump valve opened

c. Core loading

d. Interlock check

QUESTION B.14 [1.0 point]
Which ONE of the following is the radiation dose limit for the public in an unrestricted area?

a. No limit

b. 2 rem in a year

c. 2 rem in any one hour

d. 2 mrem in any one hour

QUESTION B.15 [1.0 point]
You will need an oscilloscope to complete the surveillance procedure of:

a. Continuous Air Monitor Calibration

b. Integral Power

c. Water Dump

d. Rod Drop Timing

QUESTION B.16 [1.0 point]
The _____ initiates an audible alarm and a red light on the control panel at CP-1 when tripped.

a. Intrusion Alarm

b. Airborne Activity Alarm

c. Nuclear Instruments Alarm

d. Area Radiation Monitors Alarm

QUESTION B.17 [1.0 point, 0.25 each]
Match the area gamma monitors in Column A with its trip settings in Column B.

Column A	Column B
a. Reactor Deck	1. 10 mR/hr
b. Control Room	2. 20 mR/hr
c. Equipment Hallway	3. 40 mR/hr
d. Reactor Room (Criticality Monitor)	4. 100 mR/hr

QUESTION B.18 [1.0 point]
The RPI occupational limits is established as:

a. 2% of the legal limit

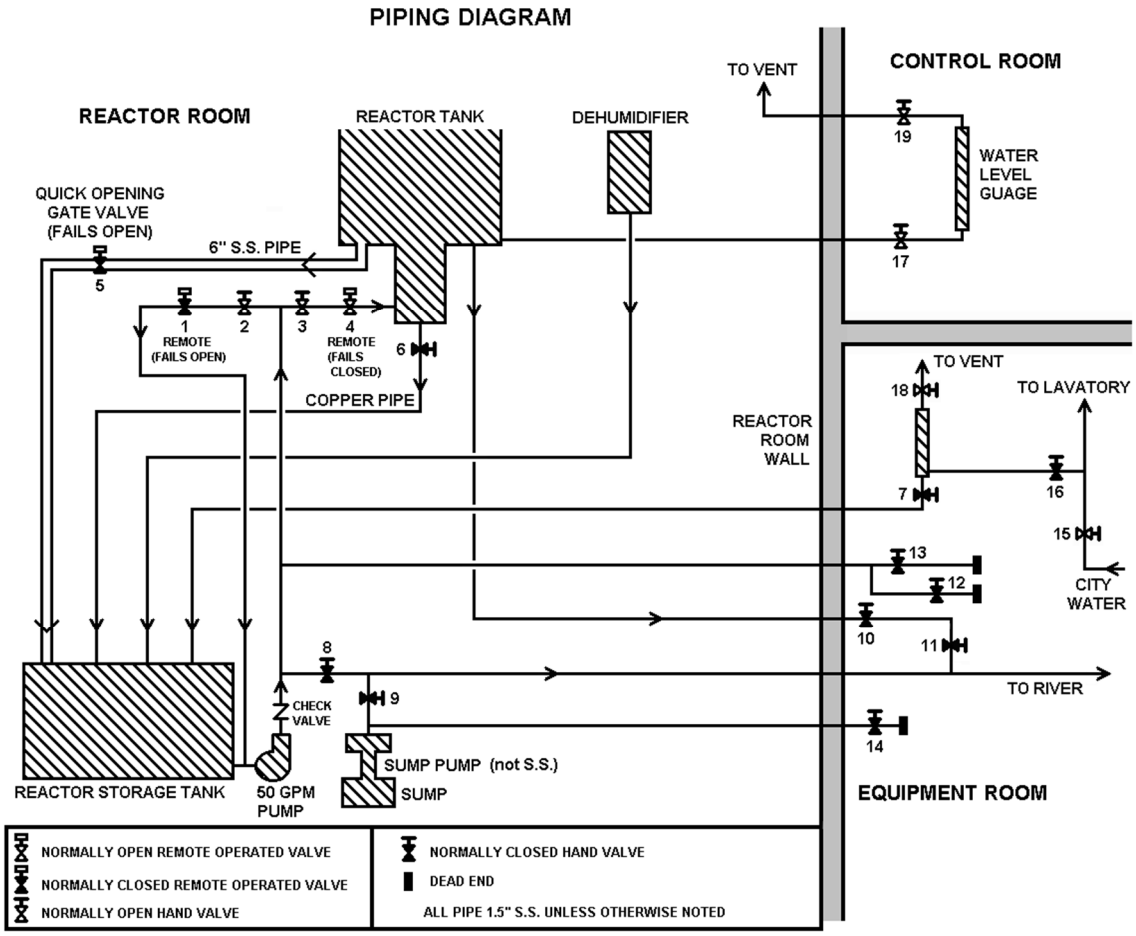
b. 10% of the legal limit

c. 20 % of the legal limit

d. Not applicable. Same as the NRC limit

********** End of Section B **********

QUESTION C.01 [1.0 point]



In the above figure, a quick opening of the gate valve occurs:

a. When the reactor is secured.

b. During an auxiliary SCRAM.

c. While disposing of moderator water to environment.

d. While filling the reactor tank (Phase 1 and Phase 2).

QUESTION C.02 [1.0 point]
The neutron startup source used in the RCF is:

a. Am-Be

b. Ra-Be

c. Sb-Be

d. Pu-Be

QUESTION C.03 [1.0 point]
Which ONE of the following channels signal comes from a BF_3 detector?

a. LP1

b. LP2

c. PP2

d. SUA

QUESTION C.04 [1.0 point]
The SPERT Fuel Pin Active Fuel Length is _____.

a. 0.20 in

b. 0.420 in

c. 36.00 in

d. 41.75 in

QUESTION C.05 [1.0 point]
"The excess reactivity of the reactor above cold, critical shall not be greater than 0.60 $" is an example of:

a. Safety Limit

b. Limiting Safety System Setting

c. Limiting Conditions for Operation

d. Surveillance Requirement

QUESTION C.06 [1.0 point]
Which ONE of the following reactor components is made of plastic and not stainless steel?

a. Top Plate

b. Middle Plate

c. Spacer Plate

d. Carrier Plate

QUESTION C.07 [1.0 point]
Which ONE of the following operations is performed from Control Panel 1 (CP-1)?

a. Auxiliary Equipment

b. Reactor Tank Fill

c. Source Drive

d. Videographic Recorders

QUESTION C.08 [1.0 point]
The Continuous Air Monitor samples air:

a. Above the Reactor Tank

b. Outside the Fuel Vault

c. In the Control Room

d. In the Equipment Hall

QUESTION C.09 [1.0 point]
Which ONE of the following is considered an “alternate” scram mechanism?

a. Fast moderator dump

b. Reactor room door

c. Reactor power console

d. High current trip

QUESTION C.10 [1.0 point]
Which ONE of the following is a requirement for loading or transferring fuel in a known core?

a. If more than 4 fuel pins are required to be added or removed, the tank shall be drained first.

b. Pins should be loaded to form a cruciform shape.

c. Fuel shall be loaded as symmetrically as possible and should not leave interior lattice locations empty.

d. The inverse multiplication method shall be used for fuel addition during the initial approach to criticality.

QUESTION C.11 [1.0 point]
Which ONE of the following monitors will be able to detect large levels of Ar-41?

a. Criticality Monitor

b. Area Gamma Monitor

c. Continuous Air Monitor

d. Environmental Monitor

QUESTION C.12 [1.0 point]
The _____ should be energized when the immersion heaters are energized.

a. Agitator

b. Impeller

c. Neutron source

d. Heating elements

QUESTION C.13 [1.0 point]
Which ONE of the following interlocks has a rod block visual alarm on the videographic recorder?

a. FILL PUMP “OFF” to close

b. RECORDER ON/OFF SWITCH “ON” to close

c. REACTOR PERIOD >15 sec to close

d. STARTUP CHANNEL B > 2 cps to close

QUESTION C.14 [1.0 point]
Which ONE of the following is the original use of the Neutron Source in the reactor core?

a. Ensure the reactor change from subcritical to critical by using neutron source only.

b. Provides a reference point where all instruments undergo a check before the reactor is brought to a critical position.

c. Provides enough neutron to assure proper nuclear instrumentation response during initial reactor startup.

d. Prevent the reactor changing from a manual to automatic if a period exceeds 10 seconds.

QUESTION C.15 [1.0 point]
In accordance with Technical Specifications, the Reactor is SECURE when all of the following conditions exist EXCEPT:

a. The console keys are removed.

b. Power is unavailable to the control rod drive by the magnet clutches from the safety amplifiers.

c. There is insufficient moderator available in the reactor to attain criticality.

d. All fuel pins have removed from the reactor.

QUESTION C.16 [1.0 point]
Discovery of contamination due to naturally occurring radionuclides such as radon daughters.

a. The reactor must immediately shutdown.

b. No action needed.

c. The reactor can continue to operate for a period not to exceed two weeks.

d. Is a reportable occurrence to the USNRC.

QUESTION C.17 [1.0 point]
When not in use, the fuel shall be stored in _____ clad steel tubes.

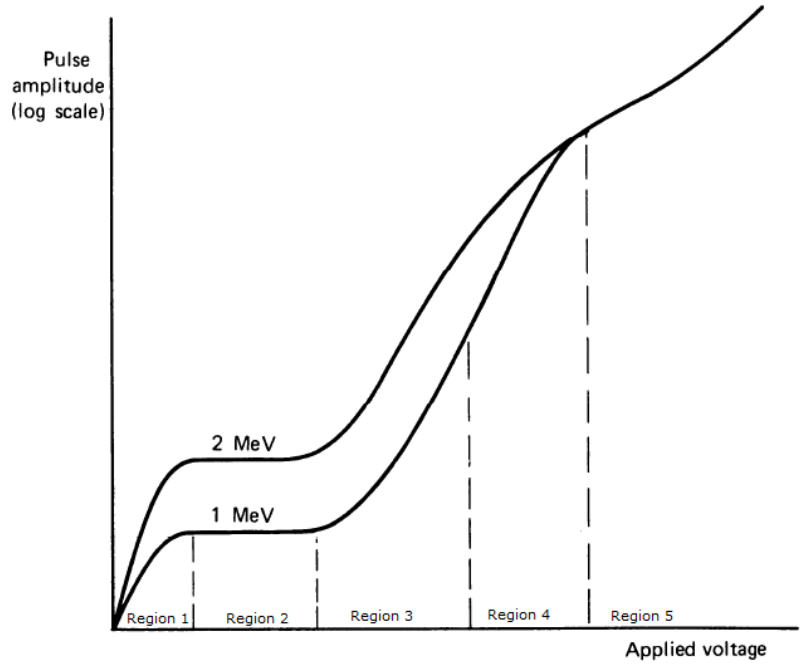
a. Cadmium

b. Boron

c. Silver

d. Indium

QUESTION C.18 [1.0 point]
The figure below the various regions for gas-filled detectors. Which ONE of the following Regions corresponds to the Geiger-Mueller Region?



a. Region 2

b. Region 3

c. Region 4

d. Region 5

********** End of Section C **********
********** End of the Exam **********

A.01
Answer: c
Reference: DOE Fundamentals Handbook, Vol. 2, NP-03, pg. 9

A.02
Answer: a
Reference: Burn, R., *Introduction to Nuclear Reactor Operations,* Section 3.2.4, pg. 3-12 and Section 3.4.4, pg. 3-33

A.03
Answer: c
Reference: DOE Fundamentals Handbook, Vol.2, NP-03, pg. 34

A.04
Answer: b
Reference: Burn, R., *Introduction to Nuclear Reactor Operations*, Section 7, pg. 7-4

A.05
Answer: d
Reference: Burn, R., *Introduction of Nuclear Reactor Operations*, Sec 3.2.1, pg. 3-4

A.06
Answer: d
Reference: Burn, R., *Introduction of Nuclear Reactor Operations*, Section 3.3.2, pg. 3-18

A.07
Answer: a
Reference: DOE Fundamentals Handbook, Vol. 2, NP-03, Table 1, pg. 7

A.08
Answer: b
Reference: DOE Fundamentals Handbook, Vol. 2, NP-03, pg. 50

A.09
Answer: a
Reference: Burn, R., *Introduction to Nuclear Reactor Operations*, Section 6.2.3, pg. 6-4

A.10
Answer: d
Reference: T.H. Trumbull, “MANE-4400: Critical Reactor Laboratory” Section 7.2, pg. 47

A.11
Answer: b
Reference: Burn, R., *Introduction to Nuclear Reactor Operations,* Section 5.5, pg. 5-18

A.12
Answer: b
Reference DOE Fundamentals Handbook, Vol. 1, NP-01, pg.43

A.13
Answer: c
Reference: DOE Fundamentals Handbook, Vol. 2, NP-03, pg.8

A.14
Answer: c
Reference: $P = P_o e^{t/T}$ When doubling time is known, the power level change from P_o is calculated by $P = P_o 2^{t/DT}$

$$P = 0.1\ mW * 2^{120s/30s}$$
$$P = 1.6\ mW$$

A.15
Answer: c
Reference: $N = S\left(\frac{1}{1-k_{eff}}\right)$

$$N = 250\frac{N}{sec} * \left(\frac{1}{1-.85}\right)$$
$$N = 1000\ \frac{N}{sec}$$

A.16
Answer: b
Reference: DOE Fundamentals Handbook, Vol. 2, NP-03, pg. 26

A.17
Answer: b
Reference: Chart of Nuclides

A.18
Answer: b
Reference: $\Delta p = \frac{K_{eff2} - K_{eff1}}{K_{eff1} K_{eff2}}$

$$\Delta p = \frac{.990 - .795}{(.795)(.990)}$$
$$\Delta p = .248$$

A.19
Answer: b
Reference: $P = P_0 e^{t/T}$

$$T = \frac{t}{\ell n(P/P_0)}$$
$$T = \frac{5}{\ell n\left(\frac{100}{50}\right)}$$
$$T = 7.21\ seconds$$

A.20
Answer: b
Reference: Burn, R., *Introduction of Nuclear Reactor Operations*, Sec 2.6.1, pg. 2-47

B.01
Answer: c
REF: $A = A_0e^{-\lambda t}$
$270 = 840e^{-180\lambda}$, $180\lambda = -\ln(0.321)$, $\lambda = 0.00631\ min^{-1}$
$t_{1/2} = 0.693 / \lambda, = 0.693 / 0.00631\ min^{-1} = 109.8$ minutes

B.02
Answer: d
REF: 10 CFR 50.54(y)

B.03
Answer: b
REF: $I_2=I_1D_1^2/d_2^2 = (100\ mR/hr)(4m)^2 / (2m)^2 = 400\ mR/hr$

B.04
Answer: a
REF: Glasstone, Sesonske, Nuclear Reactor Engineering, Section 9.88, pg. 537

B.05
Answer: b
REF: 10 CFR 55.53 (f)

B.06
Answer: b
REF: TS 3.2, Table 1, pg. 8

B.07
Answer: c
REF: RCF Emergency Plan, Section 5, pg. 8

B.08
Answer: c
REF: RCF Emergency Plan, Section 7, pg. 9
RCF Emergency Procedures, Section 5.1, pg. 4

B.09
Answer: b
REF: TS 4.2.4, pg. 15

B.10
Answer: c
REF: RCF Secure Procedure, #8

B.11
Answer: a
REF: TS 3.8.9, pg. 9

B.12
Answer: b
REF: TS 4.2.2, pg. 15

B.13
Answer: b
REF: RCF Pre-Startup Procedure, Pre-Startup Checklist

B.14
Answer: d
REF: 10 CFR 20.1301(a)(2)

B.15
Answer: d
REF: RCF Surveillance Procedures, Section B

B.16
Answer: d
REF: RCF Emergency Procedures, Section 3.1, pg. 3

B.17
Answer: a,4 b, 1 c, 3 d,2
REF: RCF Pre-Startup Procedure, Section D, pg. 5

B.18
Answer: b
REF: RCF Emergency Procedures, Section 9.2 (4), pg. 10

C.01
Answer: b
REF: Piping Diagram and Water Flow Continuous Training presentation

C.02
Answer: d
REF: SAR 4.2.4, pg. 4-14
RCF Operating Procedures, Section C.1

C.03
Answer: d
REF: SAR 7.2.3, pg. 7-1

C.04
Answer: c
REF: SAR Figure 4.5, Page 4-9

C.05
Answer: c
REF: TS 3.1 (1), pg. 6

C.06
Answer: c
REF: SAR 4.2.5, pg. 4-15

C.07
Answer: d
REF: SAR 7.1, pg. 7-1

C.08
Answer: a
REF: SAR 7.3, pg. 7-4

C.09
Answer: a
REF: SAR 13.1.3, pg. 13-2

C.10
Answer: a
REF: RCF Operating Procedures, Section K, Requirement 16

C.11
Answer: c
REF: TS 3.7 Bases, pg. 11

C.12
Answer: a
REF: RCF Operating Procedures, Section C.2.a

C.13
Answer: d
REF: SAR 7.3, pg. 7-4

C.14
Answer: c
REF: SAR 7.6, pg. 7-6

C.15
Answer: b
REF: TS 1.3, pg. 2

C.16
Answer: b
REF: TS 1.3, pg. 3

C.17
Answer: a
REF: TS 5.4, pg. 20

C.18
Answer: d
REF: RPI Lab Manual 2018, Figure 2, pg. 2