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

September 29, 2022

Dr. Partha Chowdhury, Director
Nuclear Radiation Laboratory
University of Massachusetts-Lowell
One University Avenue
Lowell, MA 01854

SUBJECT: EXAMINATION REPORT NO. 50-223/OL-22-01, UNIVERSITY OF MASSACHUSETTS-LOWELL

Dear Dr. Chowdhury:

During the week of July 18, 2022, the U.S. Nuclear Regulatory Commission (NRC) administered operator licensing examinations at the University of Massachusetts-Lowell 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 you and 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. If you have any questions regarding the examination, please contact Michele DeSouza at (301) 415-0747 or Michele.DeSouza@nrc.gov.

Sincerely,

Travis L. Tate
Digitally signed by Travis L. Tate
Date: 2022.09.29 22:40:02 -04'00'

Travis L. Tate, Chief
Non-Power Production and Utilization Facility Oversight Branch
Division of Advanced Reactors and Non-Power Production and Utilization Facilities
Office of Nuclear Reactor Regulation

Docket No. 50-223

Enclosures:
1. Examination Report No. 50-223 /OL-22-01
2. Written Examination

cc (w/o enclosures): See next page

SUBJECT: EXAMINATION REPORT NO. 50-223/OL-22-01, UNIVERSITY OF MASSACHUSETTS-LOWELL DATED: SEPTEMBER 29, 2022

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ADAMS ACCESSION No.: ML22272A524 ***via email** **NRR-079**

Office	NRR/DANU/UNPO/CE	NRR/DANU/UNPO/OLA*	NRR/DANU/UNPO/BC*
Name	MDeSouza	ZTaru	TTate
Date	07/21/2022	09/29/2022	09/29/2022

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

REPORT NO.: 50-223/OL-22-01

FACILITY DOCKET NO.: 50-223

FACILITY LICENSE NO.: R-125

FACILITY: University of Massachusetts-Lowell Research Reactor

EXAMINATION DATES: July 19-20, 2022

SUBMITTED BY: _____ 08/01/2022
Michele C DeSouza, Chief Examiner Date

SUMMARY:
During the week of July 18, the NRC administered operator licensing examinations to one Reactor Operator (RO) and one Senior Reactor Operator-Upgrade (SROU). All candidates passed all applicable portions of the examinations.

REPORT DETAILS

1. Examiners: Michele C DeSouza, Chief Examiner, NRC

2. Results:

	RO PASS/FAIL	SRO PASS/FAIL	TOTAL PASS/FAIL
Written	1/0	N/A	1/0
Operating Tests	1/0	1/0	2/0
Overall	1/0	1/0	2/0

3. Exit Meeting:
Michele C DeSouza, Chief Examiner, NRC
Leo Bobek, UMLRR

Prior to administration of the written examination, based on facility comments, adjustments were accepted. Comments provided corrections and additional clarity to questions/answers and identified where changes were appropriate based on current facility conditions. Upon completion of all operator licensing examinations, the NRC examiner met with facility staff representatives to discuss the results. At the conclusion of the meeting, the NRC examiner thanked the facility for their support in the administration of the examination.

ENCLOSURE 1

University of Massachusetts - Lowell Docket No. 50-223

cc:

Mayor of Lowell
City Hall
Lowell, MA 01852

Mr. Leo Bobek
Reactor Supervisor
University of Massachusetts - Lowell
One University Avenue
Lowell, MA 01854

Department of Environmental Protection
One Winter Street
Boston, MA 02108

Jack Priest, Director
Radiation Control Program
Department of Public Health
Schrafft Center, Suite 1M2A
529 Main Street
Charlestown, MA 02129

Ms. Samantha Phillips, Director
Massachusetts Emergency Management Agency
400 Worcester Road
Framingham, MA 01702-5399

Test, Research and Training
Reactor Newsletter
Attention: Ms. Amber Johnson
Department of Materials Science
and Engineering
University of Maryland
4418 Stadium Drive
College Park, MD 20742-2115

ENCLOSURE 1

University of Massachusetts - Lowell

Operator Licensing Examination

Week of July 20, 2022

ENCLOSURE 2

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.

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

FACILITY: University of Massachusetts - Lowell

REACTOR TYPE: POOL

DATE ADMINISTERED: 07/20/2022

CANDIDATE: _____

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

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

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

_____
Candidate's Signature

Category A: Reactor Theory, Thermodynamics, and 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 CATEGORY A *****)

Category 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 ___

B19 a b c d ___

B20 a b c d ___

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

Category 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 ___

C19 a b c d ___

C20 a b c d ___

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

EQUATION SHEET

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

$$DR = DR_0 e^{-\mu x}$$

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

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

Category A: Reactor Theory, Thermodynamics, and Facility Operating Characteristics

QUESTION A.01 [1.0 point]
The reactor is on a CONSTANT positive period. Which ONE of the following power changes will take the SHORTEST time to complete?

a. From 100 kW to 150 kW

b. From 100 W to 200 W

c. From 10 W to 30 W

d. From 1 mW to 5 mW

QUESTION A.02 [1.0 point]
What is the total reactivity change due to a temperature decrease of 150°F? Given the moderator temperature coefficient of -0.00081 $\Delta k/k/°F$.

a. – 0.1275 $\Delta k/k$

b. 0.1275 $\Delta k/k$

c. – 0.1215 $\Delta k/k$

d. 0.1215 $\Delta k/k$

QUESTION A.03 [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 10 seconds?

a. 6.8 seconds

b. 14.4 seconds

c. 23.1 seconds

d. 35.6 seconds

QUESTION A.04 [1.0 point]
Which ONE of the following describes the production of fission neutrons resulting from thermal neutrons being absorbed in the fuel?

a. Reproduction Factor (η)

b. Thermal Utilization Factor (f)

c. Resonance Escape Probability (p)

d. Fast Non-Leakage Probability (L_f)

QUESTION A.05 [1.0 point]
Excess reactivity is the amount of reactivity _____.

a. associated with burnable poisons

b. needed to achieve prompt criticality

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

d. available below that which is required to make the reactor subcritical

QUESTION A.06 [1.0 point]
Inelastic scattering is the process by which a neutron:

a. Collides with a nucleus and recoils with the same kinetic energy as prior to the collision.

b. Collides with a nucleus and is absorbed, with the nucleus emitting a charged particle.

c. Collides with a nucleus and is absorbed to form a compound nucleus, with the nucleus releasing a gamma ray.

d. Collides with a nucleus and is absorbed to form a compound nucleus, with the nucleus emitting a gamma ray and the neutron with a lower kinetic energy.

QUESTION A.07 [1.0 point]
Which ONE of the following describes the reason Xe-135 and Sm-149 have an impact on reactor physics?

a. They both cause an increase in thermal flux due to burnup.

b. They both have cause excess positive reactivity in the core.

c. They both have small thermal neutron absorption cross-sections.

d. They both have large thermal neutron absorption cross-sections which causes large removal of neutrons from the reactor.

QUESTION A.08 [1.0 point]
The count rate is 150cps. An experimenter inserts an experiment into the core and the count rate increases to 220cps. If the initial K_{eff} was 0.87, what is the worth of the experiment?

a. $\Delta\rho = -0.05$

b. $\Delta\rho = +0.05$

c. $\Delta\rho = -0.08$

d. $\Delta\rho = +0.08$

QUESTION A.09 [1.0 point]
What corresponding term is associated with the definition of "*the product of number density and microscopic cross section of an element"*?

a. Mean Free Path

b. Decay Constant

c. Thermal Cross Section

d. Macroscopic Cross Section

QUESTION A.10 [1.0 point]
The total energy produced from fission of U-235 with a thermal neutron is _____ with _____ energy produced instantaneously.

a. 210 MeV; 23 MeV

b. 200 MeV; 23 MeV

c. 200 MeV; 187 MeV

d. 210 MeV; 187 MeV

QUESTION A.11 [1.0 point]
Most text books list β for a U_{235} fueled reactor as 0.0065 ΔK/K and β_{eff} as being 0.0075 ΔK/K. Why is β_{eff} larger than β?

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

b. Delayed neutrons are born at lower energies than prompt neutrons resulting in a less loss due to leakage for these neutrons.

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

d. Some U^{238} in the core becomes Pu ^{239} (by neutron absorption) which is larger fission results.

QUESTION A.12 [1.0 point]
Which is the effective multiplication factor, given the source strength is 12,000 neutrons per second (N/sec) and it produces the stable neutron count rate of 60,000 N/sec?

a. 0.65

b. 0.70

c. 0.75

d. 0.80

QUESTION A.13 [1.0 point]
Which ONE of the following provides the number of protons, the number of neutrons, and the number of electrons in the Uranium-235 nucleus ($_{92}U^{235}$)?

a. 92, 92, 143

b. 143, 92,143

c. 92, 143, 92

d. 143, 143, 92

QUESTION A.14 [1.0 point]
Which ONE of the following describes the term prompt jump?

a. A rapid rise in power level due to an increase in the production of prompt neutrons.

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

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

d. A negative reactivity insertion that is less than k_{eff}

QUESTION A.15 [1.0 point]
An experimenter inserts an experiment into the core, and the count rate decreases to 60 cps from an original count rate of 120 cps. Given the initial K_{eff} of the reactor was 0.87, what is the worth of the experiment?

a. $\Delta\rho = -0.2$

b. $\Delta\rho = +0.4$

c. $\Delta\rho = -0.6$

d. $\Delta\rho = +0.7$

QUESTION A.16 [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. Assume all other factors remain unchanged, what is the new value for the thermal utilization factor?

a. 0.698

b. 0.714

c. 0.737

d. 0.761

QUESTION A.17 [1.0 point]
By definition, an exactly critical reactor can be made prompt critical by adding positive reactivity equal to which ONE of the following?

a. 1.0 %Δk/k

b. The B_{eff} value

c. The k_{eff} margin

d. The shutdown margin

QUESTION A.18 [1.0 point]
Which ONE of the following is the definition of SHUTDOWN MARGIN?

a. The amount of reactivity available above what is required to keep the reactor critical.

b. The amount of reactivity that would be added to a core if the rods in a critical cold clean reactor were fully inserted.

c. Provides a measure of excess reactivity available to overcome fission product buildup, fuel burnup, and power defect.

d. The negative reactivity inserted by an increase in moderator temperature within the core when the reactor is brought from zero to full power.

QUESTION A.19 [1.0 point]
Which ONE of the following is a correct representation of a beta particle?

a. $\frac{0}{1}e$

b. $\frac{0}{-1}e$

c. $\frac{2}{4}\beta$

d. $\frac{1}{0}e$

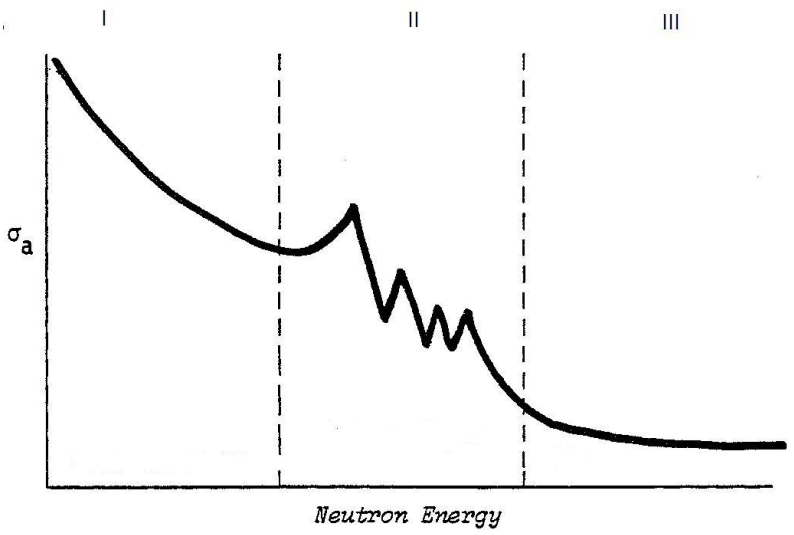
QUESTION A.20 [1.0 point]
In the following graph, how is the neutron behavior within Region II best described?

a. The neutron cross-section is inversely proportional to the neutron velocity (1/V)

b. Neutrons of specific energy levels (e.g. 50 eV, 100 keV) are more likely to be readily absorbed than neutrons at other energy levels

c. The neutron cross-section decreases steadily with increasing neutron energy (1/E)

d. Neutrons of specific energy levels (e.g. 50 eV, 100 keV) have a greater potential for leakage from the reactor core



(***** End of Category A *****)

Category B: Normal and Emergency Operating Procedures and Radiological Controls

QUESTION B.01 [1.0 point]
Per UMLRR Technical Specifications, which ONE of the following measuring channels is required to operate ONLY in FORCED CONVECTION mode of operation?

a. Log-N (Period)

b. Power Level (Linear N)

c. Reactor Coolant Flow Rate

d. Reactor Pool Temperature

QUESTION B.02 [1.0 point]
Per UMLRR Emergency Operations-02, during a major fire or explosion, who do you need to be informed if the fire involves radioactive material?

a. Security Officer

b. Reactor Supervisor

c. Radiation Safety Officer

d. Senior Reactor Operator

QUESTION B.03 [1.0 point]
In an emergency, 10 CFR 50.54 allows reasonable action that departs from a license condition or a technical specification when this action is immediately needed to protect the public health and safety. In this case, what is the MINIMUM level of authorization or approval needed to depart from a license condition or technical specification?

a. Senior Reactor Operator

b. Reactor Operator

c. Facility Director, UMLRR

d. Chief Examiner, NRC

QUESTION B.04 [1.0 point]
Which ONE of the following items is NOT required to log in the console operator's log during insertion of a sample and removal of a sample from the core?

a. Sample time in and out

b. Reactivity worth of sample

c. Sample identification number

d. Dose rate of sample after removal from the reactor core

QUESTION B.05 [1.0 point]
What is the dose rate at 3 feet given 80% of the decay of a 3 Curie source results in emission of 100 keV gamma?

a. 0.16 mR/hr

b. 1.60 mR/hr

c. 16.0 mR/hr

d. 160 mR/hr

QUESTION B.06 [1.0 point]
If the measured dose at the site boundary reads 20 mRem/hr accumulated over 24 hours, this emergency event will be classified as which ONE of the following?

a. Non-reactor safety related event

b. Unusual Event

c. Alert

d. Site Area Emergency

QUESTION B.07 [1.0 point]
What federal regulation will you find the radiation dose limits for an individual member of the public, received as a result of facility operations?

a. 10 CFR 20

b. 10 CFR 50

c. 10 CFR 55

d. 10 CFR 70

QUESTION B.08 [1.0 point]
A Reactor Operator (RO) works in a high radiation area for eight (8) hours a day. The dose rate in the area is 80 mrem/hour. Which ONE of the following is the MAXIMUM number of days in which RO may perform their duties WITHOUT exceeding 10 CFR 20 limits?

a. 6 days

b. 7 days

c. 8 days

d. 9 days

QUESTION B.09 [1.0 point]
Which ONE of the following is a '*Channel Calibration*'?

a. The Radiation Area Monitor (RAM) detector is exposed to a 2 mCi check source to verify its output is operable

b. During performance of the Daily Checklist, a SCRAM button is pressed to verify a scram on the safety system channel

c. Adjustment of the Fission Chamber in accordance with data collected during a recent reactor power calibration

d. During performance of the Daily Checklist, readings of Radiation Area Monitor 1 and Radiation Area Monitor 2 are compared

Category B: Normal and Emergency Operating Procedures and Radiological Controls

QUESTION B.10 [1.0 point]
According to the UMLRR Emergency Plan, who is the individual responsible for termination of an emergency?

a. Lowell Police Department

b. Emergency Director, UMLRR

c. Reactor Supervisor, UMLRR

d. Senior Reactor on duty

QUESTION B.11 [1.0 point]
Which ONE of the following nuclides would most likely be present on the Continuous Air Monitor (CAM) in the event of a suspected fuel leak?

a. Boron-10

b. Argon-41

c. Cobalt-60

d. Rubidium-88

QUESTION B.12 [1.0 point]
The UMLRR Requalification Program must be conducted for a continuous period not to exceed 24 months in duration, in accordance with _____.

a. 10 CFR 19

b. 10 CFR 20

c. 10 CFR 50

d. 10 CFR 55

Category B: Normal and Emergency Operating Procedures and Radiological Controls

QUESTION B.13 [1.0 point]
What is the MINIMUM number of hours you must complete before resumption of functions authorized by your license if you were unable to perform the functions of an operator for the minimum number of hours during the previous calendar quarter?

a. 4

b. 6

c. 8

d. 10

QUESTION B.14 [1.0 point]
During reactor operations, you use a Geiger-Mueller detector to measure about 1 foot from the demineralizer. You measure the radiation reading between close window and open window of the detector. In comparing the close window reading to the open window reading would:
(Assume no piping leaks or contamination)

a. increase because it measures additional beta radiation of Argon-41 decay from the tank.

b. remain the same because the quality factor for gamma and beta radiation are the same.

c. increase because it measures additional radiation of Nitrogen-16 and Tritium betas from the tank.

d. remain the same because it only measures gamma radiation from the demineralizer tank.

QUESTION B.15 [1.0 point]
Which ONE of the following is the appropriate 10 CFR 55 requirement associated with a time interval of 1 year?

a. Medical Examination

b. License Expiration

c. Written Examination

d. Operating Test

QUESTION B.16 [1.0 point]
Which ONE of the following conditions below is NOT permissible when the reactor is operating? (According to the UMLRR Technical Specifications).

a. Shutdown margin = 2.3%Δk/k

b. Core excess reactivity = 0.02%Δk/k

c. Temperature = 180 º F

d. Absolute reactivity of any single secured experiment = 0.4%Δk/k

QUESTION B.17 [1.0 point]
Which ONE of the following events does NOT require the direction of a licensed Senior Reactor Operator at the facility?

a. Initial reactor startup and approach to power

b. Insertion of a movable experiment worth 0.1%Δk/k

c. Recovery from an unscheduled shutdown

d. Relocation of control rods within the reactor core

QUESTION B.18 [1.0 point]
A 40-mm thick sheet of lead placed at a certain location in a beam of gamma rays reduced the gamma radiation level from 600 mR/hr to 150 mR/hr. How much ADDITIONAL lead would be needed to reduce the gamma radiation level to 75 mR/hr?

a. 10 mm

b. 20 mm

c. 35 mm

d. 75 mm

QUESTION B.19 [1.0 point]
Which ONE of the following terms is associated with '*those measures taken in anticipation of an emergency or after an emergency has occurred to protect health and safety of individuals and to prevent damage to property'*'?

a. Protective Actions

b. Emergency Action Levels

c. Corrective Actions

d. Emergency Procedure Guides

QUESTION B.20 [1.0 point]
There has been an observation of a natural phenomenon affecting the reactor site. According to the UMLRR Emergency Plan, what is the emergency action level classification?

a. Alert

b. Unusual Event

c. Site Area Emergency

d. General Emergency

(***** End of Category B *****)

Category C: Facility and Radiation Monitoring Systems

QUESTION C.01 [1.0 point]
Which ONE of the following methods will be used to recalibrate the control rods following a change in core configuration?

a. Inverse multiplication

b. Positive period method

c. Count rate versus k-effective

d. Blade position versus temperature

QUESTION C.02 [1.0 point]
Which ONE of the following is used to transfer a capsule in and out of the reactor core within the pneumatic system?

a. Argon

b. Helium

c. Compressed air

d. Compressed Nitrogen

QUESTION C.03 [1.0 point]
Which ONE of the Radiation Monitors *'monitors gaseous and particulate effluents"*?

a. Gamma Detector

b. Neutron Detector

c. Stack Effluent Monitor

d. Continuous Air Monitors

QUESTION C.04 [1.0 point]
Which ONE of the following is the '*main radiological consideration with the use of the beam ports"*?

a. Generation of Argon-41

b. Production of Helium

c. Generation of Nitrogen-16

d. Production of Depleted Uranium

Category C: Facility and Radiation Monitoring Systems

QUESTION C.05 [1.0 point]
Which ONE of the following conditions will NOT initiate the closure of the reactor ventilation system?

a. High power level scram

b. Loss of power and activation of ventilation freeze alarm

c. Activating the LREA in the control room

d. Activating the GREA in the Reactor Supervisor's office

QUESTION C.06 [1.0 point]
If there is a significant buildup of radioactivity from the reactor pool, what is the impact on the pool water conductivity?

a. No relationship between radioactivity and conductivity in the pool water

b. Stays the same

c. Decreases

d. Increases

QUESTION C.07 [1.0 point]
Which ONE of the following detectors provides reactor period?

a. Energy Compensated Geiger-Mueller

b. Uncompensated Ion Chamber

c. Fission Chamber

d. B-10 Proportional Counter

QUESTION C.08 [1.0 point]
Which ONE of the following radiation monitoring systems utilizes a scintillation detector?

a. Bridge Area Radiation Monitor

b. Stack Effluent

c. Continuous Air Monitor

d. Environmental Monitor

Category C: Facility and Radiation Monitoring Systems

QUESTION C.09 [1.0 point]
Which ONE of the following best identifies the UMLRR emergency exhaust system filters?

a. Glass conventional

b. Conventional and high efficiency

c. Activated charcoal and high efficiency

d. Pressure monitoring and activated charcoal

QUESTION C.10 [1.0 point]
Which ONE of the following will result from the inadvertent >1 inch movement of the reactor bridge?

a. Rod rundown

b. Automatic scram

c. Evacuation alarm

d. Status light illumination on the reactor control console only

QUESTION C.11 [1.0 point]
Which ONE of the following is the gaseous radioactive waste product produced in largest quantity at the UMLRR?

a. Helium-2

b. Argon-41

c. Nitrogen-16

d. Radon-222

QUESTION C.12 [1.0 point]
What is the UMLRR standard flat plate MTR-type fuel elements fueled with?

a. Low enrichment <20% U-235 U_3Si_2 clad with stainless steel

b. Low enrichment <25% U-235 U_3Si_2 clad with stainless steel

c. Low enrichment <25% U-235 U_3Si_2 clad with aluminum

d. Low enrichment <20% U-235 U_3Si_2, clad with aluminum

Category C: Facility and Radiation Monitoring Systems

QUESTION C.13 [1.0 point]
Which region of the pulse size versus applied voltage curve does UMLRR fission chamber operate?

a. Recombination

b. Geiger-Mueller

c. Ion Chamber

d. Limited Proportional

QUESTION C.14 [1.0 point]
Which ONE of the following is the neutron poison material in the control elements?

a. B_4C_2 in the regulating rod

b. Boron in the safety blades

c. B_2C in all but the regulating blade

d. B_4C in the safety blades and regulating rod

QUESTION C.15 [1.0 point]
Which ONE of the following statements is INCORRECT concerning the primary coolant flow rate?

a. Steel orifice in the primary piping

b. Stainless steel orifice

c. Installed in the primary piping

d. After the heat exchanger

QUESTION C.16 [1.0 point]
Members of the UMLRR Radiation Safety Committee are appointed by and responsible to which ONE of the following?

a. Senior Reactor Operator

b. Reactor Supervisor, UMLRR

c. Chancellor of UML

d. NRC Safety Division

Category C: Facility and Radiation Monitoring Systems

QUESTION C.17 [1.0 point]
What is the purpose of monitoring primary coolant conductivity?

a. To ensure pH levels are reduced.

b. To ensure acceptable corrosion control.

c. To ensure demineralizer resin is not channeled thru pressurization.

d. To ensure dose rates are maintained in accordance with 10 CFR 20 limits.

QUESTION C.18 [1.0 point]
The confinement building emergency exhaust system requires an operability surveillance be performed _____ and the carbon filter efficiency shall be tested _____.

a. Quarterly, Annually

b. Quarterly, Biennially

c. Biannually, Quarterly

d. Biennially, Quarterly

QUESTION C.19 [1.0 point]
What is the purpose of the dash pots on the control rods?

a. Force air to allow pulsing

b. Draw water in to support slowing neutrons

c. Create a suction effect to move the rod down quickly

d. Slow it down to prevent damage

Category C: Facility and Radiation Monitoring Systems

QUESTION C.20 [1.0 point]
What is the MAXIMUM k_{eff}, according to UMLRR Technical Specifications, that fuel elements must be stored in a safe array?

a. 0.7

b. 0.8

c. 0.9

d. 1.0

(***** End of Category C *****)
(********** End of the Exam **********)

Category A: Reactor Theory, Thermodynamics, and Facility Operating Characteristics

A.01
Answer: a
Reference: $P=P_o e^{t/T} \rightarrow t=T*\ln(P/P_o)$ assume constant period=1; The smallest ratio of P/P_o is the shortest time to complete

A.02
Answer: d
Reference: DOE Handbook, *Fundamentals of Nuclear Engineering*, Volume 2, NO-03, "Reactivity Coefficients and Reactivity Defect", pg 21,
$\Delta\rho = \alpha T*\Delta T = (-0.00081\ pcm/^oF) * (-150^oF) = 0.1215\ \Delta k/k$.

A.03
Answer: b
Reference: $P = P_0\, e^{t/T} \longrightarrow T= t/\ln(P/P_0)$
$T= 10/\ln(100/50)$; T = 14.4 sec

A.04
Answer: a
Reference: DOE Handbook, *Fundamentals of Nuclear Engineering,* Volume 2, NP-03, pg 13

A.05
Answer: c
Reference: DOE Handbook, *Fundamentals of Nuclear Engineering*, Chapter 3, pg 61

A.06
Answer: d
Reference: DOE Handbook, *Fundamentals of Nuclear Engineering*, Volume 1, Module 1, p 45

A.07
Answer: d
Reference: UMLRR standard nuclear knowledge

A.08
Answer: b
Reference: $CR_1 / CR_2 = (1 - K_{eff2}) / (1 - K_{eff1})$
$150 / 220 = (1 - K_{eff2}) / (1 - 0.87)$
Therefore $K_{eff2} = 0.911$
$\Delta\rho = (K_{eff2} - K_{eff1}) / (K_{eff2} * K_{eff1})$
$\Delta\rho = (0.911 - 0.87) / (0.911 * 0.87)$
$\Delta\rho = + 0.052$

A.09
Answer: d
Reference: Burn, *Introduction to Nuclear Reactor Operations,* Section 2.5.2, pg 2-43

A.10
Answer: c
Reference: DOE Handbook, *Fundamentals of Nuclear Engineering*, Volume 1, Module 1, Atomic and Nuclear Physics, pg 61

A.11
Answer: b
Reference: Burn, *Introduction to Nuclear Reactor Operations,* Section 3.2.4, pg 3-12

A.12
Answer: d
Reference: $CR = S/(1-K) \rightarrow 60{,}000 = 12{,}000/(1 - K) = 1 - X = 12{,}000 / 60{,}000$
$1 - K = - 0.2;\ K = 1 - 0.2;\ K = 0.8$

A.13
Answer: c
Reference: Chart of the Nuclides; 92 protons, 143 neutrons & 92 electrons

A.14
Answer: a
Reference: Burn, *Introduction to Nuclear Reactor Operations,* Section 4.7, page 4-21

A.15
Answer: a
Reference: $CR_1 / CR_2 = (1 - K_{eff2}) / (1 - K_{eff1});\ 120 / 60 = (1 - K_{eff2}) / (1 - 0.87)$
Therefore $K_{eff2} = 0.74$
$\Delta\rho = (K_{eff2} - K_{eff1}) / (K_{eff2} * K_{eff1});\ \Delta\rho = (0.74 - 0.87) / (0.74 * 0.87)$
$\Delta\rho = (- 0.13) / (0.6438) = - 0.2$

A.16
Answer: a
Reference: $K_{eff} = 1.03 \cdot 0.84 \cdot 0.96 \cdot 0.88 \cdot 1.96 \cdot X;\ X = 1 / 1.4326;\ X = 0.698$

A.17
Answer: b
Reference: Burn, , *Introduction to Nuclear Reactor Operations,* Section 3.3.7, pg 3-31 and problem 3.4.4 pg 3-33

A.18
Answer: b
Reference: Burn, *Introduction to Nuclear Reactor Operations,* Example 6.2.3(a), pg 6-4

A.19
Answer: b
Reference: DOE Handbook*, Fundamentals of Nuclear Engineering*, Volume 1, NP-01, pg 24

A.20
Answer: b
Reference: DOE Handbook, *Fundamentals of Nuclear Engineering*, NP-02

Category B: Normal and Emergency Operating Procedures and Radiological Controls

B.01
Answer: c
Reference: UMLRR Technical Specifications 3.2

B.02
Answer: c
Reference: UMLRR SOP, EO-2

B.03
Answer: a
Reference: 10 CFR 50.54(y)

B.04
Answer: d
Reference: UMLRR SOP, RO-4

B.05
Answer: d
Reference: 6Cen = R/hr at 1 ft. 6 x (3 Ci) x (0.8 x 0.1) = 1.44 R/hr @ 1 ft. = 0.16 R/hr or 160 mR/hr @ 3 ft.

B.06
Answer: b
Reference: UMLRR Emergency Plan, Appendix A

B.07
Answer: a
Reference: 10 CFR 20

B.08
Answer: b
Reference: 10CFR20.1201(a)(1)

$$\frac{5000 \text{ mr} \times 1 \text{ hr} \times \text{day}}{80 \text{ mr} * 8 \text{ hr}} = 7.8 \text{ days}$$

You cannot round off to 8 days that will exceed 10CFR20 limits

B.09
Answer: c
Reference: UMLRR Technical Specifications Definitions

B.10
Answer: b
Reference: UMLRR EPlan, 3.3

B.11
Answer: d
Reference: UMLRR standard nuclear knowledge

Category B: Normal and Emergency Operating Procedures and Radiological Controls

B.12
Answer: d
Reference: 10 CFR 55.59(a)(1)

B.13
Answer: b
Reference: 10 CFR 55.53 (f)

B.14
Answer: d
Reference: Standard NRC and Radiation Protection question
(betas cannot make it through the tank)

B.15
Answer: d
Reference: 10 CFR 55

B.16
Answer: c
Reference: UMLRR Technical Specifications, Sections 3.7.1 and 4.1

B.17
Answer: b
Reference: UMLRR Technical Specifications Section 3.7 and 6.1.3

B.18
Answer: b
Reference: $DR = DR^{*}e^{-\mu X}$, Find μ; $150 = 600^{*} e^{-\mu^{*}40}$; $\mu = 0.0346$
If insertion of an HVL (thickness of lead), the original intensity will be reduced by half.
Find X: $1 = 2^{*} e^{-0.0346^{*}X}$; X= 20 mm
Find HVL by shortcut: 600mR- 300 mR is the 1st HVL; 300 mR – 150 mR is the 2nd HVL; 150- mR – 75 mR is the 3rd HVL

B.19
Answer: a
Reference: UMLRR Emergency Plan Definitions

B.20
Answer: b
Reference: UMLRR Emergency Plan 4.2

Category C: Facility and Radiation Monitoring Systems

C.01
Answer: b
Reference: UMLRR RO-1, 4.14

C.02
Answer: c
Reference: UMLRR SAR Part 2, 10.2.7

C.03
Answer: c
Reference: UMLRR SAR Table 7-8

C.04
Answer: a
Reference: UMLRR SAR Part 2, 10.2.1, pg 10-6

C.05
Answer: a
Reference: UMLRR SAR Part 1, 3.4.2.1

C.06
Answer: d
Reference: UMLRR Technical Specifications 4.5

C.07
Answer: c
Reference: UMLRR SAR Part 1, 7.4.1.2

C.08
Answer: b
Reference: UMLRR EP 8.2.1

C.09
Answer: a
Reference: UMLRR SAR Part 1, 6.2.5

C.10
Answer: b
Reference: UMLRR SAR Part 2, 3.2.3

C.11
Answer: b
Reference: UMLRR Technical Specifications 3.6.2

C.12
Answer: d
Reference: UMLRR Technical Specifications 5.3

Category C: Facility and Radiation Monitoring Systems

C.13
Answer: c
Reference: UMLRR standard nuclear knowledge

C.14
Answer: d
Reference: UMLRR SAR 4.5, pg 4-25

C.15
Answer: a
Reference: UMLRR SAR 7.4.2.1

C.16
Answer: c
Reference: UMLRR SAR 11.1.2.2

C.17
Answer: b
Reference: UMLRR SAR Part 2, 5.1

C.18
Answer: b
Reference: UMLRR SAR Part 2, 4.4

C.19
Answer: d
Reference: UMLRR SAR 3.5.2

C.20
Answer: c
Reference: UMLRR Technical Specifications 5.4