



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

March 5, 2019

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

SUBJECT: EXAMINATION REPORT NO. 50-223/OL-19-01, UNIVERSITY OF
MASSACHUSETTS - LOWELL

Dear Dr. Chowdhury:

During the week of February 11, 2019, the U.S. Nuclear Regulatory Commission (NRC) administered an operator licensing examination at your 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 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. John T. Nguyen at (301) 415-4007 or via internet e-mail John.Nguyen@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. 50-223

Enclosures:

1. Examination Report No. 50-223/OL-19-01
2. Written examination

cc: w/o enclosures: See next page

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MASSACHUSETTS LOWELL DATED MARCH 5, 2019

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NRR-079

OFFICE	NRR/DLP/PROB/CE	NRR/DLP/IOLB/OLA	NRR/DLP/PROB/BC
NAME	JNguyen	LQChen	AMendiola
DATE	03/01/2019	02/27/2019	03/05/2019

OFFICIAL RECORD COPY

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
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Boston, MA 02108

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

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

REPORT NO.: 50-223/OL-19-01

FACILITY DOCKET NO.: 50-223

FACILITY LICENSE NO.: R-125

FACILITY: UMLRR-II

EXAMINATION DATES: February 14, 2019

SUBMITTED BY: /RA/ 03/01/2019
John T. Nguyen, Chief Examiner Date

SUMMARY:

During the week of February 11, 2019, the NRC administered the retake of the written examination to one Reactor Operator (RO) candidate who failed part B of the written examination on August 30, 2018. The candidate passed the retake examination.

REPORT DETAILS

1. Examiner: John T. Nguyen, Chief Examiner, NRC

2. Results:

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

3. Exit Meeting:
John T. Nguyen, Chief Examiner, NRC
Leo Bobek, Reactor Director, UMLRR

The NRC Examiner discussed the result with Mr. Bobek and thanked him for supporting in the administration of the examination.

ENCLOSURE 1

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

FACILITY: University of Massachusetts - Lowell

REACTOR TYPE: Pool

DATE ADMINISTERED: 02/14/2019

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% is required to pass the examination. Examination will be picked up one (1) hour after the examination starts.

<u>CATEGORY</u>	<u>% OF</u>	<u>CANDIDATE'S</u>	<u>% OF</u>	
<u>VALUE</u>	<u>TOTAL</u>	<u>SCORE</u>	<u>VALUE</u>	<u>CATEGORY</u>
<u>N/A</u>	<u> </u>	<u> </u>	<u> </u>	A. REACTOR THEORY, THERMODYNAMICS AND FACILITY OPERATING CHARACTERISTICS
<u>20.00</u>	<u>100</u>	<u> </u>	<u> </u>	B. NORMAL AND EMERGENCY OPERATING PROCEDURES AND RADIOLOGICAL CONTROLS
<u>N/A</u>	<u> </u>	<u> </u>	<u> </u>	C. FACILITY AND RADIATION MONITORING SYSTEMS
<u>20.00</u>		<u> </u>	<u> </u>	% TOTALS
		<u> </u>		FINAL GRADE

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

Candidate's Signature

ENCLOSURE 2

Category B – Normal/Emergency Operating Procedures and Radiological Controls

ANSWER SHEET

Multiple Choice (Circle or X your choice)

If you change your Answer, write your selection in the blank.

B01 a ____ b ____ c ____ d ____ (0.25 each)

B02 a b c d ____

B03 a b c d ____

B04 a b c d ____

B05 a b c d ____

B06 a b c d ____

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 EXAM *****)

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 one (1) hours for completion of the examination.

EQUATION SHEET

$$Q = mc_p \Delta T = m \Delta H = UA \Delta T$$

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

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

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

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

$$\lambda^* = 1 \times 10^{-4} \text{ sec}$$

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

$$CR_1(1 - K_{eff_1}) = CR_2(1 - K_{eff_2}) \quad CR_1(-\rho_1) = CR_2(-\rho_2)$$

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

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

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

$$M = \frac{1 - K_{eff_1}}{1 - K_{eff_2}}$$

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

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

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

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

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

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

$$DR_1 d_1^2 = DR_2 d_2^2$$

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

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

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

1 Curie = 3.7 x 10¹⁰ dis/sec

1 kg = 2.21 lb

1 Horsepower = 2.54 x 10³ BTU/hr

1 Mw = 3.41 x 10⁶ BTU/hr

1 BTU = 778 ft-lb

°F = 9/5 °C + 32

1 gal (H₂O) ≈ 8 lb

°C = 5/9 (°F - 32)

c_p = 1.0 BTU/hr/lb/°F

c_p = 1 cal/sec/gm/°C

Category B – Normal/Emergency Operating Procedures and Radiological Controls

QUESTION B.01 [1.0 point, 0.25 each]

Match the appropriate 10CFR part in Column A with the requirements in Column B.

<u>Column A</u>	<u>Column B</u>
a. 10CFR19	1. Technical information including the safety limit
b. 10CFR20	2. Individual radiation exposure data
c. 10CFR50	3. Postings of notices to workers
d. 10CFR55	4. Medical examination by a physician every two years

QUESTION B.02 [1.0 point]

A 5 curie source emits a 1.3 MeV gamma and a 1.1 MeV gamma 100% of the time. The source will be placed in the reactor storage room. How far from the source should a high radiation area sign be posted?

- a. 5 feet
- b. 11 feet
- c. 15 feet
- d. 21 feet

QUESTION B.03 [1.0 point]

Which ONE of the following reactor primary coolant conditions is a violation of UMLRR Technical Specifications?

- a. Primary coolant conductivity is 4 micromhs/cm averaged over a month.
- b. Radioactivity in the pool water shall be analyzed weekly.
- c. Pool level is 25 feet measured above core center.
- d. Pool temperature is 110 °F.

Category B – Normal/Emergency Operating Procedures and Radiological Controls

QUESTION B.04 [1.0 point]

Per UMLRR Technical Specifications, what is a minimum level of authority to approve substantive changes to the maintenance procedures which could have an effect on reactor safety?

- a. Reactor Safety Subcommittee
- b. Director of the Radiation Laboratory
- c. Reactor Supervisor
- d. US NRC

QUESTION B.05 [1.0 point]

Per UMLRR Technical Specifications, all radiation monitoring systems shall be calibrated:

- a. monthly.
- b. quarterly.
- c. semiannually.
- d. annually.

QUESTION B.06 [1.0 point]

Per UMLRR Technical Specifications, what is the MINIMUM shutdown margin relative to the cold, clean (xenon free) critical condition, with the most reactive rod fully withdrawn, and experiments in their most reactive state?

- a. $0.50 \Delta k/k$
- b. $0.50 \% \Delta k/k$
- c. $2.70 \Delta k/k$
- d. $2.70 \% \Delta k/k$

Category B – Normal/Emergency Operating Procedures and Radiological Controls

QUESTION B.07 [1.0 point]

How many hours (MINIMUM) are Test and Research Reactors licensed operators required to perform the functions of a licensed operator to resume activities if a licensee has not been actively performing the functions of a reactor operator or senior reactor operator?

- a. 4 hours
- b. 6 hours
- c. 8 hours
- d. 10 hours

QUESTION B.08 [1.0 point]

If the measured dose at the site boundary reads between 10 to 15 mRem/hr accumulated over 24 hours, this emergency event will be classified as:

- a. Site Area Emergency
- b. Alert
- c. Unusual Events
- d. Non-Reactor Safety Related Event

QUESTION B.09 [1.0 point]

A radioactive source has a current activity of 1 Curies. The activity 10 years ago was 100 Curies. The half-life of the radioactive source is:

- a. 1.5 years
- b. 2.5 years
- c. 3.5 years
- d. 4.5 years

Category B – Normal/Emergency Operating Procedures and Radiological Controls

QUESTION B.10 [1.0 point]

Per UMLRR Technical Specifications, which ONE of the following will violate the Limiting Safety System Settings for forced convection flow?

- a. Height of water above center line of the core is at 24 ft.
- b. Reactor coolant inlet temperature is at 101 °F.
- c. Steady State reactor power is at 1.22 MWt.
- d. Coolant flow rate is at 1300 gpm.

QUESTION B.11 [1.0 point]

An irradiated sample provides a dose rate of 0.5 rem/hr at 2 ft. Approximately how far from the sample reads 5 mrem/hr?

- a. 6 ft.
- b. 9 ft.
- c. 14 ft.
- d. 20 ft.

QUESTION B.12 [1.0 point]

The UMLRR Reed Technical Specification requires the worth of movable single experiment shall be < _____ and the total worth of secured experiments shall be < _____.

- a. 0.1 % Δ k/k and 0.50 % Δ k/k
- b. 0.5 % Δ k/k and 2.50 % Δ k/k
- c. 0.1 % Δ k/k and 2.50 % Δ k/k
- d. 0.5 % Δ k/k and 0.50 % Δ k/k

Category B – Normal/Emergency Operating Procedures and Radiological Controls

QUESTION B.13 [1.0 point]

Under conditions of natural convection flow, the maximum reactor thermal power at low pool level shall be 1.25 KW. This above statement is an example of:

- a. a Safety Limit (SL)
- b. a Limiting Safety System Setting (LSSS)
- c. a Limiting Condition for Operation (LCO).
- d. a Design Feature (DF).

QUESTION B.14 [1.0 point]

Which ONE of the following meets the MINIMUM staffing requirement when the reactor is NOT secured?

- a. 1 RO in the control room, a second person in the reactor building, and 1 SRO on call
- b. 1 SRO in the control room and Reactor supervisor on call
- c. 1 RO in the control room, Reactor supervisor on call
- d. 1 SRO in the control room and 1 SRO on call.

QUESTION B.15 [1.0 point]

Calculate an individual's total whole body dose given the individual received the following doses: 20 mrad of alpha, 10 mrad of gamma, and 5 mrad of neutron (unknown energy)

- a. 35 mrem
- b. 415 mrem
- c. 435 mrem
- d. 460 mrem

Category B – Normal/Emergency Operating Procedures and Radiological Controls

QUESTION B.16 [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. Dose rate of sample after removal from the reactor core
- b. Sample identification number
- c. Reactivity worth of sample
- d. Sample time in and out

QUESTION B.17 [1.0 point]

Which ONE of the following shall NOT be used in any experiments within the reactor pool?

- a. Cryogenic liquids
- b. Experiments with a static pressure
- c. Explosive materials in quantity of 20 mg
- d. Materials corrosive to reactor components

QUESTION B.18 [1.0 point]

Per UMLRR Technical Specifications, which ONE of the following Measuring Channels is required to operate ONLY in the forced convection mode of operation?

- a. Log N (Period)
- b. Reactor Pool Temperature
- c. Reactor Coolant Flow rate
- d. Power Level (Linear N)

Category B – Normal/Emergency Operating Procedures and Radiological Controls

QUESTION B.19 [1.0 point]

Which ONE of the following Equipment/Condition will tend to maintain a negative building pressure without unloading any large fraction of possible airborne activity?

- a. Truck Door Closed
- b. Vacuum Relief Device
- c. Emergency Exhaust System
- d. Containment Isolation Initiation System

QUESTION B.20 [1.0 point]

Per EO-2, during a major fire or explosion, who do you need to be informed if the fire involves radioactive material?

- a. Senior Reactor Operator
- b. Radiation Safety Officer
- c. Reactor Supervisor
- d. Security Officer

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

((***** END OF EXAM *****))

Answer key

B.01

Answer: a (3), b(2), c(1), d(4)

Reference: 10CFR19.11, 10CFR20.1501(2)(i), 10CFR50.34(1)(ii)(A), 10CFR55.21

B.02

Answer: d

Reference: $I = 6CEn = R/hr@ft. \rightarrow 6 * 5Ci \times [(1.3Mev \times 100\%) + (1.1 \times 100\%)] = R/hr@ 1 ft.$
 $(1ft)^2 * 72 R/hr = 0.1 R/hr * D^2 = \sqrt{720 R/hr} = 26.8 \text{ feet.}$

B.03

Answer: d

Reference: TS 3.3, 3.8.1, and 4.5

B.04

Answer: a

Reference: TS 6.3.10

B.05

Answer: c

Reference: TS 4.3

B.06

Answer: d

Reference: TS 3.1

B.07

Answer: b

Reference: 10CFR55.53(f)(2)

B.08

Answer: c

Reference: Emergency Plan, Appendix A

B.09

Answer: a

Reference: $T A = A_0 * e^{-\lambda t}$
 $1Ci = 100Ci * e^{-\lambda(t)}$ Note: $\lambda = -\ln 2 / t^{1/2}$
 $\lambda = \ln(1/100) = 10 * \lambda$ so $\lambda = -0.461$
 $t^{1/2} = -\ln(2) / -0.461$
 $t^{1/2} = 1.5 \text{ years}$

B.10

Answer: a

Reference: TS 2.2.1

B.11

Answer: d

Reference: $DR_1 \cdot (D_1)^2 = DR_2 \cdot (D_2)^2$;
 $500 \text{ mrem} (2)^2 = 5 \text{ mrem} (d)^2$
 $D = 20 \text{ ft}$

B.12

Answer: c

Reference: TS 3.1

B.13

Answer: b

Reference: TS 2.2.2

B.14

Answer: a

Reference: TS 6.1

B.15

Answer: d

Reference: $20 \text{ mrad Alpha} \times 20 = 400 \text{ mrem}$, $10 \text{ mrad Gamma} \times 1 = 10 \text{ mrem}$, $5 \text{ mrad neutron} \times 10 = 50 \text{ mrem} \rightarrow 400 \text{ mrem} + 10 \text{ mrem} + 50 \text{ mrem} = 460 \text{ mrem}$

B.16

Answer: a

Reference: SOP, RO-4 § 2.1.9

B.17

Answer: a

Reference: TS 3.6

B.18

Answer: c

Reference: TS 3.2

B.19

Answer: c

Reference: TS 3.5

B.20

Answer: b

Reference: SOP, EO-2