September 24, 2015

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

SUBJECT: EXAMINATION REPORT NO. 50-223/OL-15-01, UNIVERSITY OF MASSACHUSETTS – LOWELL

Dear Dr. Chowdhury:

During the week of August 10, 2015, the U.S. Nuclear Regulatory Commission (NRC) administered operator licensing examinations at your University of Massachusetts – Lowell 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 at the conclusion of the examinations with those members of your staff identified in the enclosed report.

In accordance with Title 10, Section 2.390 of the Code of Federal Regulations, 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 Public Electronic Reading Room). The NRC is forwarding the individual grades to you in a separate letter which will not be released publicly. If you have any questions concerning these examinations, please contact Ms. Paulette Torres at (301) 415-5656, or via email at Paulette.Torres@nrc.gov.

Sincerely,

/RA/

Kevin Hsueh, Chief
Research and Test Reactors Oversight Branch
Division of Policy and Rulemaking
Office of Nuclear Reactor Regulation

Docket No. 50-223

Enclosures: 1. Examination Report No. 50-223/OL-15-01
2. Facility Comments on the Written Examination with NRC Resolution
3. Written Examination with Facility Comments Incorporated

cc: Leo Bobek, Reactor Supervisor, University of Massachusetts – Lowell
cc: w/o enclosures: See next page

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ADAMS Accession No: ML15243A052

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DATE	08/25/2015		08/31/2015		09/24/2015

OFFICIAL RECORD COPY

cc:

Mayor of Lowell
City Hall
Lowell, MA 01852

Department of Environmental Protection
One Winter Street
Boston, MA 02108

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

John Giarrusso, Planning and Preparedness Division Chief
Massachusetts Emergency Management Agency
400 Worcester Road
Framingham, MA 01702-5399

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

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

REPORT NO.: 50-223/OL-15-01

FACILITY DOCKET NO.: 50-223

FACILITY LICENSE NO.: R-125

FACILITY: University of Massachusetts – Lowell Reactor

EXAMINATION DATES: August 11-13, 2015

SUBMITTED BY: _____ _____
Paulette Torres, Chief Examiner Date

SUMMARY:

During the week of August 10, 2015, the NRC administered operator licensing examinations to five Reactor Operator (RO) license candidates. The candidates passed all applicable portions of the examinations.

REPORT DETAILS

1. Examiner: Paulette Torres, Examiner, NRC

2. Results:

	RO PASS/FAIL	SRO PASS/FAIL	TOTAL PASS/FAIL
Written	5/0	N/A	5/0
Operating Tests	5/0	N/A	5/0
Overall	5/0	N/A	5/0

3. Exit Meeting:
Paulette Torres, Chief Examiner, NRC
Leo Bobek, Reactor Supervisor, University of Massachusetts – Lowell

The facility licensee agreed to email their comments on the written examination that were incorporated in the examination report (see Enclosure 2).

FACILITY COMMENT ON THE WRITTEN EXAMINATION WITH NRC RESOLUTION

QUESTION B.19 [1.0 point]
Which ONE of the following conditions regarding experiments is not allowed under ANY condition? The experiment _____.

a. Causes the outside temperature of a submerged material to reach 90°C (176°F).

b. Causes a reduction in the reading for the startup channel.

c. Contains 2.1 milligrams of explosive material.

d. Contains cryogenic liquids.

Answer: b

REF: TS 3.6, specifications 3, 5, 7 and 8

Facility Comments and Recommendations: Answer B or D is correct. Though the question stipulates "…conditions regarding experiments is not allowed under ANY condition…" (the emphasis on ANY), the question is sufficiently broad and non-specific such that answer D (TS 3.6.8) could also be considered correct.

NRC Resolution: The NRC agrees with the comments and accepts both "b" and "d" as correct answers for question B.19.

QUESTION C.10 [1.0 point]
What is the maximum power at which the UMLRR could be operated when cooled by natural convection?

a. 100 kW

b. 0.66 MW

c. 0.97 MW

d. 1.0 MW

Answer: b

REF: SAR section 9.1.1.7

Facility Comments and Recommendations: While answer B is consistent with the safety analysis, the value is inconsistent with the license technical specifications. Answer A should be considered correct. The LSSS (TS 2.2.2) for reactor power under natural convection is 125kW. Though not specifically stated in the license or TS, the maximum steady state power level for natural convection is considered to be 100kW.

NRC Resolution: The NRC agrees with the comments. The correct answer for Question C.10 is changed to “a.”

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

FACILITY: University of Massachusetts - Lowell

REACTOR TYPE: Pool

DATE ADMINISTERED: 08/11/2015

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

A. RX THEORY, THERMO & FAC OP CHARS

A N S W E R S H E E T

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

A01 a b c d ___

A02 a b c d ___

A03 a b c d ___

A04 a b c d ___

A05 a b c d ___

A06 a b c d ___

A07 a b c d ___

A08 a b c d ___

A09 a b c d ___

A10 a b c d ___

A11 a b c d ___

A12 a b c d ___

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 *****)

B. NORMAL/EMERG PROCEDURES & RAD CON

A N S W E R S H E E T

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

B01 a b c d ___

B02 a b c d ___

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 *****)

C. PLANT AND RAD MONITORING SYSTEMS

A N S W E R S H E E T

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

C01 a b c d ___

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 **********)

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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]
Shutdown Margin is defined as:

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

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

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

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

QUESTION A.02 [1.0 point]
A reactor scram has resulted in the instantaneous insertion of 0.005 ΔK/K of negative reactivity. Which ONE of the following is the stable negative reactor period resulting from the scram?

a. 25 seconds

b. 54 seconds

c. 80 seconds

d. 125 seconds

QUESTION A.03 [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.04 [1.0 point]
The count rate is 100 cps. An experimenter inserts an experiment into the core, and the count rate decreases to 70 cps. Given the initial K_{eff} of the reactor was 0.9, what is the worth of the experiment?

a. $\Delta\rho = - 0.56$

b. $\Delta\rho = + 0.56$

c. $\Delta\rho = - 0.03$

d. $\Delta\rho = + 0.03$

QUESTION A.05 [1.0 point]
Which ONE of the following is the MAJOR source of energy released during fission?

a. Kinetic energy of the fission neutrons.

b. Kinetic energy of the fission fragments.

c. Decay of the fission fragments.

d. Prompt gamma rays.

QUESTION A.06 [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 has a larger for fission.

QUESTION A.07 [1.0 point]
As the moderator temperature increases, the resonance escape probability _____.

a. Increases, since the moderator becomes less dense.

b. Decreases, since the time required for a neutron to reach thermal energy increases.

c. Remains constant, since the effect of moderator temperature change is relatively small.

d. Increases, since the moderator-to-fuel ratio increases.

QUESTION A.08 [1.0 point]
Two minutes following shutdown, reactor power is at 10 kW and decreases with a constant reactor period. Which ONE of the following is the correct power for three minutes later?

a. 0.5 kW

b. 1.1 kW

c. 3.3 kW

d. 6.7 kW

QUESTION A.09 [1.0 point]
Which ONE of the following is the time period in which the maximum amount of Xenon-135 will be present in the core? Peak Xenon is reached _____.

a. 7 to 10 hours after a startup to 100% power.

b. 7 to 10 hours after shutdown.

c. 4 to 6 hours after a power increase from 50% to 100%.

d. 4 to 6 hours after a power decrease from 100% to 50%.

QUESTION A.10 [1.0 point]
Which ONE defines an integral rod worth curve?

a. Conforms to an axial flux shape.

b. Any point on the curve represents the amount of reactivity that one inch of rod motion would insert at that position in the core.

c. Represents the cumulative area under the differential curve starting from the bottom of the core.

d. Reactivity is highest at the top of the core and lowest at bottom of the core.

QUESTION A.11 [1.0 point]
During a fuel loading of the core, as the reactor approaches criticality, the value of 1/M:

a. Increases toward one

b. Decreases toward one

c. Increases toward infinity

d. Decreases toward zero

QUESTION A.12 [1.0 point]
INELASTIC scattering is the process by which a neutron collides with a nucleus and:

a. Recoils with the same kinetic energy it had prior to the collision.

b. Recoils with a lower kinetic energy than it had prior to the collision, with the nucleus emitting a gamma ray.

c. Is absorbed, with the nucleus emitting a gamma ray.

d. Recoils with a higher kinetic energy than it had prior to the collision, with the nucleus emitting a gamma ray.

QUESTION A.13 [1.0 point]
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.

QUESTION A.14 [1.0 point]
Core Excess Reactivity changes with:

a. Fuel Element Burnup

b. Control Rod Height

c. Neutron Energy Level

d. Reactor Power Level

QUESTION A.15 [1.0 point]
The reactor is critical at 5 watts. Which ONE of the following correctly describes the reactor behavior when a reactivity worth of 0.50 % ΔK/K is IMMEDIATELY inserted to the reactor core?

a. Subcritical

b. Critical

c. Supercritical

d. Delayed critical

QUESTION A.16 [1.0 point]
By definition, an exactly critical reactor can be made prompt critical by adding positive reactivity equal to:

a. The shutdown margin

b. The K_{exc} margin

c. The β_{eff} value

d. 1.0 % $\Delta K/K$

QUESTION A.17 [1.0 point]
Which ONE of the following is the correct reason that delayed neutrons enhance control of the reactor?

a. There are more delayed neutrons than prompt neutrons.

b. Delayed neutrons increase the average neutron generation time.

c. Delayed neutrons take longer to reach thermal equilibrium.

d. Delayed neutrons are born at higher energies than prompt neutrons and therefore have a greater effect.

QUESTION A.18 [1.0 point]
Which ONE of the following describes the production of fission neutrons resulting from thermal neutrons being absorbed in the fuel?

a. Fast Non-Leakage Probability (L_f)

b. Resonance Escape Probability (p)

c. Thermal Utilization Factor (f)

d. Reproduction Factor (η)

QUESTION A.19 [1.0 point]
A subcritical reactor is being started up. A control blade is raised in four equal steps. Which ONE of the following statement most accurately describes the expected reactor response?

a. Power increases by the same amount for each withdrawal.

b. Each withdrawal will add the same amount of reactivity.

c. The time for power to stabilize after each successive withdrawal increases.

d. A lower critical rod height is attained by decreasing the time intervals between withdrawals.

QUESTION A.20 [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 which has attained criticality on prompt neutrons alone.

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

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

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

QUESTION B.01 [1.0 point]
Per 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 Inlet Temperature

d. Power Level (Linear N)

QUESTION B.02 [1.0 point]
Per Technical Specifications, which ONE of the following Systems Components will automatically scram the reactor when ≥ 125% of range scale?

a. Startup Count Rate

b. Reactor Power Level

c. Pool Water Level

d. Detector High Voltage Failure

QUESTION B.03 [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. Emergency Exhaust System

c. Containment Isolation Initiation System

d. Vacuum Relief Device

QUESTION B.04 [1.0 point]
Per Technical Specifications, a _____ of the primary coolant flow rate shall be made annually.

a. Channel Calibration

b. Channel Check

c. Channel Replacement

d. Channel Test

QUESTION B.05 [1.0 point]
A small radioactive source is to be stored in the reactor building. The source reads 2 Rem/hr at 1 foot. Assuming no shielding is to be used, a Radiation Area barrier would have to be established from the source at least a distance of approximately:

a. 400 feet

b. 40 feet

c. 20 feet

d. 10 feet

QUESTION B.06 [1.0 point]
UMLRR _____ requires each operator to be cognizant of facility procedures changes.

a. Emergency Preparedness Plan

b. Security Plan

c. Operator Requalification Program

d. Technical Specifications

QUESTION B.07 [1.0 point]
Per EO-2, during a major fire or explosion, the _____ needs to be informed if the fire involves radioactive material.

a. Senior Reactor Operator

b. Radiation Safety Officer

c. Reactor Supervisor

d. Chief Reactor Operator

QUESTION B.08 [1.0 point]
A rapid loss of pool water can occur due all of the following EXCEPT:

a. Rupture in the secondary cooling loop of the heat exchanger.

b. Major damage to the reactor pool liner in either side of the pool.

c. Rupture in a beam-tube.

d. Rupture in the primary piping.

QUESTION B.09 [1.0 point]
Which ONE of the following is considered a Non- Reactor Safety Related Event?

a. Personnel injury accompanied with contamination.

b. Fire or explosion which might adversely affect the reactor or its safety system.

c. Report of a tornado, hurricane, or other severe weather or natural phenomenon that could strike the facility and adversely affect reactor safety systems.

d. TEDE levels at site boundary exceed 20 mrem/hr for one hour.

QUESTION B.10 [1.0 point]
_____ are specific thresholds that initiate appropriate emergency measures.

a. Emergency Planning Zone

b. Emergency Action Levels

c. Protection Action

d. Emergency Plan Procedures

QUESTION B.11 [1.0 point]
Per Emergency Preparedness Plan, following an evacuation of the facility during an emergency, who by title, shall authorize reentry into the UMLRR building?

a. US NRC

b. Senior Reactor Operator

c. Radiation Safety Officer

d. Emergency Director

QUESTION B.12 [1.0 point]
Which ONE of the following defines the term “Radiation Area”?

a. Any area to which access is limited for any reason.

b. Any area to which access is limited for the purpose of protecting individuals against undue risks from exposure to radiation and radioactive materials.

c. Area where radiation exposure rates would result in a dose equivalent in excess of 5 mrem (0.05 mSv) in one hour at 30 centimeters from the radiation source.

d. Area where radiation exposure rates would result in a dose equivalent in excess of 0.1 rem (1 mSv) in one hour at 30 centimeters from the radiation source.

QUESTION B.13 [1.0 point]
Any sample having or expected to have a reactivity worth of 0.1 %ΔK/K or greater shall be treated as a _____.

a. Movable Experiment

b. New Experiment

c. Routine Experiment

d. Secured Experiment

QUESTION B.14 [1.0 point]
Which ONE of the following surveillance procedures does not have a Technical Specification surveillance requirement associated with it?

a. Iodine Penetration of Activated Charcoal Filtering System

b. Ventilation Air Flow Measurements

c. Regulating Rod Orientation

d. Scram Functions Test

QUESTION B.15 [1.0 point]
A radioactive source generates a dose of 100 mR/hr at a distance of 10 feet. Using a two inch thick sheet of lead for shielding the reading drops to 50 mR/hr at a distance of 10 feet. What is the minimum number of sheets of the same lead shielding needed to drop the reading to less than 5 mR/hr at a distance of 10 feet?

a. 3

b. 4

c. 5

d. 6

QUESTION B.16 [1.0 point]
Reactor Operator works in a high radiation area for eight (8) hours a day. The dose rate in the area is 100 mR/hour. Which ONE of the following is the MAXIMUM number of days in which Reactor Operator may perform his duties WITHOUT exceeding 10 CFR 20 limits?

a. 5 days

b. 6 days

c. 7 days

d. 12 days

QUESTION B.17 [1.0 point]
10 CFR 20 defines the "Derived Air Concentration (DAC)" as:

a. The concentration of a given radionuclide in air which, if breathed by the reference man for a working year of 2,000 hours under conditions of light work (inhalation rate 1.2 cubic meters of air per hour), results in an intake of one ALI.

b. The derived limit for the amount of radioactive material taken into the body of an adult worker by inhalation or ingestion in a year.

c. The dose equivalent to organs or tissues of reference (T) that will be received from an intake of radioactive material by an individual during the 50-year period following the intake.

d. The sum of the effective dose equivalent (for external exposures) and the committed effective dose equivalent (for internal exposures).

QUESTION B.18 [1.0 point]
Which ONE of following types of radiation is the HIGHEST Quality Factor specified in 10 CFR 20?

a. Alpha

b. Beta

c. Gamma

d. Neutron (unknown energy)

QUESTION B.19 [1.0 point]
Which ONE of the following conditions regarding experiments is not allowed under ANY condition? The experiment _____.

a. Causes the outside temperature of a submerged material to reach 90°C (176°F).

b. Causes a reduction in the reading for the startup channel.

c. Contains 2.1 milligrams of explosive material.

d. Contains cryogenic liquids.

QUESTION B.20 [1.0 point]
You are currently the licensed operator at the control of the reactor. Which ONE of the following violates 10 CFR Part 55.53 “Conditions of licenses”?

a. Last license medical examination was 26 months ago.

b. Last requalification operating test was 11 months ago.

c. Last quarter you were the licensed operator for 6 hours.

d. Last requalification written examination was 13 months ago.

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

QUESTION C.01 [1.0 point]
Which ONE of the following ventilation exhausts has a carbon filter?

a. Thermal Column Case Vent

b. Emergency Exhaust

c. Pneumatic Tubes Exhaust

d. Experimental Basement Hood Vent

QUESTION C.02 [1.0 point]
Which ONE of the following valves opens upon activation of a containment isolation condition?

a. Valve A

b. Valve C

c. Valve E

d. Valve F

QUESTION C.03 [1.0 point]
The start-up source used in the UML reactor is a _____ neutron source.

a. Am-Li

b. Am-Be

c. Sb-Be

d. Pu-Be

QUESTION C.04 [1.0 point]
Which ONE of the following prevents the accidental siphoning of reactor pool water?

a. The manual closure of the break valve.

b. The capacity of the holdup tank.

c. Air admitted to the antisiphon risers.

d. A positive pressure difference inside the heat exchanger.

QUESTION C.05 [1.0 point]
Which ONE of the following experimental facilities is located on the stall pool section of the core?

a. Pneumatic tubes

b. In-core radiation baskets

c. Dry gamma radiation facility

d. Hot cell

QUESTION C.06 [1.0 point]
The output of the _____ drives the SCALER.

a. Current pulse amplifier

b. Linear pulse amplifier

c. Log count rate amplifier

d. Log count rate recorder

QUESTION C.07 [1.0 point]
In the event of a loss of primary flow, the reactor is set to scram _____.

a. Immediately.

b. At 100% flow.

c. At 80% the full core flow.

d. The reactor will not scram.

QUESTION C.08 [1.0 point]
Which ONE of the following radiation monitors uses a beta scintillator detector?

a. Stack Effluent Monitor

b. Constant Air Monitors

c. Facilities Exhaust Filter

d. Core Exit Lane

QUESTION C.09 [1.0 point]
A sample of secondary cooling water is collected once daily and analyzed for ^{24}Na to determine the integrity of the:

a. Cooling Tower

b. Makeup Demineralizer

c. Holdup Tank

d. Heat Exchanger

QUESTION C.10 [1.0 point]
What is the maximum power at which the UMLRR could be operated when cooled by natural convection?

a. 100 kW

b. 0.66 MW

c. 0.97 MW

d. 1.0 MW

QUESTION C.11 [0.25 points each]
Match each instrument (channel) listed in column A with a specific purpose in column B. Items in column B is to be used only once.

Column A	Column B
a. Automatic Power Level Channel	1. Monitors the power level of the reactor over the range of approximately 0.1 watt to 106 watts.
b. Startup Channel	2. Overlap the startup channel range and cover the Log N and period channel range.
c. Intermediate Channel	3. Hold the reactor power at a preselected flux level.
d. Safety Channel	4. Indicates output of log CR meter as the logarithm of the fission rate at the counter.

QUESTION C.12 [1.0 point]
The UMLRR standard fuel element shall be flat plate MTR-type elements fueled with:

a. Low enrichment (<20% U-235) U_3Si_2, clad with aluminum.

b. Low enrichment (<30% U-235) U_3Si_2, clad with aluminum.

c. Low enrichment (<20% U-235) U_3Si_2, clad with stainless steel.

d. Low enrichment (<30% U-235) U_3Si_2, clad with stainless steel.

QUESTION C.13 [1.0 point]
The gaseous radioactive waste product produced in largest quantity at the UMLRR is:

a. ^{16}N

b. ^{41}Ar

c. ^{220}Rn

d. ^{222}Rn

QUESTION C.14 [1.0 point]
Which ONE of the following pneumatic tube systems components provides the means of changing the direction of air flow, and thus the means of determining rabbit direction?

a. Centrifugal Exhauster

b. Deflector

c. Receivers

d. Wind Gate Cabinet

QUESTION C.15 [1.0 point]
Under the conditions of forced convection flow, which ONE of the following is the reason that the true value of the reactor coolant inlet temperature (pool temperature, T_p) shall not be greater than 110° F?

a. The pool temperature coefficient changes from negative to positive.

b. The pool cleanup system fails.

c. The onset of nucleate boiling (ONB) at the hot spot in the hot channel.

d. The upper limit of the effective temperature range for the ion exchange resin.

QUESTION C.16 [1.0 point]
Inadvertent movement of the reactor bridge > 1 inch will result in:

a. Illumination of a status light in the reactor control console only.

b. A rod rundown.

c. An automatic scram.

d. An evacuation alarm.

QUESTION C.17 [1.0 point]
Which ONE of the following is true about the Mechanical Stops of the Control Blade Drives?

a. Are provided at the upper and lower limit switch positions to prevent damage to the drive tube and control blade in the event that either limit switch fails to operate.

b. Provides speed reduction and prevents possible control blade drift.

c. Actuates adjustable limit switches at the top and bottom of the 26-inch stroke, which shuts off the drive motor.

d. Actuates an indicator light in the reactor control room to indicate blade engagement.

QUESTION C.18 [1.0 point]
The composition of each Safety/Regulation elements consists of _____.

a. Hafnium

b. Boral

c. Boron Carbide (B_4C)

d. Boron Steel

QUESTION C.19 [1.0 point]
In the event of a Limited Radiation Emergency Alarm (LREA), detector (I) Building Exhaust Plenum is set to trip at about _____.

a. 5 mR/h

b. 100 mR/h

c. 10 times MPC (Maximum Permissible Concentration)

d. Not set to trip for a LREA

QUESTION C.20 [0.25 points each]
Match the radiation detection equipment in column A, with its use in column B.

column A	column B
a. Ion chamber	1. Four week intervals for measurement for the integral external gamma dose.
b. Film badge	2. Portable instruments for detection and measurement of radiation.
c. Pocket dosimeter	3. Measure external dose. Mandatory for operations in high radiation areas.
d. Thermoluminescent dosimeter	4. On the spot estimation of gamma exposures.

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

A.01
Answer: c
REF: Burns, example 6.2.3 (a), pg. 6-4

A.02
Answer: c
REF: Burn, example 4.5(a), pg. 4-13 and 4-16

A.03
Answer: b
REF: DOE Handbook volume1, NP-01, pg. 24

A.04
Answer: a
REF: $CR_1 / CR_2 = (1 - K_{eff2}) / (1 - K_{eff1})$
$100 / 70 = (1 - K_{eff2}) / (1 - 0.90)$
Therefore $K_{eff2} = 0.86$
$\Delta\rho = K_{eff2} - K_{eff1} / K_{eff2} * K_{eff1}$
$\Delta\rho = (0.86 - 0.90) / (0.86 * 0.90)$
$\Delta\rho = - 0.558$

A.05
Answer: b
REF: Burns, Section 3.2.1, and Table 3.2, pg. 3-4 and 3-5

A.06
Answer: b
REF: Burns, Section 3.2.4, pg. 3-12

A.07
Answer: b
REF: Lamarsh, Introduction to Nuclear Engineering, 2nd edition, pg. 372
Burns, Section 3.3.2, pg. 3-18

A.08
Answer: b
REF: $P=P_o e^{t/\tau}$ x =10 kW* $e^{180/-80}$ x = 10 kW *0.105 = 1.05 kW

A.09
Answer: b
REF: Burns, Section 8.8.3 (d), pg. 8-24

A.10
Answer: c
REF: Burns, Section 7.3, pg. 7-5 to 7-7

A.11
Answer: d
REF: Burns, Table 5.5, pg. 5-15

A.12
Answer: b
REF: DOE Handbook volume1, NP-01, pg. 45

A.13
Answer: d
REF: $T = (\ell^*/\rho) + [(\beta - \rho)/ \lambda_{eff} \rho]$

A.14
Answer: a
REF: Harrer, Nuclear Reactor Control Engineering, pg. 398-399
Burns, Section 6.1, pg. 6-1 and Example 6.2.1(a), pg. 6-2

A.15
Answer: c
REF: Burn, Section 4.2
0.5 % delta-K/K =0.005 delta-K/K <0.007, therefore reactor is supercritical

A.16
Answer: c
REF: Burns, Section 4.2, pg. 4-1 and Figure 4.1, pg. 4-2

A.17
Answer: b
REF: Burns, Section 3.3.7, pg. 3-31 and Problem 3.4.4, pg. 3-33

A.18
Answer: d
REF: DOE Handbook volume 2, NP-03, pg. 13

A.19
Answer: c
REF: Burns, Section 5.3, pg. 5-7

A.20
Answer: a
REF: Burns, Section 4.7, pg. 4-21

B.01
Answer: c
REF: TS 3.2

B.02
Answer: b
REF: TS 3.3

B.03
Answer: b
REF: TS 3.5 #4

B.04
Answer: a
REF: TS 4.2 #4.b

B.05
Answer: c
REF:

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

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

$$d_2^2 = \frac{2000}{5} \times 1^2 = 400\,ft^2$$

$$d_2 = 20\,ft$$

B.06
Answer: c
REF: AP-1, Attachment A: APF-1, pg. 4

B.07
Answer: b
REF: EO-2-01, pg. 1

B.08
Answer: a
REF: EO-6, Attachment: 1, pg. 2

B.09
Answer: a
REF: EO-9, Attachment: 1, pg. 2

B.10
Answer: b
REF: EPP 2.7, pg. 2

B.11
Answer: d
REF: EPP 3.4, pg. 8

B.12
Answer: c
REF: 10 CFR 20.1003

B.13
Answer: d
REF: RO-4, Section 1.2.3, pg. 2

B.14
Answer: c
REF: Surveillance Procedures List

B.15
Answer: c
REF: Two inches = one-half thickness ($T_{½}$). Using 5 half-thickness will drop the dose by a factor of $(½)^5$ = 1/32. Then 100/32 = 3.125 mR/hr

B.16
Answer: b
REF: 10 CFR 20.1201(a)(1)

$$5000mR * \frac{1hr}{100mR} * \frac{1day}{8hr} = 6.25days$$

B.17
Answer: a
REF: 10 CFR 20.1003

B.18
Answer: a
REF: 10 CFR 20.1004

B.19
Answer: b and d
REF: TS 3.6, specifications 3, 5, 7 and 8/Per facility comment

B.20
Answer: a
REF: 10 CFR Part 55.53

- 55.53(i) – the licensee shall have a biennial medical examination.
- 55.53(h), 55.59(c) – annual operating tests
- 55.53(e) – the licensee shall actively perform the functions of a licensed operator for a minimum of 4 hours per calendar quarter.
- 55.53(h), 55.59(c)(1) – ”The requalification program must be conducted for a continuous period not to exceed 2 years”

C.01
Answer: b
REF: SAR figure 3.5 and section 3.3.3

C.02
Answer: d
REF: SAR section 3.4.2.2 (1)

C.03
Answer: b
REF: SAR section 4.1.4

C.04
Answer: c
REF: SAR section 4.2.2

C.05
Answer: a
REF: SAR section 4.3 and 4.3.3

C.06
Answer: b
REF: SAR section 4.4.8, figure 4.19 and table 4.3

C.07
Answer: c
REF: SAR 9.1.3

C.08
Answer: a
REF: SAR section 1.2.3, section 7.4.6(2), appendix 10

C.09
Answer: d
REF: SAR section 7.4.3(2)

C.10
Answer: a
REF: Per facility comment

C.11
Answer: a,3 b,4 c,1 d,2
REF: SAR 4.4.8, 4.4.12, 4.4.13, 4.4.14

C.12
Answer: a
REF: TS 5.1.1, pg. TS-40

C.13
Answer: b
REF: SAR 1.2.3, pg. 21 and TS 3.7

C.14
Answer: d
REF: SAR 4.3.3 (3)

C.15
Answer: c
REF: TS 2.1.1 basis

C.16
Answer: c
REF: TS 3.3

C.17
Answer: a
REF: SAR 4.1.7

C.18
Answer: b
REF: SAR Summary of reactor data, pg. 18-19, SAR Table 1.1

C.19
Answer: a
REF: SAR Appendix 10

C.20
Answer: a,2 b,1 c,4 d,3
REF: SAR 7.6.1, 7.6.3, 8.3.2.1 and 8.3.3