October 4, 2011

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

SUBJECT: EXAMINATION REPORT NO. 50-223/OL-11-01, UNIVERSITY OF MASSACHUSETTS – LOWELL

Dear Dr. Kegel:

During the week of August 29, 2011, the U.S. Nuclear Regulatory Commission (NRC) administered operator licensing examinations at your University of Massachusetts – Lowell reactor. The examination was 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 examination 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 this examination, please contact Phillip T. Young at 301-415-4094 or via internet e-mail Phillip.young@nrc.gov.

Sincerely,

/RA/

Johnny H. Eads, Jr., 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-11-01
2. Facility comments with resolution
3. Written examination with facility comments incorporated

cc w/o enclosures: see next page

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NAME	PYoung		CRevelle		JEads	
DATE	9/29/2011		9/29/2011		10/04/2011	

OFFICIAL RECORD COPY

cc:

Mayor of Lowell
City Hall
Lowell, MA 01852

Mr. Leo Bobek
Reactor Supervisor
University of Massachusetts - Lowell
One University Avenue
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Massachusetts Emergency Management Agency
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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-11-01

FACILITY DOCKET NO.: 50-223

FACILITY LICENSE NO.: R-125

FACILITY: University of Massachusetts - Lowell

SUBMITTED BY: **/Ra/** 9/29/2011
Phillip T. Young, Chief Examiner Date

SUMMARY:

During the week of August 29, 2011, the NRC administered license examinations to five Reactor Operator license and two Senior Reactor Operator Upgrade candidates. One of the Reactor Operator candidates failed one section of the written examination. All other candidates passed all applicable portions of the examination.

REPORT DETAILS

1. Examiner: Phillip T. Young, Chief Examiner

2. Results:

	RO PASS/FAIL	SRO PASS/FAIL	TOTAL PASS/FAIL
Written	4/1	0/0	4/1
Operating Tests	5/0	2/0	7/0
Overall	4/1	2/0	6/1

3. Exit Meeting:
Phillip T. Young, NRC, Chief Examiner
Leo M. Bobek, Reactor Supervisor
Thomas Regan, Chief Reactor Operator

The NRC Examiner thanked the facility for their support in the administration of the examinations. The examiner thanked the facility for their feedback on the written examination.

ENCLOSURE 1

FACILITY COMMENTS WITH NRC RESOLUTION

Below are our comments on the written exam as discussed last week.

Question A.07

Comment: Both answers B & D are correct.
Justification: Please see Burns 3-19
NRC Resolution: Comment accepted, answers b. & d. graded as correct

Question B.02

Comment: Please accept answer A
Justification: Answer A is technically the most correct.
NRC Resolution: Comment accepted, question deleted from examination.

Question B.08

Comment: While answer C is the correct answer in terms of procedure RO-7, answer A may also be considered correct since it is a more conservative action.
Justification: Please see procedure RO-7
NRC Resolution: Comment not accepted, answer c. is the correct answer.

Question B.12

Comment: The correct answer is B (NSR).
Justification: Please see UMLRR TS 3.6.3
NRC Resolution: Comment accepted, NSR graded as correct answer

Question C.06
NRC Comment/Resolution, the examiner noted that there were two questions number C.06. The point value of section C was adjusted for the additional question

Regards,

Leo Bobek
University of Massachusetts Lowell
Radiation Laboratory
1 University Avenue
Lowell MA 01854
978-934-3365

ENCLOSURE 2

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

FACILITY: UNIVERSITY OF MASSACHUSETTS – LOWELL

REACTOR TYPE: POOL

DATE ADMINISTERED: 8/29/2011

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
21.20	33.3	_____	_____	C. FACILITY AND RADIATION MONITORING SYSTEMS
61.20		_____ FINAL GRADE	_____ %	TOTALS

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

_____
Candidate's Signature

ENCLOSURE 3

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 <u>only</u> 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.

13. When you have completed and turned in you examination, leave the examination area. If you are observed in this area while the examination is still in progress, your license may be denied or revoked.

Question A.01 [1.0 point] {1.0}

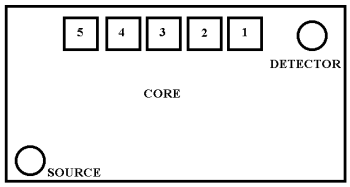
The two figures below represent the order (number in box) and direction used in placing fuel into a reactor pool. Which of the following choices shows the preferred method for performing a 1/M plot, along with the correct reason.

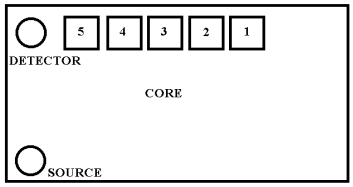
a. Figure 1 because loading from the detector towards the source gives the first fuel element more emphasis resulting in a more conservative estimate of criticality.

b. Figure 2 because loading towards the detector and the source gives the first fuel element more emphasis resulting in a more conservative estimate of criticality.

c. Figure 1 because loading from the detector towards the source gives the last fuel element more emphasis resulting in a more conservative estimate of criticality.

d. Figure 2 because loading towards the detector and the source gives the last fuel element more emphasis resulting in a more conservative estimate of criticality.





Answer: A.01 a.
Reference: Burn, R., *Introduction to Nuclear Reactor Operations,* © 1988, § 5.5, pp. 5-18, through 5-25.

Question A.02 [1.0 point, 0.25 each] {2.0}

A fissile material is one which will fission upon the absorption of a THERMAL neutron. A fertile material is one which upon absorption of a neutron becomes a fissile material. Identify each of the listed isotopes as either fissile or fertile.

a. Th^{232}
b. U^{235}
c. U^{238}
d. Pu^{239}

Answer: A.02 a. = fertile; b. = fissile; c. = fertile; d. = fissile
Reference: Burn, R., Introduction to Nuclear Reactor Operations, © 1988, § 3.2 p. 3-2 Example 3.2(a)

Question A.03 [1.0 point] {3.0}
The reactor supervisor tells you that the K_{eff} for the reactor is 0.955. How much reactivity must you add to the reactor to reach criticality?

a. +0.0471
b. +0.0450
c. -0.0471
d. -0.0450

Answer: A.03 a.
Reference: $\Delta\rho = (K_{eff1} - K_{eff2}) \div (K_{eff1} * K_{eff2})$ $\Delta\rho = (0.9550 - 1.0000) \div (0.9550 * 1.0000)$ $\Delta\rho = -0.0450 \div 0.9550 = -0.0471$

Question A.04 [1.0 point] {4.0}
When performing rod calibrations, many facilities pull the rod out a given increment, then measure the time for reactor power to double (doubling time), then calculate the reactor period. If the doubling time is 42 seconds, what is the reactor period?

a. 29 sec
b. 42 sec
c. 61 sec
d. 84 sec

Answer: A.04 c.
Reference: $\ln(2) = -\text{time}/\tau$ $\tau = \text{time}/(\ln(2)) = 60.59 \approx 61$ seconds

Question A.05 [1.0 point] {5.0}
A reactor has a shutdown margin of 0.0526 ΔK/K. Adding a reactor experiment increases the indicated count rate from 10 cps to 20 cps. Which one of the following is the new K_{eff} of the reactor?

a. 0.53
b. 0.90
c. 0.975
d. 1.001

Answer: A.05 c.
Reference: DOE Fundamentals Handbook, Nuclear Physics and Reactor Theory Volume 2, Module 4, Enabling Objective 3.6, p. 28.

$SDM = 1-K_{eff}/K_{eff} \rightarrow K_{eff} = 1/SDM + 1 \rightarrow K_{eff} = 1/0.0526 + 1 \rightarrow K_{eff} = .95$

$CR_1/CR_2 = (1 - K_{eff2}) / (1 - K_{eff1}) \rightarrow 10/20 = (1 - K_{eff2}) / (1 - 0.95)$

$(0.5) \times (0.05) = (1 - K_{eff2}) \rightarrow K_{eff2} = 1 - (0.5)(0.05) = 0.975$

Question A.06 [1.0 point, 0.20 each] {6.0}
Given a mother isotope of $({}_{35}Br^{87})^{*}$, identify each of the daughter isotopes as a result of α, β^{+}, β^{-}, γ, or n, decay.

a. ${}_{33}As^{83}$
b. ${}_{34}Se^{87}$
c. ${}_{35}Br^{86}$
d. ${}_{35}Br^{87}$
e. ${}_{36}Kr^{87}$

Answer: A.06 a. = α; b. = β^{+}; c. = n; d. = γ; e. = β^{-}
Reference: STD NRC question.

Question A.07 [1.0 point] {7.0}
Which one of the following statements details the effect of fuel temperature on core operating characteristics? As fuel temperature …

a. increases, Doppler peaks will become higher.
b. decreases, resonance escape probability will increase.
c. decreases, U^{238} will absorb more neutrons.
d. increases, the fast non-leakage probability will decrease.

Answer: A.07 b. or d. accepted per facility comment.
Reference: Introduction to Nuclear Reactor Operations, ©1982, Reed Robert Burn §

Question A.08 [1.0 point] {8.0}
WHICH ONE of the following describes the MAJOR contributions to the production and depletion of xenon in the reactor?

a. Produced directly from fission and depletes by neutron absorption only.
b. Produced from radioactive decay of iodine and depletes by neutron absorption only.
c. Produced directly from fission and depletes by radioactive decay and neutron absorption.
d. Produced from radioactive decay of iodine and depletes by radioactive decay and neutron absorption.

Answer: A.008 d.
Reference: Burn, R., Introduction of Nuclear Reactor Operations, © 1988, §

Question A.09 [1.0 point] {9.0}
The probability of neutron interaction per cm of travel in a material is defined as:

a. a neutron flux.

b. a mean free path.

c. a microscopic cross section.

d. a macroscopic cross section.

Answer: A.09 d.
Reference: Burn, R., *Introduction to Nuclear Reactor Operations,* © 1982, Section 2.5.2, page 2-44.

Question A.10 [1.0 point] {10.0}
Which ONE of the following is the reason for the -80 second period following a reactor scram?

a. The ability of U^{235} to fission source neutrons.

b. The half-life to the longest-lived group of delayed neutron precursors is 55 seconds.

c. The amount of negative reactivity added on a scram is greater than the shutdown margin.

d. The Doppler effect, which adds positive reactivity due to the temperature decrease following a scram.

Answer: A.10 b.
Reference: Burn, R., Introduction to Nuclear Reactor Operations, © 1988, §

Question A.11 [1.0 point] {11.0}
Which ONE of the following conditions would INCREASE the shutdown margin of a reactor?

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

b. Inserting an experiment adding positive reactivity.

c. Depletion of a burnable poison.

d. Depletion of uranium fuel.

Answer: A.011 d.
Reference: Burn, R., *Introduction to Nuclear Reactor Operations,* © 1988, § 6.2.3, p. 6-4.

Question A.12 [1.0 point] {12.0}
Which one of the following is the PRIMARY reason that delayed neutrons are so effective at controlling reactor power?

a. Delayed neutrons make up a very large fraction of the fission neutrons in the core.

b. Delayed neutrons have a much longer mean lifetime than prompt neutrons.

c. Delayed neutrons are born at lower energies than prompt neutrons.

d. Delayed neutrons are born at thermal energies.

Answer: A.12 b.
Reference: Burn, R., Introduction to Nuclear Reactor Operations, © 1982, §§ 3.2.2 — 3.2.3

Question A.13 [1.0 point] {13.0}
Which one of the following is the principal source of heat in the reactor after a shutdown from extended operation at 1 MW?

a. Gamma interactions

b. Spontaneous fission of U-238

c. Production of delayed neutrons

d. Kinetic energy of fission fragments

Answer: A.13 d.
Reference: Burn, R., Introduction to Nuclear Reactor Operations, © 1982, § 4.9, pp. 4-23 — 4-26.

Question A.14 [1.0 point] {14.0}
Which one of the following is a correct statement concerning the factors affecting control rod worth?

a. As Rx power increases rod worth increases.

b. Fuel burn up causes the rod worth for periphery rods to decrease.

c. Fuel burn up causes the rod worth to increase in the center of the core.

d. The withdrawal of a rod causes the rod worth of the remaining inserted rods to increase.

Answer: A.014 d.
Reference: Burn, R., Introduction to Nuclear Reactor Operations, © 1982, § 7.2 & 7.3, pp. 7-1 — 7-10.

Question A.15 [1.0 point] {15.0}
Pool temperature increases by 20°F. Given αT moderator = -0.0005 ΔK/K/°F and an average regulating rod worth of 0.004 ΔK/K/inch. By how much and in what direction did the regulating rod move to compensate for the temperature change?

a. 0.25 inches in

b. 0.25 inches out

c. 2.5 inches in

d. 2.5 inches out

Answer: A.015 d.
Reference: +20°F × -0.0005 ΔK/K/°F = - 0.01 ΔK/K. To compensate the rod must add +0.01 ΔK/K. +0.01ΔK/K ÷ +0.004 ΔK/K/inch = +2.5 inches

Question A.16 [1.0 point] {16.0}
Which factor of the Six Factor formula is most easily varied by the reactor operator?

a. Fast Fission Factor (ε)

b. Reproduction Factor (η)

c. Thermal Utilization Factor (f)

d. Fast Non-Leakage Factor ($\mathcal{L}_f$)

Answer A.016 c.
Reference Burn, R., *Introduction to Nuclear Reactor Operations,* © 1988, § 6.4

Question A.17 [1.0 point] {17.0}
You perform two startups with exactly the same core characteristics. During the first startup you proceed straight to criticality. During the second startup you receive a phone call after starting to pull rods, but before reaching criticality. How will this increase in time before reaching criticality affect reactor critical conditions? For the second startup …

a. rod height will be the same, reactor power will be the same.

b. rod height will be the same, reactor power will be higher.

c. rod height will be higher, reactor power will be higher.

d. rod height will be lower, reactor power will be lower.

Answer A.017 b.
Reference Burn, R., *Introduction to Nuclear Reactor Operations,* © 1988, § 5.3

Question A.18 [1.0 point] {18.0}
The term "prompt jump" refers to:

a. the instantaneous change in power due to raising a control rod.

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

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

d. a negative reactivity insertion which is less than β_{eff}.

Answer A.018 a.
Reference Burn, R., *Introduction to Nuclear Reactor Operations,* © 1988, § 4.7

Question A.19 [1.0 point] {19.0}
An experimenter makes an error loading a rabbit sample. Injection of the sample results in a 100 millisecond period. If the scram which causes the reactor to shutdown is set at 1.25 MW and the scram delay time is 0.1 seconds, **WHICH ONE** of the following is the peak power of the reactor at shutdown.

a. 1.25 MW

b. 2.5 MW

c. 3.4 MW

d. 12.5 MW

Answer A.019 c.
Reference $P = P_0\, e^{t/\tau}$, $P = 1.25 \text{ Mwatt} \times e^{0.1/0.1} = 1.25 \times e = 3.3979$

Question A.20 [1.0 point] (20.0)
Regarding the Am-Be neutron source: The decay of Americium produces _____ which are absorbed by the Beryllium producing the reaction _____

a. Alphas; ${}_4Be^9$ (α,n) ${}_6C^{12}$

b. Betas; ${}_4Be^9$ (β,n) $3Li^8$

c. Gammas; ${}_4Be^9$ (γ,n) $2({}_2He^4)$

d. Neutrons (from Spontaneous fission); ${}_4Be^9$ (n,2n) ${}_4Be^8$

Answer A.20 a.
Reference Burn, R., *Introduction to Nuclear Reactor Operations,* © 1988, § 5.2, also Chart of the Nuclides.

Question B.01 [1.0 point] {1.0}
According to Technical Specification 3.4.1.a "A moveable experiment shall have a reactivity worth less than or equal to …

a. 0.05% Δk/k
b. 0.1% Δk/k
c. 0.5% Δk/k
d. 1.0% Δk/k

Answer: B.01 b.
Reference: Technical Specification 3.1.

Question B.02 [1.0 point] {2.0}
Which ONE of the following conditions is an Reportable Occurrence per the Technical Specification definition?

a. Operation of the reactor with a minimum shutdown margin (Xenon free, with the most reactive rod in the fully withdrawn position) of 3.0% Δk/k.
b. Operation of the reactor with valve "H, Acid Vent (Basement)" out of service with the valve in the closed position.
c. Operation of the reactor with the Continuous Air Monitor (CAM) on the experimental level out of service. The CAM on the pool level is operating fine.
d. Operation of the reactor with a pool level of 25 ft. above the centerline of the core.

Answer: B.02 ~~c~~ a. per facility comment
Reference: Technical Specification 1.1, 3.1.1, 3.1.3, 3.5.2

Question B.03 [1.0 point] {3.0}
An experimenter wishes to irradiate three specimens with reactivity worths of 0.15% Δk/k, 0.17% Δk/k and 0.3% Δk/k. Can these specimens be placed in the reactor as <u>SECURED</u> experiments and why (why not).

a. Yes, the sum of the three specimens is less than 2.5% Δk/k.
b. No, the sum of the three specimens is greater than 0.5% Δk/k.
c. No, each of the experiments is greater than 0.1% Δk/k.
d. No, one of the specimens is greater than 0.25% Δk/k.

Answer: B.03 a.
Reference: Technical Specifications 3.1. Specification 9.

Question B.04 [1.0 point] {4.0}

Following an irradiation of a specimen, the resulting radioisotope is expected to equal 12 curies. The radioisotope will decay by the emission of two gamma rays per disintegration with energies of 1.14 Mev and 1.36 Mev. Which one of the following is the radiation exposure rate (R/hr) at one 6 feet from the specimen with no shielding?

a. 180 R/hr

b. 30 R/hr

c. 5 R/hr

d. 2.72 R/hr

Answer: B.04 c.

Reference: $R = \frac{6\ C\ E\ n}{6^2} = \frac{6\ (12\ ci)\ (1.36 + 1.14\ Mev)}{36} = 5$ R/hr.

Question B.05 [1.0 point] {5.0}

A small radioactive source is to be stored in the reactor bay with no shielding. The source reads 2 R/hr at 1 foot. A “Radiation Area” barrier would have to be erected approximately ___ from the source.

a. 400 feet

b. 40 feet

c. 20 feet

d. 10 feet

Answer: B.05 c.

Reference: Standard NRC Question

Question B.06 [1.0 point] {6.0}

A room contains a source which, when exposed, results in a general area dose rate of 175 millirem per hour. This source is scheduled to be exposed continuously for 35 days. Select an acceptable method for controlling radiation exposure from the source within this room.

a. Lock the room to prevent inadvertent entry into the room.

b. Post the area with the words "Danger-Radiation Area".

c. Equip the room with a motion detector that will alarm in the control room.

d. Equip the room with a device to visually display the current dose rate within the room.

Answer: B.06 a.

Reference: 10CFR20.1601(a)(3)

Question B.07 [1.0 point] {7.0}
Which one of the following statements describes the basis for the Safety Limit in the forced convection mode of operation?

a. The onset of nucleate boiling at the hot spot in the hot channel.

b. To prevent undesirable radiation levels on the surface of the pool.

c. The combination of reactor power and coolant flow rate will prevent the LSSS from being exceeded.

d. Excessive gas pressure between the fuel-moderator and cladding may result in loss of fuel element cladding integrity.

Answer: B.07 a.
Reference: Technical Specifications 2.1

Question B.08 [1.0 point] {8.0}
At 8:00 am, prior to the start of reactor operation, a checkout procedure is performed in accordance with RO-7. The reactor is started up, operated, and then shutdown at 1:00 PM. Which one of the following describes the checkout requirement for a subsequent startup at 4:00 PM ?

a. a new checkout procedure must be performed.

b. the checkout procedure does not need to be performed.

c. only the manual scram channel test must be performed.

d. only the power range monitor checks and tests, and fuel temperature 1 and 2 channel checks and tests must be performed.

Answer: B.08 c.
Reference: RO-5; Step 3.2

Question B.09 [1.0 point] {9.0}
An Emergency Action Level is:

a. a condition which calls for immediate action, beyond the scope of normal operating procedures, to avoid an accident or to mitigate the consequences of one.

b. a class of accidents for which predetermined emergency measures should be taken or considered.

c. a procedure that details the implementation actions and methods required to achieve the objectives of the Emergency Plan.

d. a specific instrument reading or observation which may be used as a threshold for initiating appropriate emergency measures.

Answer: B.09 d.
Reference: E-Plan Definitions

Question B.10 [1.0 point] {10.0}
According to EO-7 Stuck Rod of Safety Blade, which ONE of the following is the console operator's primary responsibility?

a. Maintain power level constant.

b. To unstick the stuck rod.

c. To run the unstuck blades and regulating rod in.

d. To determine the cause of the stuck rod.

Answer: B.10 c
Reference: EO-7

Question B.11 [1.0 point, ¼ each] {11.0}
Match type of radiation (a thru d) with the proper penetrating power (1 thru 4)

a.	Gamma	1.	Stopped by thin sheet of paper
b.	Beta	2.	Stopped by thin sheet of metal
c.	Alpha	3.	Best shielded by light material
d.	Neutron	4.	Best shielded by dense material

Answer: B.11 a, = 4; b, = 2; c, = 1; d, = 3
Reference: Standard NRC Health Physics Question

Question B.12 [1.0 point, ¼ each] {12.0}
Identify whether each of the following experiments has no special requirements (NSR), requires Double encapsulation (DBL), requires NRC approval (NRC), or is Not Authorized (NA).

a. Corrosive Materials

b. The surface temperature of a submerged experiment exceeds 90°C (194°F)

c. A newly installed experiment significantly affects critical rod height.

d. Less than 25 mg of nitroglycerine. Out-of-core test indicate that, with the containment provided, no damage to the explosive containers, the reactor or the reactor components shall occur upon detonation of the explosive.

Answer: B.12 a, = DBL; b, = NSR; c, = NA; d, = ~~NRC~~ NSR, per facility comment
Reference: Technical Specification 3.6 Limitations of Experiments

Question B.13 [1.0 point, ¼ each] {13.0}
Identify the PRIMARY source (irradiation of air, irradiation of water, or fission product) of EACH of the radioisotopes listed.

a. ${}_{1}H^{3}$

b. ${}_{18}Ar^{41}$

c. ${}_{7}N^{16}$

d. ${}_{54}Xe^{135}$

Answer: B.13 a, = Water; b, = Air; c, = Water; d, = Fission
Reference: Standard NRC question.

Question B.14 [1.0 point] {14.0}
Which ONE of the following is the maximum reactivity of a rabbit sample which may be inserted by someone who does NOT have an operator (RO or SRO) license?

a. 0.01 % Δk/k

b. 0.02 % Δk/k

c. 0.10 % Δk/k

d. 0.20 % Δk/k

Answer: B.14 b.
Reference: RO-4, §§ 4.1.5 & 4.1.6.

Question B.15 [1.0 point] {15.0}
All of the monitors checked by RO-13 are checked using a Co^{60} source, except one which uses a Cf^{252} neutron emitting source. The channel which uses the Cf^{252} source is channel …

a. C (Continuous Air Monitor #1)

b. E (Fission Product Monitor)

c. I (Plenum)

d. L (Thermal Column)

Answer: B.15 b.
Reference: RO-13 § 13.1.a.

Question B.16 [1.0 point] {16.0}
An oral examination on facility and procedure changes must be administered to an operator who has not performed licensed duties as a Reactor Operator or as a Senior Reactor Operator:

a. at least once per month.

b. for four or more months.

c. six hours per calendar quarter.

d. at least once per calendar year.

Answer: B.16 b.
Reference: Requalification Plan, Sect. 3.3

Question B.17 [1.0 point] {17.0}
According to the Emergency plan, the Emergency Planning Zone …

a. is the area enclosed within the containment vessel.

b. lies within the site boundary and is bounded by a 150 meter radius from the exhaust stack.

c. is the geographical area beyond the site boundary, where the Reactor Director has direct authority over all activities.

d. specifies contamination levels (airborne, radiation dose, or dose rates) that may be used as thresholds for establishing emergency classes.

Answer: B.17 a.
Reference: Emergency Plan Chapter 2.0, Definitions, § 2.11.

Question B.18 [1.0 point] {18.0}
After a reactor scram, neither you nor the SRO is able to determine the cause of the scram. What is the minimum level of management who may authorize restart of the reactor under this condition?

a. The Senior Reactor Operator on his/her own.

b. The Reactor Supervisor after consultation with the Reactor Director.

c. The Chief Reactor Operator after consultation with the Reactor Supervisor.

d. The Senior Reactor Operator on consultation with either the Chief Reactor Operator or the Reactor Supervisor.

Answer: B.18 d.
Reference: RO-7, Reactor Shutdown, § 7.32.4. pp. RO7-2 & 3.

Question B.19 [1.0 point] {19.0}
Which ONE of the following classifications for an emergency is not credible for the U. Mass.-Lowell reactor? (Note: Items are listed alphabetically, NOT in order of severity!)

a. Alert

b. Non-Reactor Safety Related Event

c. Notification of Unusual Event

d. Site Area Emergency

Answer: B.19 d.
Reference: Emergency Plan §§ 4.0 through 4.5.

Question B.20 [1.0 point] {20.0}
While working on an experiment, you receive the following radiation doses: 100 mrem (β), 25 mrem (γ), and 5 mrem (thermal neutrons). Which ONE of the following is your total dose?

a. 175 mrem

b. 155 mrem

c. 145 mrem

d. 130 mrem

Answer: B.20 d.
Reference: A rem is a rem is a rem.

Question C.01 [1.0 point] {1.0}
According to the Safety Analysis Report (SAR), which ONE of the following locations has the potential of generating the greatest amount of Ar^{41}?

a. Thermal Column Case Vent
b. Beam Port
c. Pneumatic Tube
d. Primary Coolant (Pool)

Answer: C.01 b.
Reference: SAR pp. 3-18 and 7-2.

Question C.02 [1.0 point] {2.0}
The Control Blades have a maximum operating speed of _____ while Servo Regulating Rod has an operating speed of _____ .

a. 78 in/min 3.7 in/min
b. 60 in/min 5 in/min
c. 54 in/min 17 in/min
d. 40.5 in/min 26 in/min

Answer: C.02 a.
Reference: FSAR Section 4.1.7 and 4.18

Question C.03 [1.0 point] {3.0}
The Control Blades shrouds have small holes at the bottom of the shroud to aid in?

a. Providing control blade cooling.
b. Providing flux shaping across the core.
c. Prevent control blade sticking at the bottom of the shroud.
d. Minimizing the effect of viscous damping on the scram time.

Answer: C.03 d.
Reference: FSAR Section 4.1.5

Question C.04 [1.0 point] {4.0}
Which one of the following valves does NOT receive a signal in response to a ventilation freeze alarm?

a. "B" Fan EF-12 Exhaust Isolation
b. "D" Fan EF-14 Exhaust Isolation
c. "F" Fan AC-2 Exhaust Isolation
d. "H" Acid Vent Isolation

Answer: C.04 b.
Reference: FSAR, §3.4.2.3 pp. 3-24, 3-25

Question C.05 [1.0 point] {5.0}
With the MASTER SWITCH in the TEST position, and the BLADE 1 OUT light ENERGIZED, what it the position of BLADE 1 control rod?

a. The rod is fully out, the lead screw is fully inserted.
b. The rod is fully inserted ,the lead screw is fully out.
c. Both the rod and the lead screw are fully out.
d. Both the rod and the lead screw are fully inserted.

Answer: C.05 b.
Reference: FSAR, § 4,4,3, Table 4.3 p. 4-49

Question C.06 [1.0 point] {6.0}
Which one of the following radiation detectors does NOT supply a signal for initiation of either GREA or LREA?

a. Stack Particulate "A"
b. CAM 2 "C"
c. FPM "E"
d. Rabbit Filters "G"

Answer: C.06 d.
Reference: UMLR Study Guide Section covering Radiation Monitors.

Question C.06 [1.0 point] {6.0}
The console operator is maintaining reactor power at 100 kilowatts with reactor control in automatic at the 50% withdrawn position. The operator notes an unexplained power excursion and scrams the reactor. All four of the control blades fully insert into the core. Which one of the following describes the position of the regulating rod?

a. fully inserted.

b. 50% withdrawn in AUTO control.

c. 50% withdrawn in MANUAL control

d. 100% withdrawn in AUTO control.

Answer: C.06 c.
Reference: FSAR §§ 4.6 and 4.7.

Question C.07 [1.0 point] {7.0}
Given the following conditions:
- An experiment requires the core flux to be as flat as possible both radially and axially.
- Core life is at MOL (Middle of Life)
- The experiment requires all fuel elements to be in the core.

Select the method for obtaining the required core flux.

a. Run with ALL control blades fully withdrawn.

b. Remove the graphite reflector elements.

c. Place the start-up source in the core during operation.

d. Invert or rotate the fuel elements to achieve the desired flux.

Answer: C.07 d.
Reference: SAR, Paragraph 4.1.1 & 4.1.2 and reactor theory.

Question C.08 [1.0 point] {8.0}
Which one of the following scrams is disabled by placing the range switch (7S5) in the 0.10 MW position?

a. Coolant Gate Open (Riser).

b. High Voltage Failure

c. Pool Level

d. Containment Air Leak Doors Open

Answer: C.08 a.
Reference: RO-9 Reactor and Control System Checkout, § 9.2.2

Question C.09 [1.2 point, 0.2 each] {9.2}
Using the attached figure, match each of the core locations listed in Column A with its correct component from Column B.

	Column A (Grid Position)		Column B
a.	A1	1.	Proportional Counter
b.	A2	2.	Compensated Ion Chamber
c.	A5	3.	Startup Source
d.	B4	4.	Graphite Reflector Element
e.	D9	5.	Fuel Element
f.	G9	6.	Irradiation Basket
		7.	Servo Control Element (Regulating rod)

Answer: C.09 a, = 2; b, = 4; c, = 3; d, = 5; e, = 7; f, = 1
Reference: SAR Figure 4.1, Core Arrangement

Question C.10 [1.0 point] {10.2}
A severe storm causes a loss of power while you were maintaining the reactor at 1 megawatt. The emergency generator did NOT start. Select the condition of the ventilation system. The ventilation fans …

a. have stopped and the ventilation valves, except valve F have closed.
b. continue to run and the ventilation valves, except valve F have closed.
c. have stopped and the ventilation valves, except valve F remain open.
d. continue to run and the ventilation valves, except valve F remain open.

Answer: C.10 a.
Reference: SAR § 3.4.2.1, System Closure and § 3.4.2.2 Response to Initiation of System Closure.

Question C.11 [1.0 point] {11.2}
Which ONE of the following devices is designed to prevent the reactor pool from being completely drained by a leak in the primary coolant piping?

a. Primary Delay Tank
b. Pool Wall Liner
c. Primary Coolant Pump
d. Break Valve

Answer: C.11 d.
Reference: Previous NRC exam question

Question C.12 [1.0 point] {12.2}

Which ONE of the following is the reason that city water is brought into an open tank?

a. To allow for off-gassing prior to feeding the water into the makeup demineralizer.

b. to allow for addition of chemicals prior to feeding the water into the makeup demineralizer

c. to create a physical break so that potentially contaminated primary water does NOT have a flow path back into the city water system.

d. to allow sediment to settle on the bottom of the tank prior to feeding the water into the makeup demineralizer.

Answer: C.12 c.
Reference: Previous NRC exam question

Question C.13 [1.0 point, ¼ each] {13.2}

Match the purification system conditions listed in column A with their respective causes listed in column B. Each choice is used only once. Higher than normal …

	Column A		Column B
a.	Radiation Level at demineralizer.	1.	Channeling in demineralizer.
b.	Radiation Level downstream of demineralizer.	2.	Fuel element failure.
c.	flow rate through demineralizer.	3.	High temperature in demineralizer
d.	pressure upstream of demineralizer.	4.	Clogged demineralizer system

Answer: C.13 a, = 2; b, = 3; c, = 1; d, = 4
Reference: Standard NRC cleanup loop question.

Question C.14 [1.0 point] {14.2}
Which one of the following correctly describes the operation of a Thermocouple?

a. A bi-metallic strip which winds/unwinds due to different thermal expansion constants for the two metals, one end is fixed and the other moves a lever proportional to the temperature change.

b. a junction of two dissimilar metals, generating a potential (voltage) proportional to temperature changes.

c. a precision wound resistor, placed in a Wheatstone bridge, the resistance of the resistor varies proportionally to temperature changes.

d. a liquid filled container which expands and contracts proportional to temperature changes, one part of which is connected to a lever.

Answer: C.14 b.
Reference: Standard NRC question

Question C.15 [1.0 point] {15.2}
Which ONE of the following is the main function performed by the DISCRIMINATOR circuit in the Startup Channel?

a. To generate a current signal equal and of opposite polarity as the signal due to gammas generated within the Startup Channel Detector.

b. To filter out small pulses due to gamma interactions, passing only pulses due to neutron events within the Startup Channel Detector.

c. To convert the linear output of the Startup Channel Detector to a logarithmic signal for metering purposes.

d. To convert the logarithmic output of the metering circuit to a δt (delta time) output for period metering purposes.

Answer: C.15 b.
Reference: Standard NRC Question

Question C.16 [1.0 point] {16.2}
The baffles in the holdup tank are designed to allow which two isotopes time to decay?

a. $_1H^3$ and $_6C^{14}$

b. $_1H^3$ and $_7N^{16}$

c. $_6C^{14}$ and $_8O^{19}$

d. $_7N^{16}$ and $_8O^{19}$

Answer: C.16 d.
Reference: Study Guide for Key Access and Intro. To Operator Training, § covering primary system and NRC exam administered September, 1997.

Question C.17 [1.0 point, ¼ each] {17.2}
Match each of the control blade rod withdrawal interlocks (column A) with its corresponding set point (column B).

	Column A	Column B
a.	Low source count rate - ___ cps.	3
b.	Short Period - ___ seconds.	5
c.	Low flux - ___ %	7
d.	Time delay block after "reactor startup" - ___ seconds.	10
		15
		20
		30

Answer: C.17 a, = 3; b, = 15; c, = 5; d, = 10
Reference: USAR, § 4.4.9 and table 4.4. R.0.9 "Reactor and Control System Checkout Procedures".

Question C.18 [1.0 point] {18.2}
The purpose of the thermal column is to …

a. enhance heat transfer characteristics of the core.

b. enhance natural convection flow.

c. provide a thermal temperature rise for experiments.

d. provide a thermal neutron flux for experiments.

Answer: C.18 d.
Reference: SAR, § 4.3.1, Thermal Column

Question C.19 [1.0 point] {19.2}

You are performing a reactor shutdown and notice that the source range instrument does not come on scale until AFTER the intermediate range instrumentation went off-scale low. Select the cause for the lack of overlap.

a. Source range high voltage is de-energized.

b. Source range high voltage is set too high.

c. Intermediate range compensating voltage is set too low.

d. Intermediate range compensating voltage is set too high.

Answer: C.19 d.
Reference: Procedure RO-9, Reactor and Control System Checkout Procedures, steps 3.17 & 4.11.

Question C.20 [1.0 point, ¼ each] {20.2}

Match each of the electrical loads listed in column A with its electrical source listed in column B. (Each load has only one answer. Items in column may be used more than once or not at all.)

	Column A		Column B
a.	Secondary Pump	1.	Motor Control Center #l;
b.	Pneumatic tube system blower	2.	Motor Control Center #2;
c.	Exhaust Blower EF-12	3.	PPL-R1
d.	Emergency Exhaust EF-14	4.	ELPL-Rl

Answer: C.20 a, = 2; b, = 1; c, = 2; d, = 4;
Reference: Study Guide for Key Access and Introduction to Operator Training "Electrical System", Figure 3.5.