September 6, 2013

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

SUBJECT: EXAMINATION REPORT NO. 50-223/OL-13-01, UNIVERSITY OF MASSACHUSETTS – LOWELL

Dear Dr. Kegel:

During the week of August 5, 2013, 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/

Gregory T. Bowman, 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-13-01
2. Written examination

cc: w/o enclosures: see next page

September 3, 2013

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

SUBJECT: EXAMINATION REPORT NO. 50-223/OL-13-01, UNIVERSITY OF MASSACHUSETTS – LOWELL

Dear Dr. Kegel:

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Docket No.: 50-223

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NAME	PYoung	CRevelle	GBowman
DATE	8/27/2013	8/30/2013	9/ 03/2013

OFFICIAL RECORD COPY

cc:

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

REPORT NO.: 50-223/OL-13-01

FACILITY DOCKET NO.: 50-223

FACILITY LICENSE NO.: R-74

FACILITY: University of Massachusetts - Lowell

SUBMITTED BY: /RA/ 8/20/2013
Phillip T. Young, Chief Examiner Date

SUMMARY:

During the week of August 5, 2013, an Operator License Examination was administered to one Reactor Operator applicant and two Senior Reactor Operator Upgrade applicants. All applicants passed all sections of the examinations.

REPORT DETAILS

1. Examiner: Phillip T. Young, Chief Examiner

2. Results:

	RO PASS/FAIL	SRO PASS/FAIL	TOTAL PASS/FAIL
Written	1/0	0/0	1/0
Operating Tests	1/0	2/0	3/0
Overall	1/0	2/0	3/0

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

The examiner thanked the facility for their support in completing the examinations.

ENCLOSURE 1

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

FACILITY:	UNIVERSITY OF MASSACHUSETTS – LOWELL
REACTOR TYPE:	POOL
DATE ADMINISTERED:	8/06/2013
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	N/A	_____	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	N/A	_____	C.	FACILITY AND RADIATION MONITORING SYSTEMS
20.00		___________ FINAL GRADE	_____%		TOTALS

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

____
Candidate's Signature

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.

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.001 [1.0 point] (1.0)
The term "Prompt Critical" refers to:

a. the instantaneous jump in power due to a rod withdrawal
b. a reactor which is supercritical using only prompt neutrons
c. a reactor which is critical using both prompt and delayed neutrons
d. a reactivity insertion which is less than $ß_{eff}$

Answer: A.01 b.
Reference: DOE Fundamentals Handbook, Nuclear Physics and Reactor Theory Module 4, Enabling Objective 2.8, p. 15.

Question A.002 [1.0 point] (2.0)
Which one of the following is the principal source of heat in the reactor after a shutdown from extended operation at 100 KW?

a. Production of delayed neutrons
b. Subcritical reaction of photoneutrons
c. Spontaneous fission of U^{238}
d. Decay of fission fragments

Answer: A.02 d.
Reference: DOE Fundamentals Handbook, Nuclear Physics & Reactor Theory Volume 1, Module 1, Enabling Objective 4.9, p. 61.

Question A.003 [1.0 point] (3.0)
Match the description of plant conditions in column A with resulting xenon conditions in column B.

	Column A	Column B
a.	4 hours after a power increase	1. Xe concentration is increasing to a peak
b.	2 hours after a power decrease	2. Xe concentration is decreasing to a dip
c.	16 hours after a “clean” startup	3. Xenon concentration is zero (reactor is “clean”)
d.	72 hours after a shutdown	4. Xenon concentration is steady at a “non-zero” value

Answer: A.03 a. = 2; b. = 1; c. = 4; d. = 3
Reference: DOE Fundamentals Handbook, Nuclear Physics & Reactor Theory Volume 2, Module 3, Enabling Objective 4.1, p. 34.

Question A.004 [1.0 point] (4.0)
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

Answer: A.04 d.
Reference: Introduction to Nuclear Reactor Operations, ©1982, Reed Robert Burn

Question A.005 [1.0 point] (5.0)
The term K_{eff} is defined as …

a. absorption/(production + leakage)

b. (production + leakage)/absorption

c. (absorption + leakage)/production

d. production/(absorption + leakage)

Answer: A.05 d.
Reference: Burn, R., Introduction of Nuclear Reactor Operations, © 1988,

Question A.006 [1.0 point] (6.0)
Following a significant reactor power increase, the moderator temperature coefficient becomes increasingly more negative. This is because:

a. as moderator density decreases, less thermal neutrons are absorbed by the moderator than by the fuel.

b. the change in the thermal utilization factor dominates the change in the resonance escape probability.

c. a greater density change per degree F occurs at higher reactor coolant temperatures.

d. the core transitions from an under-moderated condition to an over-moderated condition.

Answer: A.06 c.
Reference: DOE Fundamentals Handbook, Nuclear Physics and Reactor Theory Volume 2, Module 3, Enabling Objective 2.4, p. 26.

Question A.007 [1.0 point] (7.0)
Which ONE of the following will be the resulting stable reactor period when a 0.312 %Δk/k reactivity is inserted into an exactly critical reactor core? Given $\beta = 0.007$

a. 12 seconds

b. 24 seconds

c. 38 seconds

d. 50 seconds

Answer: A.07 a.
Reference: Glasstone, S. and Sesonske, A, *Nuclear Reactor Engineering,* 1991, § 5.18, p. 234.
$T = (\beta-\rho)/\lambda\rho$ $T = (.007 - .00312)/.1 \times .00312 = 12$ seconds

Question A.008 [1.0 point] (8.0)
With the reactor critical at 10 KW a blade is pulled to insert a positive reactivity of 0.00126 ΔK/K. Which one of the following will be the stable reactor period as a result of this reactivity insertion?

a. 10 seconds

b. 45 seconds

c. 55 seconds

d. 65 seconds

Answer A.08 b.
Reference: $\tau = (\beta-\rho)/\lambda_{eff}\rho = \frac{.007 - .00126}{(.1)(.00126)} = 45.5$ seconds

Question A.009 [1.0 point] (9.0)
An initial count rate of 100 is doubled five times during a startup. Assuming an initial Keff of 0.950, which one of the following is the new Keff?

a. 0.957

b. 0.979

c. 0.985

d. 0.998

Answer: A.09 d.
Reference: CR1 (1-Keff1) = CR2 (1 - Keff2) or M1 (1-Keff1) = M2 (1 - Keff2)
CR2/CR1 = 32 → CR1 (1-Keff1)/CR2 = 1 - Keff2)
→ 100 (1-0.950)/3200 = 1 - Keff2 Keff2 = 1 - .0015625 = .998

Question A.010 [1.0 point] (10.0)

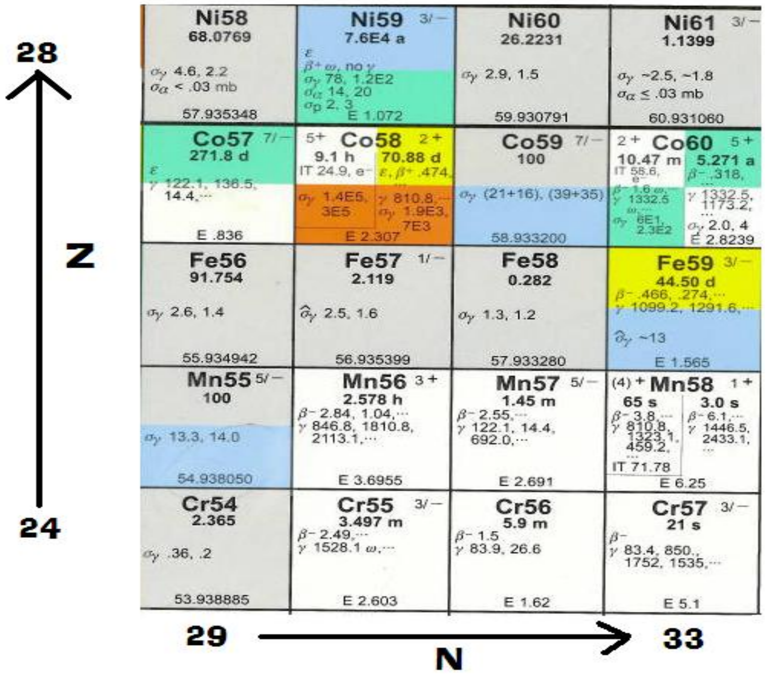
Using the applicable portion from the chart of the nuclides, what will Mn-56 decay into?

a. Mn-55

b. Co-60

c. Fe-56

d. Fe-58



Answer A.10 c.

REF: Mn-56 is beta decay, which is the conversion of a neutron into a proton and electron. Baum, E., Knox, H., and Miller, T. 2002. Nuclides and Isotopes 16^{th} Ed. p. 28

Question A.011 [1.0 point] (11.0)

You are assigned to check the operation of a new nuclear instrumentation channel. You know that the reactor will stabilize with a - 80 second period shortly after shutdown. To check the channel you measure the time for power to decrease by a factor of 10. This time should be approximately…

a. 45 seconds (¾ minute)

b. 90 seconds (1-½ minutes)

c. 135 seconds (2-¼ minutes)

d. 180 seconds (3 minutes)

Answer A.11 d.

REF: $P/P_0 = e^{-t/\tau}$ $\ln(0.1) = -(t)/\tau(-80\text{sec})$ Time $(t) = \ln(0.1) \times -80$ sec $= 184$ seconds ≈ 3 minutes

Question A.012 [1.0 point] (12.0)
All four control rods are worth 11.4% ΔK/K. Core excess is 4.2% ΔK/K. Regulating rod worth is 0.6% ΔK/K. If the regulating rod is stuck in the fully out position, calculate the actual (NOT TECHNICAL SPECIFICATION) Shutdown Margin. (Ignore temperature and poisons.)

a. 2.5% ΔK/K

b. 3.3% ΔK/K

c. 6.6% ΔK/K

d. 7.8% ΔK/K

Answer A.12 c.
Reference (11.4% - 4.2% - 0.6%)ΔK/K = 6.6% ΔK/K)

Question A.013 [1.0 point] (13.0)
The number of neutrons passing through a one square centimeter of target material per second is the definition of which one of the following?

a. Neutron Population (np)

b. Neutron Impact Potential (nip)

c. Neutron Flux (nv)

d. Neutron Density (nd)

Answer: A.13 c.
Reference: DOE Fundamentals Handbook, Nuclear Physics and Reactor Theory,

Question A.014 [1.0 point] (14.0)
The neutron microscopic cross-section for absorption (σ_a) of an isotope generally …

a. increases as neutron energy increases

b. decreases as neutron energy increases

c. increases as target nucleus mass increases

d. decreases as target nucleus mass increases

Answer: A.14 b.
Reference: DOE Fundamentals Handbook, Nuclear Physics and Reactor Theory,

Question A.015 [1.0 point] (15.0)
A reactor contains three safety rods and a control rod. Which one of the following would result in a determination of the excess reactivity of this reactor?

a. The reactor is critical at a low power level, with all safety rods full out and the control rod at some position. The reactivity remaining in the control rod (i.e. its rod worth from its present position to full out) is the excess reactivity.

b. The reactor is shutdown. Two safety rods are withdrawn until the reactor becomes critical. The total rod worth withdrawn is the excess reactivity.

c. The reactor is at full power. The total worth of all rods withdrawn is the excess reactivity.

d. The reactor is at full power. The total worth remaining in all the safety rods and the control rod (i.e. their worth from their present positions to full out) is the excess reactivity.

Answer: A.15 a.
Reference: DOE Fundamentals Handbook, Nuclear Physics and Reactor Theory, Vol.

Question A.016 [1.0 point, 0.25 each] (16.0)
The listed isotopes are all potential daughter products due to the radioactive decay of $_{35}Br^{87}$. Identify the type of decay necessary (Alpha, Beta, Gamma or Neutron emission) to produce each of the isotopes.

a. $_{33}As^{83}$

b. $_{35}Br^{86}$

c. $_{35}Br^{87}$

d. $_{36}Kr^{87}$

Answer: A.16 a. = α; b. = n; c. = ỹ; d. = β^-
Reference: DOE Fundamentals Handbook, Nuclear Physics and Reactor Theory

Question A.017 [1.0 point] (17.0)
With the reactor on a constant period, which of the following changes in reactor power would take the LONGEST time?

a. 5% — from 1% to 6%

b. 15% — from 20% to 35%

c. 20% — from 40% to 60%

d. 25% — from 75% to 100%

Answer: A.17 a.
Reference: $P = P_0 e^{t/\tau}$ $\ln(P/P_0) = t/\tau$ Since you are looking for which would take the longest time it is obvious to the most casual of observers that the ratio P/P_0 must be the largest.

Question A.018 [1.0 point, 0.25 each] (18.0)
Match each term in column A with the correct definition in column B.

	Column A		Column B
a.	Prompt Neutron	1.	A neutron in equilibrium with its surroundings.
b.	Fast Neutron	2.	A neutron born directly from fission.
c.	Thermal Neutron	3.	A neutron born due to decay of a fission product.
d.	Delayed Neutron	4.	A neutron at an energy level greater than its surroundings.

Answer: A.18 a. = 2; b. = 4; c. = 1; d. = 3
REF: DOE Fundamentals Handbook, Nuclear Physics and Reactor Theory, Volume

Question A.019 [1.0 point] (19.0)
A thin foil target of 10% copper and 90% aluminum is in a thermal neutron beam. Given $\sigma_{a\,Cu}$ = 3.79 barns, $\sigma_{a\,Al}$ = 0.23 barns, $\sigma_{s\,Cu}$ = 7.90 barns, and $\sigma_{s\,Al}$ =1.49 barns, which ONE of the following reactions has the highest probability of occurring? A neutron

a. scattering reaction with aluminum

b. scattering reaction with copper

c. absorption in aluminum

d. absorption in copper

Answer: A.19 a.
Reference: DOE Fundamentals Handbook, Nuclear Physics and Reactor Theory
0.1 x 3.79 = 0.379 0.9 x 0.23 = 0.207 0.1 x 7.9 = 0.79 0.9 x 1.49 = 1.34

Question A.020 [1.0 point] (20.0)

ELASTIC SCATTERING is the process by which a neutron collides with a nucleus and …

a. is absorbed, with the nucleus emitting a gamma ray.

b. recoils with the same kinetic energy it had prior to the collision.

c. recoils with less kinetic energy than it had prior to the collision 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.

Answer: A.20 b.

Reference: DOE Fundamentals Handbook, Nuclear Physics and Reactor Theory

Question: B.001 [1.0 point] (1.0)
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.01 a.
Reference: Emergency Plan Chapter 2.0, Definitions, § 2.11.

Question: B.002 [1.0 point] (2.0)
Which ONE of the following is the definition of ***Emergency Action Level***?

a. a condition that calls for immediate action, beyond the scope of normal operating procedures, to avoid an accident or to mitigate the consequences of one.
b. Specific instrument readings, or observations; radiation dose or dose rates; or specific contamination levels of airborne, waterborne, or surface-deposited radioactive materials that may be used as thresholds for establishing emergency classes and initiating appropriate emergency methods.
c. classes of accidents grouped by severity level for which predetermined emergency measures should be taken or considered.
d. a document that provides the basis for actions to cope with an emergency. It outlines the objectives to be met by the emergency procedures and defines the authority and responsibilities to achieve such objectives.

Answer: B.02 b.
Reference: Emergency Plan, § 2.0 Definitions (2.7)

Question: B.003 [1.0 point] (3.0)
Match the 10CFR55 requirements for maintaining an active operator license in column A with the corresponding time period from column B.

Column A	Column B
a. Renew License	1 year
b. Medical Exam	2 years
c. Pass Requalification Written Examination	4 years
d. Pass Requalification Operating Test	6 years

Answer: B.03 a. = 6; b. = 2; c. = 2; d. = 1
Reference: 10CFR55.

Question: B.004 [1.0 points, 0.25 each] (4.0)
Identify each of the following actions as either a channel CHECK, a channel TEST, or a channel CALibration.

a. Prior to startup you place a known radioactive source near a radiation detector, noting meter movement and alarm function operation.

b. During startup you compare all of your nuclear instrumentation channels ensuring they track together.

c. At power, you perform a heat balance (calorimetric) and determine you must adjust Nuclear Instrumentation readings.

d. During a reactor shutdown you note a -80 second period on Nuclear Instrumentation.

Answer: B.04 a. = Test; b. = Check; c. = Cal; d. = Check
Reference: Technical Specification 1.2.3-5.

Question: B.005 [1.0 point] (5.0)
During a normal reactor startup, the neutron source is normally removed at …

a. 500 milliwatts
b. 5 watts
c. 50 watts
d. 500 watts

Answer: B.05 d.
Reference: RO-5 Routine Startup, § 4.11

Question: B.006 [1.0 point] (6.0)
During a reactor start-up the console operator is withdrawing a control blade and notices that the position indicator for the control blade is not changing. Select the operator action for these conditions.

a. Attempt to insert the control blade whose position indicator was not changing during blade withdrawal.

b. Continue the reactor start-up. Level power at 1 watt and investigate the cause.

c. Verify that source range counts are not changing.

d. Run the other unstuck blades and the Regulating Rod fully in.

Answer: B.06 d.
Reference: EO-7, "Stuck Rod or Safety Blade," step 1

Question: B.007 [1.0 point] (7.0)
When removing a sample from the pneumatic tube receiver, Health Physics coverage is required if the sample reads greater than …

a. 0.001 Rem/hr.

b. 0.01 Rem/hr.

c. 0.1 Rem/hr.

d. 1 Rem/hr.

Answer: B.07 d.
Reference: U. Mass.-Lowell, RO-4 § 1.4.1

Question: B.008 [1.0 point] (8.0)
10CFR50.54(x) states: "A licensee may take reasonable action that departs from a license condition or a technical specification (contained in a license issued under this part) in an emergency when this action is immediately needed to protect the public health and safety and no action consistent with license conditions and technical specifications that can provide adequate or equivalent protection is immediately apparent." 10CFR50.54(y) states that the minimum level of management which may authorize this action is …

a. any Reactor Operator licensed at the facility.

b. any Senior Reactor Operator licensed at the facility.

c. Facility Manager (or equivalent at facility).

d. NRC Project Manager.

Answer: B.08 b.
Reference: 10CFR50.54(y).

Question: B.009 [1.0 point] (9,0)
Which ONE of the following correctly describes a Safety Limit?

a. Limits on important process variables which are found to be necessary to reasonably protect the integrity of certain physical barriers which guard against the uncontrolled release of radioactivity.

b. The Lowest functional capability of performance levels of equipment required for safe operation of the facility.

c. Settings for automatic protective devices related to those variables having significant safety functions.

d. a measuring or protective channel in the reactor safety system.

Answer: B.09 a.
Reference: Standard NRC Tech Spec Question.

Question: B.010 [1.0 point] (10.0)
You bring a radiation monitor into the pump room during reactor operation. If you were to open the window on the detector you would expect the meter reading to … (Assume no piping leaks.)

a. increase, because you would now be receiving signal due to H3 and O16 betas.
b. remain the same, because the Quality Factors for gamma and beta radiation are same.
c. increase, because the Quality Factor for betas is greater than for gammas.
d. remain the same, because you still would not be detecting beta radiation.

Answer: B.10 d.
Reference: BASIC Radiological Concept (Betas don't make it through piping.)

Question: B.011 [1.0 point] (11.0)
What is the maximum K_{eff} allowed (per Technical Specifications) for reactor fuel element storage under quiescent flooding with water.

a. 0.7
b. 0.75
c. 0.8
d. 0.85

Answer: B.11 d.
Reference: Technical Specifications § 5.4, p. IV

Question: B.012 [1.0 point] (12.0)
An experiment irradiated in the pool reads 50mr/hr at 2 feet below the pool surface and 100 mr/hr at 1 foot below the pool surface. You decide to place the experiment at 20 feet below the surface of the pool. Based on the attenuation you noted between the 2 foot and 1 foot levels, you would expect the shielding due to 20 feet of water to reduce the dose by a factor of approximately … (Note: Ignore dose decrease due to distance.)

a. 1000

b. 10,000

c. 100,000

d. 1,000,000

Answer B.12 d.
Reference: 2^{20} = 1,048,756 ˜ 1,000,000

Question: B.013 [1.0 points, 0.2 each] (13.0)
As a licensed reactor operator you will be responsible for ensuring the correctness of Irradiation Request Forms (IRFs). To do this you must know your technical specification reactivity limits. Match the terms listed in column A with the respective reactivity limit from column B. (Only one answer for each item in column A. Items in column B may be used more than once or not at all.)

	Column A		Column B
a.	Total all experiments	1.	0.1% ΔK/K
b.	Single Moveable	2.	0.2%ΔK/K
c.	Total Moveable	3.	0.25%ΔK/K
d.	Single Secured	4.	0.5%ΔK/K
e.	Total Secured	5.	2.0%ΔK/K
		6.	2.5%ΔK/K

Answer: B.13 a. = 9; b. = 1; c. = 4; d. = 4; e. = 6
Reference: U. Mass-Lowell Technical Specifications § 3.1

Question: B.014 [1.0 point] (14.0)
The CURIE content of a radioactive source is a measure of

a. the number of radioactive atoms in the source.

b. the amount of energy emitted per unit time by the source

c. the amount of damage to soft body tissue per unit time.

d. the number of nuclear disintegrations per unit time.

Answer B.14 d.
Reference: Standard Health Physics Definition.

Question: B.015 [1.0 point] (15.0)
Which ONE of the following statements correctly describes the relationship between the Safety Limit (SL) and the Limiting Safety System Setting (LSSS)?

a. The SL is a maximum operationally limiting value that prevents exceeding the LSSS during normal operations.

b. The SL is a parameter that assures the integrity of the fuel cladding. The LSSS initiates protective actions to preclude reaching the SL.

c. The LSSS is a parameter that assures the integrity of the fuel cladding. The SL initiates protective action to preclude reaching the LSSS.

d. The SL is a maximum setpoint for instrumentation response. The LSSS is the minimum number of channels required to be operable.

Answer: B.15 b.
Reference: Standard NRC Tech Spec Question

Question: B.016 [1.0 point] (16.0)
Which ONE of the following is the definition of Committed Dose Equivalent?

a. The sum of the deep dose and the committed effective dose equivalent.

b. The dose equivalent that the whole body receives from sources outside the body.

c. The sum of external deep dose equivalent and the organ dose equivalent.

d. The 50 year dose equivalent to an organ or tissue resulting from an intake of radioactive material.

Answer: B.16 d.
Reference: 10CFR20.1003 Definitions

Question: B.017 [1.0 point] (17.0)
You initially remove a sample from the pool reading 1 R/hr at 30 cm from the source. You then replace the sample in the pool. An hour later you remove the sample and the reading is now 390 mR/hr at 30 cm. You again replace the sample back in the pool. How much longer should you wait to be able to bring out the sample without generating a high radiation area?

a. ½ hour

b. 1 hour

c. 1½ hours

d. 2 hours

Answer: B.17 c.
REF: $I_t = I_0 e^{-\lambda t}$ 390 mR/hr ÷ 1000 mR/hr = $e^{-\lambda 1hr}$ ln(0.39) = -λ * 1 hr. λ = 0.9416 $hour^{-1}$
SOLVING for additional time: $I_f = I_t e^{-\lambda t}$ 100mR/hr = 390 mR/hr $e^{-0.9416 \text{ (time)}}$ ln (0.25) = -0.9163 * t t = 1.4454

Question: B.018 [1.0 point] (1.0)
Upon discovery that no Area Radiation Monitors on the experimental levels are operable, you may continue steady-state operation providing you replace the inoperable monitor with a portable gamma-sensitive monitor having its own alarm within ________ discovery of the condition.

a. 15 minutes

b. 30 minutes

c. an hour

d. eight hours

Answer: B.18 a.
Reference: Technical Specifications 3.4.3.

Question: B.019 [1.0 point] (19.0)
Which ONE of the following is the lowest level of permission required to restart the reactor following violation of a Safety Limit?

a. Licensed Senior Operator on call

b. Reactor Supervisor

c. Facility Director

d. Nuclear Regulatory Commission

Answer: B.19 d.
Reference: Technical Specification 6.5 1

Question: B.020 [1.0 point] (20.0)
You (a licensed Reactor Operator) and a Senior Reactor Operator (SRO) are operating the reactor on the weekend. No one else is available. In order to meet Technical Specifications requirements if you are on the console the SRO must be …

a. within the reactor containment.

b. within the confines of the North Campus.

c. within 15 minutes walk of the reactor facility.

d. within the reactor containment or the Pinanski Building.

Answer: B.20 d.
Reference: T.S. 6.0

Section C Facility and Radiation Monitoring Systems

Question: C.001 [1.0 point, 0.166 each] (1.0)
Identify whether the following scrams are ENABLED or DISABLED after placing the Power Level selector switch (7S5) in the "0.10 MW" position.

a. Primary low flow
b. Pool high temperature
c. Core inlet high temperature
d. Bridge Movement
e. Coolant gates open. (Riser and downcomer)
f. Thermal Column Door

Answer: C.01 a. = D; b. = E; c. = D; d. = E; e. = D; f. = E
Reference: ULR Technical Specifications, § 3.3.

Question: C.002 [1.0 point] (2.0)
Using the drawing of the primary system provided, which ONE of the following valves will cause a scram if the valve is opened (moved off closed seat)?

a. P-1
b. P-9
c. P-11
d. P-12

Answer C.02 d.
Reference: Study Guide for Key Access and Intro. to Operator Training, Primary System.

Question: C.003 [1.0 point] (3.0)
Which one of the following combinations of detector alarms would cause you to activate the "Limited Radiation Emergency Alarm"?

a. Stack Monitor (A) and Bridge Monitor (K).
b. Bridge Monitor (K) and Control Room Monitor (R).
c. Facilities Exhaust Monitor (F) and Pump Room Monitor (P).
d. Reactor Constant Air Monitor (C) and Fission Product Monitor (E).

Answer: C.03 b.
Reference: U. Mass — Lowell, FSAR Appendix 10.

Question: C.004 [1.0 point] (4.0)
Fan EF-14 has an extra component in the bank of filters in its suction. Which ONE of the following is the extra filter component? (NOTE: A diagram of the ventilation system is in the handout.)

a. Carbon filter

b. HEPA filter

c. Absolute Filter

d. Roughing Filter

Answer: C.04 a.
Reference: Study Guide for Key Access and Introduction to Operator Training, figure 3.5, Ventilation schematic.

Question: C.005 [1.0 point] (5.0)
Fans 3, 4, 5 and 6 are all rated at 600 cpm except… (NOTE: A diagram of the ventilation system is in the handout.)

a. # 3, Thermal Column/Beamports & Medical Embedment Drain line vent

b. # 4, Pneumatic Tubes Exhaust

c. # 5, Hot Cell

d. # 6, Gamma Cave

Answer: C.05 b.
Reference: Study Guide for Key Access and Introduction to Operator Training, Containment/Ventilation System, ¶ 5.

Question: C.006 [1.0 point] (6.0)
You are instructed to place the core in the #1 position and align the core for minimum vibration (induced by flow). Select the position and mode of cooling for the core.

	Position	Flow Alignment
a.	Bulk Pool	downcomer mode
b.	Stall Pool	cross-stall mode
c.	Bulk Pool	cross-stall mode
d.	Stall Pool	downcomer mode

Answer: C.06 b.
Reference: ULRR FSAR, § 4.2.2, Primary Coolant Systems

Question: C.007 [1.0 point] (7.0)
Reactor Power is 500 Kilowatts when a large leak develops in the primary coolant piping. Select the device that ensures the reactor pool will not be completely drained.

a. The primary coolant pump.

b. The pool divider gate.

c. The pool wall liner.

d. The break valve.

Answer: C.07 d.
Reference: ULRR FSAR, Paragraph 4.2.2., "Primary Coolant System."

Question: C.008 [1.0 point] (8.0)
How does the facility assure that the 24 VDC wet cells used to provide flash current to the emergency generator will work?

a. 50% of the bank is replaced every 6 months.

b. 100% of the bank is replaced every two years.

c. House power feeds a charger which maintains a constant trickle charge.

d. House power feeds a charger for the Emergency lights which in turn provide a trickle charge to the Wet cells.

Answer: C.08 c.
Reference: ULRR FSAR § 6.5.1, p. 6-7.

Question: C.009 [1.0 point] (9.0)
When the scram magnet assemblies are energized, the control blades are:

a. coupled to the drive tube.

b. moving in the outward direction.

c. moving in the inward direction.

d. dropped into the core.

Answer: C.09 a.
Reference: ULRR FSAR, Paragraph 4.1.7, "Control Blade Drives."

Question: C.010 [1.0 point] (10.0)
Which ONE of the following is used when the reactor is operating to reduce the buildup of Ar^{41} in the reactor bay?

a. Purification system via the ion bed.

b. Diffuser pumps which decrease the release of Ar^{41} from the pool.

c. None required due to the relatively short half-life of Ar^{41} (seven seconds).

d. Operation of the ventilation system, which releases the Ar^{41} through the stack.

Answer: C.10 d.
Reference: ULRR FSAR

Question: C.011 [1.0 point, ¼ each] (11.0)
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.11 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.012 [1.0 point] (12.0)
Which ONE of the following correctly describes the operation of the RTD (temperature detector used for the temperature recorder).

a. A precision wound resistor, which changes resistance proportional to temperature.

b. A precision wound inductor, which changes inductance proportional to temperature.

c. A bimetallic junction, which generates a potential (micro-volt range) proportional to temperature.

d. A bimetallic strip which because of differing thermal expansion coefficients causes the strip to bend proportional to temperature.

Answer: C.12 a.
Reference: ULRR FSAR § 4.4.17.5

Question: C.013 [1.0 point] (13.0)
Which ONE of the following correctly describes how a compensated ion chamber detects neutrons? A neutron interacts with the …

a. B^{10} lining of the tube.
b. U^{235} lining of the tube.
c. N_2 gas which fills the tube.
d. BF_3 gas which fills the tube.

Answer: C.13 a.
Reference: Standard NRC Question

Question: C.014 [1.0 points, 0.25 each] (14.0)
The liquid radwaste system divides cooling water into four sections for the purpose of performance checks/monitoring. Match the cooling water sections in Column A with its appropriate performance checks from Column B. Note that some performance checks in Column B may be used more than once or not at all.

Column A	Column B
a. Pool	1. External gamma monitor and delayed neutron detector.
b. Primary Loop	2. Continuous conductivity measurements.
c. Cleanup Loop	3. Periodic sampling for quality and presence of radionuclides.
d. Secondary Loop	4. Daily sampling for Na^{24}.

Answer: C.14 a. = 3; b. = 1; c. = 2; d. = 4
Reference: ULRR FSAR § 7.2.4, Page 7-5

Question: C.015 [1.0 point] {15.0}
You are performing a reactor shutdown and notice that the source range instrument does not come on scale until <u>AFTER</u> 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.15 d.
Reference: Procedure RO-9, Reactor and Control System Checkout Procedures, steps 3.17 & 4.11.

Question: C.016 [1.0 point] {16.0}
Which ONE of the following loads is supplied from the air compressor located on the intermediate level inside the reactor building?

a. Air lock doors.

b. Thermal column door.

c. Pneumatic tube system.

d. Containment isolation valves.

Answer: C.16 a.
Reference: ULRR FSAR, § 6.2, p 6-5

Question: C.017 [1.0 point] (17.0)
Which ONE of the following is the type of startup neutron source use for your reactor?

a. Californium

b. Plutonium-Beryllium

c. Neptunium-Antimony

d. Americium-Beryllium

Answer: C.17 d.
Reference: ULRR FSAR § 4.1.4, page 4-6

Question: C.018 [1.0 point] {18.0}
Which ONE of the following describes how the signal for regulating rod position indication is generated?

a. A tachometer that counts the revolutions of the lead screw.

b. A series of magnetic switches which respond to lead screw position.

c. A mechanical position transmitter that is chain driven by the drive motor.

d. A series of limit switches that are actuated by the ball bearing screw assembly.

Answer: C.18 c.
Reference: ULRR FSAR, §4.1.8, p 4-11; Figures 4.6 and 4.7. C.14

Question: C.019 [1.0 point] {19.0}

The purpose of the filter in the reactor pool cleanup system is to …

a. prevent demineralizer resin fines from entering the pool.

b. prevent larger particles from plugging the demineralizer resin.

c. remove particles that could clog the cleanup system pump seals.

d. remove crud from the coolant limiting the radiation levels associated with the demineralizer.

Answer: C.19 a.

Reference: ULRR FSAR, §4.2.5, p 4-29.

Question: C.020 [1.0 points, 0.166 each] {20.0}

Using the drawing of the primary system provided, if the reactor is in position 1, with the coolant system in the cross-stall mode (preferred line-up). Identify the position of the valves listed (Open, Closed, Throttled).

a. P-1

b. P-2

c. P-3

d. P-4

e. P-9

f. P-11

Answer: C.20 a. = Open; b. = Open; c. = Closed; d. = Closed; e. = Open; f. = Throttled

Reference: ULRR FSAR § 4.2.2, also, Training Handout section on Primary System, and drawing.