February 19, 2013

Dr. David E. Moncton, Director
of the Nuclear Reactor Laboratory
Massachusetts Institute of Technology
138 Albany Street
Mail Stop NW 12-208
Cambridge, MA 02139

SUBJECT: EXAMINATION REPORT NO. 50-020/OL-13-01,
MASSACHUSETTS INSTITUTE OF TECHNOLOGY

Dear Dr. Moncton:

During the week of February 4, 2013, the U.S. Nuclear Regulatory Commission (NRC) administered operator licensing examinations at your Massachusetts Institute of Technology reactor. The examinations were conducted in accordance with NUREG-1478, "Operator Licensing Examiner Standards for Research and Test Reactors," Revision 2. Examination questions and preliminary findings were discussed with those members of your staff identified in the enclosed report at the conclusion of the examination.

In accordance with Title 10 of the *Code of Federal Regulations* Section 2.390, a copy of this letter and the enclosures will be available electronically for public inspection in the NRC Public Document Room or from the Publicly Available Records component of NRC's Agencywide Documents Access and Management System (ADAMS). ADAMS is accessible from the NRC Web site at http://www.nrc.gov/reading-rm/adams.html. The NRC is forwarding the individual grades to you in a separate letter which will not be released publicly. Should you have any questions concerning this examination, please contact Mr. Phillip T. Young at (301) 415-4094 or via email 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. 50-020

Enclosures: 1. Examination Report No. 50-020/OL-13-01
2. Written examination with facility comments incorporated

cc without enclosures: See next page

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Gregory Bowman, Chief
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Docket No. 50-020

Enclosures: 1. Examination Report No. 50-020/OL-13-01
2. Facility comments on written examination with NRC resolution
3. Written examination with facility comments incorporated

cc without enclosures: See next page

DISTRIBUTION w/ encls.:

PUBLIC	PRTB r/f	RidsNRRDPRPRTA
RidsNRRDPRPRTB	Facility File (CRevelle) O-7 F-08	

ADAMS ACCESSION #: ML13045A280 **TEMPLATE #:NRR-074**

OFFICE	PRTB:CE		IOLB:LA	E	PRTB:BC	
NAME	PYoung		CRevelle		GBowman	
DATE	2/19 /2013		2/15 /2013		2/19 /2013	

Official Record Copy

cc:

City Manager
City Hall
Cambridge, MA 02139

Department of Environmental Protection
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Boston, MA 02108

Mr. Robert Gallagher, Acting Director
Radiation Control Program
Department of Public Health
Schrafft Center, Suite 1M2A
529 Main Street
Charlestown, MA 02129

Nuclear Preparedness Manager
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.: 50-20/OL-13-01

FACILITY DOCKET NO.: 50-20

FACILITY LICENSE NO.: R-37

FACILITY: MITR-II

EXAMINATION DATES: February 4 - 6, 2013

SUBMITTED BY: **/RA/** 2/12/2013
Phillip T. Young, Chief Examiner Date

SUMMARY:

During the week of February 4, 2013 the NRC administered licensing examinations to one Senior Reactor Operator- Instant (SROI) applicant and two Senior Reactor Operator-Upgrade (SROU) applicants. All applicants passed all portions of their examinations.

REPORT DETAILS

1. Examiners: Phillip T. Young, Chief Examiner, NRC

2. Results:

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

3. Exit Meeting:
Phillip T. Young, Chief Examiner, NRC
Mr. John Foster, MIT
Mr. Frank Warmsley, MIT

At the conclusion of the examinations the chief examiner thanked the facility for their support during the examinations.

FACILITY COMMENTS WITH NRC RESOLUTION

This is the memo regarding questions on this February 4th NRC written exam.

Question: A.020
Comment: The answer key lists a) U233 as the correct answer, however, we believe that d), Th232 should be the only correct answer.

NRC Resolution: Comment accepted, the exam was graded accepting 'd' as the correct answer.

Question: B.016
Comment: "In the event of an On-Site Evacuation, personnel should be directed to proceed to the:"
The answer key lists c) NW13 Receiving Room as the correct answer, however, PM 4.4.4.11, page 5 of 9 does state that for a building evacuation, the NW13 Machine Shop is a location to proceed to. For this exam, we suggest that answers c) and d) be accepted.

NRC Resolution: Comment accepted, the exam was graded accepting either 'c' or 'd' as correct.

Question: C.007
Comment: "Please identify each of the channel descriptions with the applicable oddly numbered channel (1,3,5,7 or 9)."

a) The answer key has 3 as being correct, this is from the systems manual which is in the process of being updated. It was found by the instrumentation personnel that Ch #3 at some point had been replaced with an uncompensated ion chamber. The systems manual is being updated to reflect this information.
b) No problem.
c) The answer key has 3, however 9 is the correct answer.
d) No problem.
e) No problem.
f) The answer key has 5, however 7 is the correct answer. Currently though, Ch#7 is OOC and hence we do not have any Compensated Ion Chambers.

NRC Resolution: Comment accepted, the exam was graded accepting '9' for C.07c and deleting c.07f from the examination.

Question: C.010
Comment: "Which one of the following list the two radio-nuclides which will be seen by the detectors in the secondary water system signaling that there is a leak within the heat exchangers with the reactor operating normally (no fuel element failure)?
The answer key lists b) H3 and F18 as the correct answer, however, our water monitors are not capable of detecting H3, we believe that answer d) F18 and N16 is the only correct answer.

NRC Resolution: Comment accepted, the exam was graded accepting 'd' for C.010.

Question: C.012
Comment: “Match the reactor location or feature from Column I with the gas from Column II which is used as the primary cover or operating gas.
For C.12c the answer key lists iii) N2 as the correct answer, however iv) He is the only correct answer.

This completes the list of items that we have on the written exam. We would like to thank you for the well written exam, questions and your time to do your usual diligence.

Frank Warmsley
Asst. Superintendent and Training Supervisor,
MIT Nuclear Reactor Laboratory

Enclosure 2

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

FACILITY: Massachusetts Institute of Technology

REACTOR TYPE: MITR II Research HW

DATE ADMINISTERED: 02/04/2013

CANDIDATE: _____

INSTRUCTIONS TO CANDIDATE:
Answers are to be written on the answer sheet provided. Attach the answer sheets to the examination. Points for each question are indicated in brackets for each question. A 70% in each section is required to pass the examination. Examinations will be picked up three (3) hours after the examination starts.

Category Value	% of Total	% of Candidates Score	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
19.00	33.3	_____	____	C. Facility and Radiation Monitoring Systems
59.00		_____	____% 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 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.

EQUATION SHEET's

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

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

$$\ell^* = 1 \; x \; 10^{-4} \; seconds$$

$$\lambda_{eff} = 0.1 \; seconds^{-1}$$

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

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

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

$$M = \frac{1-K_{eff_0}}{1-K_{eff_1}}$$

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

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

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

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

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

EQUATION SHEET's

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

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

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

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

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

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

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

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

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

EQUATION SHEET's

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

1 Curie = 3.7×10^{10} dis/sec

1 kg = 2.21 lbm

1 Horsepower = 2.54×10^{3} BTU/hr

1 Mw = 3.41×10^{6} BTU/hr

1 BTU = 778 ft-lbf

°F = 9/5°C + 32

1 gal (H_2O) ≈ 8 lbm

°C = 5/9 (°F - 32)

c_P = 1.0 BTU/hr/lbm/°F

c_p = 1 cal/sec/gm/°C

Section A Reactor Theory, Thermo, and Facility Characteristic

Question: A.001 [1.0 point] (1.0)
The following shows part of a decay chain for the Radioactive element Radon (Rn). This decay chain is a good example of ___ decay.

$$^{222}_{86}Rn \xrightarrow{3.8\ \text{d}} {}^{218}_{84}Po$$

a. Alpha

b. Beta

c. Gamma

d. Neutron

Answer: A.01 a.
Reference: DOE Fundamentals Handbook *Nuclear Physics and Reactor Theory Vol. 2*

Question: A.002 [1.0 point] (2.0)
A nuclear reactor startup is being performed by adding **equal** amounts of positive reactivity and waiting for neutron population to stabilize. As the reactor approaches criticality, the numerical change in stable neutron population after each reactivity addition _____, and the time required for the neutron population to stabilize after each reactivity addition _____.

a. increases; remains the same

b. increases; increases

c. remains the same; remains the same

d. remains the same; increases

Answer: A.02 b.
Reference: ***NRC Generic Fundamentals Examination Question Bank—PWR2010***

Section A Reactor Theory, Thermo, and Facility Characteristics

Question: A.003 [1.0 point] (3.0)
Which ONE of the following statements is the most correct regarding a characteristic of subcritical multiplication?

a. The number of neutrons gained per generation doubles for each succeeding generation.

b. A constant neutron population is achieved when the total number of neutrons produced in one generation is equal to the number of source neutrons in the next generation.

c. For equal reactivity additions, it takes less time for the equilibrium subcritical neutron population level to be reached as K_{eff} approaches one.

d. Doubling the indicated power will reduce the margin to criticality by approximately one-half.

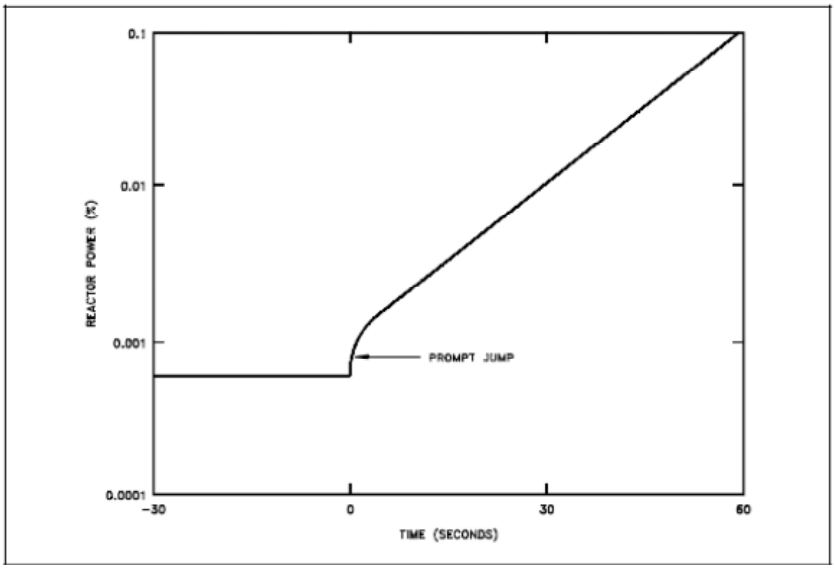
Answer A.03 d. Reference: DOE Handbook, Vol 2, Section 2.0 If CR_2 is twice CR_1, then to be equal, (1-$Keff_2$) must be half of (1-$Keff_1$).

$$\frac{CR_1}{CR_2} = \frac{1-k_2}{1-k_1}$$

Section A Reactor Theory, Thermo, and Facility Characteristic

Question: A.004 [1.0 point] (4.0)

Given the following diagram, which of the following most correctly describe the condition of the reactor? :



a. The prompt jump occurs because the production rate of delayed neutrons abruptly changes as reactivity is added.

b. At T=15s, the reactor is considered prompt critical.

c. After the prompt jump, the rate of change of power cannot increase any more rapidly than the built-in time delay the neutron precursor half-lives allow.

d. Shortly after T=0s, the reactor power is immediately turned due to the rise in moderator temperature.

Answer: A.04 c.
Reference: PSBR Training Manual, Chapter 2.22

Question: A.005 [1.0 point] (5.0)

Given a critical nuclear reactor operating below the point of adding heat (POAH), what reactivity effects are associated with reaching the POAH?

a. There are no reactivity effects because the reactor is critical.

b. The increase in fuel temperature will begin to create a positive reactivity effect.

c. The decrease in fuel temperature will begin to create a negative reactivity effect.

d. The increase in fuel temperature will begin to create a negative reactivity effect.

Answer: A.05 d.
Reference: DOE Fundamentals Handbook *Nuclear Physics and Reactor Theory Vol. 2*

Section A Reactor Theory, Thermo, and Facility Characteristics

Question: A.006 [1.0 point] (6.0)
Which one of the following most correctly completes the following as the reason for having an installed neutron source within the core?

A startup without an installed neutron source...

a. could result in a very short period due to the reactor going critical before neutron population built up high enough to be read on nuclear instrumentation.

b. is impossible as there would be no neutrons available to start up the reactor.

c. would be very slow due to the long time to build up neutron population from so low a level.

d. can be compensated for by adjusting the compensating voltage on the source range detector.

Answer: A.06 a.
Reference: DOE Fundamentals Handbook *Nuclear Physics and Reactor Theory Vol. 2*

Question: A.007 [1.0 point] (7.0)
Which ONE of the following conditions will **INCREASE** the core excess of a nuclear reactor?

a. Higher moderator temperature (assume negative temperature coefficient)

b. Insertion of a negative reactivity worth experiment

c. Burnout of a burnable poison

d. Fuel depletion

Answer: A.07 c.
Reference: DOE Fundamentals Handbook *Nuclear Physics and Reactor Theory Vol. 2*

Section A Reactor Theory, Thermo, and Facility Characteristic

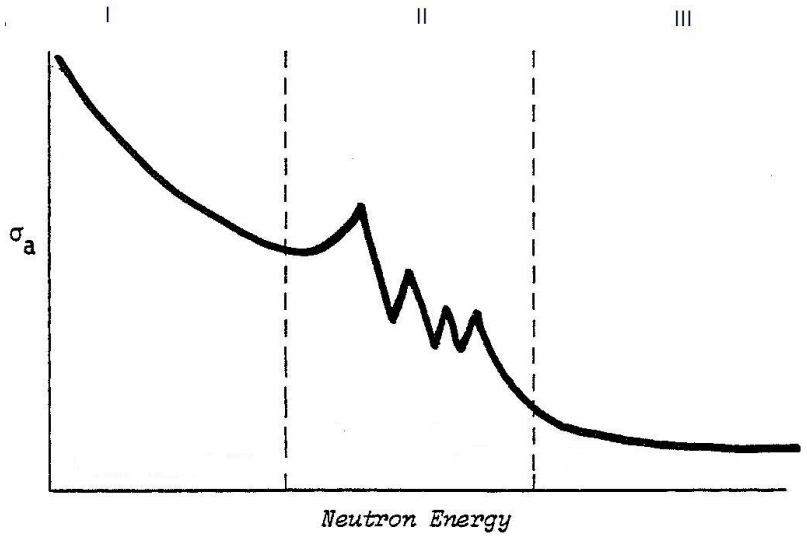
Question: A.008 [1.0 point] (8.0)
Given the associated graph, which of the following answers best describe the neutron behavior within Region II?

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

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

c. Neutrons of specific energy levels (e.g., 50 ev, 100 kev) have a greater potential for leakage from the reactor core

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



Answer: A.08 d.
Reference: DOE Fundamentals Handbook *Nuclear Physics and Reactor Theory Vol. 2*

Question: A.009 [1.0 point] (9.0)
The effective neutron multiplication factor, K_{eff}, for a critical reactor is:

a. Equal to ∞.

b. Equal to 1.

c. Equal to the effective delayed neutron fraction.

d. Any value < 1.

Answer: A.09 b.
Reference: DOE Fundamentals Handbook *Nuclear Physics and Reactor Theory Vol. 2*

Section A Reactor Theory, Thermo, and Facility Characteristics

Question: A.010 [1.0 point] (10.0)
_____ releases the most amount of energy during an average fission event.

a. Fission product recoil
b. Fission product decay
c. Fast neutrons
d. Prompt gammas

Answer: A.10 a.
Reference: PSBR Training Manual, Chapter 2 “Principles of Reactor Operation”, p.2

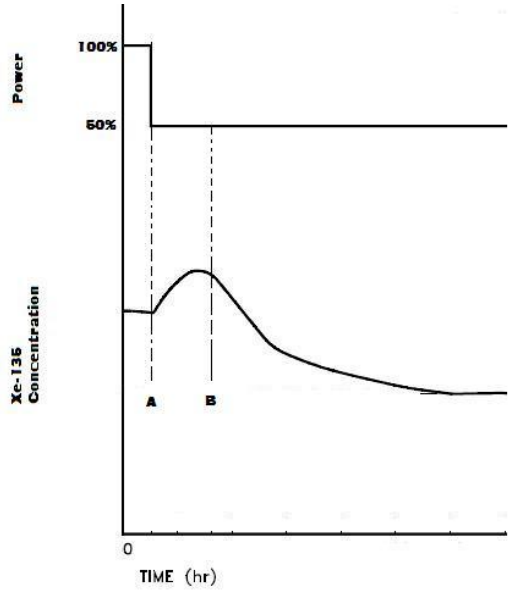
Question: A.011 [1.0 point] (11.0)
Using the associated graph which of the following best describes what happens to the concentration of Xenon (Xe)-135 from point A to B?

a. The concentration of Iodine-135 was at a higher equilibrium level at 100% power and is therefore producing Xe-135 at a higher rate until it reaches a maximum value 7-8 hours later.

b. The concentration of Xe-135 reaches a maximum value 40 hours after the down power transient and will decrease to a new, higher equilibrium value until it reaches a maximum value equilibrium

c. The insertion of control rods displaces the axial reactor flux causing an increased production rate of xenon gas until it reaches a maximum value 7-8 hours after the down power transient.

d. The decay rate of fission product, Cesium-135 increases due to the down power transient which increases the concentration of Xe-135 to a maximum value 40 hours later.



Answer: A.11 a.
Reference: DOE Fundamentals Handbook *Nuclear Physics and Reactor Theory Vol. 2*

Section A Reactor Theory, Thermo, and Facility Characteristic

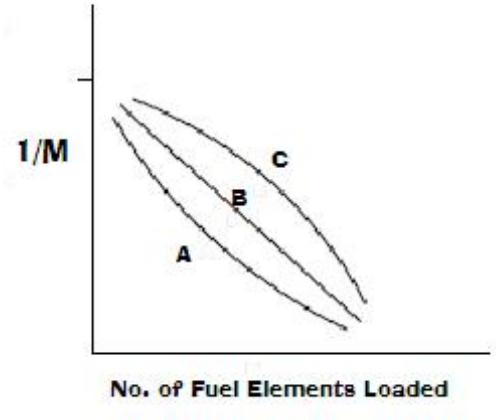
Question: A.012 [1.0 point] (12.0)
A reactor with K_{eff} = 0.8 contributes 1000 neutrons in the first generation. When progressing from the FIRST generation to the SECOND generation, how many **TOTAL** neutrons are there after the SECOND generation?

a. 1250
b. 1600
c. 1800
d. 2000

Answer: A.12 c.
Reference: Burn, R., Introduction to Nuclear Reactor Operations, © 1982, § 5.3, p. 5.6
2nd generation=n + K*n=1000+800=1800 neutrons

Question: A.013 [1.0 point] (13.0)
Refer to the associated figure which includes drawings for three 1/M plots labeled A, B, and C Plot B shows an ideal approach to criticality. Therefore, the least conservative approach to criticality is represented by plot _____ and could possibly be the result of recording count rates at _____ time intervals after incremental fuel loading steps compared to the situations represented by the other plots.

a. A; shorter
b. A; longer
c. C; shorter
d. C; longer



Answer: A.13 c.
Reference: PSU Training Manual, Section 2.7
"Critical Mass Experiment"

Section A Reactor Theory, Thermo, and Facility Characteristics

Question: A.014 [1.0 point] (14.0)
Which is the correct definition of shutdown margin?

a. The reactor is in a cold xenon-free condition, with the most reactive blade and the regulating rod full out, the reflector dumped, and all samples in their most reactive positions.

b. The reactor is in a cold xenon-free condition, with the most reactive blade and the regulating rod full in, the reflector dumped, and all samples in their most reactive positions.

c. The reactor can be made subcritical by at least 1% delta K/K in a cold xenon-free condition, with the most reactive blade and the regulating rod full out, and all samples in their most reactive positions.

d. The reactor is in a cold xenon loaded condition, with the most reactive blade and the regulating rod full out, the reflector dumped, and all samples in their least reactive positions.

Answer: A.14 c.
Reference: T.S. 3.9

Question: A.015 [1.0 point] (15.0)
The reactor is operating at 100 KW. The reactor operator withdraws the Regulating Rod adding 250 mβ of reactivity and allowing power to increase. The operator then inserts the same rod to its original position, decreasing power.

In comparison to the rod withdrawal, the rod insertion will result in:

a. a longer period due to long lived delayed neutron precursors.

b. a shorter period due to long lived delayed neutron precursors.

c. the same period due to equal amounts of reactivity being added.

d. the same period due to equal reactivity rates from the rod.

Answer: A.15 a.
Reference:

Section A Reactor Theory, Thermo, and Facility Characteristic

Question: A.016 [1.0 point] (16.0)
Moving the control blades, primarily changes reactivity in the reactor by changing which ONE of the four factors?

a. Fast Fission Factor (ε)
b. Reproduction Factor (η)
c. Resonance Escape Probability (p)
d. Thermal Utilization Factor (f)

Answer: A.16 d.
Ref:

Question: A.017 [1.0 point] (17.0)
The table provided lists data taken during a core loading. Estimate the number of fuel elements needed to go critical.

Count Rate	Number for Fuel Elements
842	2
886	7
1052	12
1296	17
4210	22

a. 24
b. 27
c. 30
d. 38

Answer: A.17 a.
Reference: Standard NRC question

Section A Reactor Theory, Thermo, and Facility Characteristics

Question: A.018 [1.0 point] (18.0)
Given the data in the table to the right, which ONE of the following is the closest to the half-life of the material?

TIME	ACTIVITY
0 minutes	2400 cps
10 minutes	1757 cps
20 minutes	1286 cps
30 minutes	941 cps
60 minutes	369 cps

a. 11 minutes

b. 22 minutes

c. 44 minutes

d. 51 minutes

Answer: A.18 b.
Reference: Reactor Training Manual -Reactivity

Question: A.019 [1.0 point] (19.0)
In a subcritical reactor, K eff is increased from 0.861 to 0.946. Which ONE of the following is the amount of reactivity that was added to the reactor core?

a. 0.085 delta k/k

b. 0.104 delta k/k

c. 0.161 delta k/k

d. 0.218 delta k/k

Answer: A.19 b.
Reference: Reactor Physics Notes, Reactivity Kinetics, pg. 2
.1 = (0.861 - 1)/0.861 = -0.161.k/k; .2 = (0.946 - 1)/0.946 = -0.057.k/k
.. = .2 -.1 = -0.057 - (-0.161) = +0.104 delta k/k

Section A Reactor Theory, Thermo, and Facility Characteristic

Question: A.020 [1.0 point] (20.0)

A fissile material is one which will fission upon the absorption of a THERMAL neutron. Which ONE of following listed isotopes is not a fissile material?

a. U233

b. U235

c. Pu239

d. Th232

Answer: A.20 ~~a.~~ d. per facility comment.
Reference: Glasstone and Sesonske, Third Ed. § 1.45

Section B Normal/Emergency Procedures & Radiological Controls

Question B.001 (1.00 point) {1.0}
Before any change is made in the core configuration (refueling), the proposed change must be reviewed and approved by:

a. the Operator-in-charge and a Senior Reactor Operator.
b. the Reactor Superintendent and a Senior Reactor Operator.
c. the MIT Reactor Safeguards Committee and the Reactor Superintendent.
d. the MIT Reactor Safeguards Committee and the Director of Reactor Operations.

Answer: B.01 b.
Reference: PM 1.15, p 1.

Question B.002 (1.00 point) {2.0}
How are the stack accumulators verified to be operable?

a. A signal is introduced into the detector and if the detector records readings, then it is operable.
b. The background signal is observed and compared to previously know background levels.
c. The system is checked for the illumination of an error light.
d. A local visual observation of proper operation.

Answer: B.02 a.
Reference: PM 3.1.2.2 Pg. 1 of 14

Question B.003 (1.00 point) {3.0}
The English units for absorbed dose and dose equivalent, respectively, are:

a. Rad; Rem
b. Rem; Becquerel
c. Curie; Sievert
d. Sievert; Gray

Answer: B.03 a.
Reference: Glasstone & Sesonske, *Nuclear Reactor Engineering; Third Edition*, Pg. 778

Section B Normal/Emergency Procedures & Radiological Controls

Question B.004 (1.00 point) {4.0}
Which ONE of the following federal regulations establishes procedures and criteria for the issuance of licenses to operators and senior operators?

a. 10 CFR 20
b. 10 CFR 50
c. 10 CFR 55
d. 10 CFR 73

Answer: B.04 c.
Reference: 10 CFR 55.1(a)

Question B.005 (1.00 point) {5.0}
While responding to low pressure condition in the D_2O Helium System and monitoring the recombiner, the gasholder level decreases rapidly. The primary concern associated with this condition is:

a. a buildup of Argon-41 in containment.
b. an oil spill from a ruptured blow-out patch.
c. a release of Tritium to the equipment room.
d. the loss of loop seal overpressure protection for the recombiner.

Answer: B.05 c.
Reference: PM 5.5.13

Question B.006 (1.00 point) {6.0}
Pump MM-1 is **LOCKED OUT** to support corrective maintenance on the pump (replace packing). During performance of the work the key will remain in the custody of the …

a. person performing the work.
b. Operator-in-Charge.
c. Senior Reactor Operator.
d. Reactor Supervisor or his designee.

Answer: B.06 a.
Reference: Administrative Procedures § 1.14.3 Equipment Tagout & Lockout Procedure.

Section B Normal/Emergency Procedures & Radiological Controls

Question B.007 (1.00 point) {7.0}
Following a change in fuel configuration, measurements must be made to determine the conditions of Technical Specification 3.1 are met prior to exceeding …

a. 1 kilowatt
b. 10 kilowatts
c. 100 kilowatts
d. 1 Megawatt

Answer: B.07 a.
Reference: MITR-II, PM 1.15 ¶3, pg. 1 of 5

Question B.008 (1.00 point) {8.0}
During the performance of an Abnormal Operating Procedure, a temporary change to the procedure is required. Select the minimum complement of personnel required to approve this temporary change.

a. Two members of the reactor staff, at least one of whom holds a Senior Reactor Operator License.
b. The Duty Shift Supervisor and an appropriate group Supervisor.
c. A licensed Senior Reactor Operator and a member of the Reactor Safeguards Committee.
d. Two licensed Senior Reactor Operators and the Director of Reactor Operations.

Answer: B.08 a.
Reference: PM 1.5

Question B.009 (1.00 point) {9.0}
Consider two point sources, each having the SAME curie strength. Source A's gammas have an energy of 0.5 MeV, while Source B's gammas have an energy of 1.0 MeV. Using a Geiger-Müller detector the reading from source B will be … (NOTE: Ignore detector efficiency.)

a. four times that of source A.
b. twice that of source A.
c. the same.
d. half that of source A.

Answer: B.09 c.
Reference: Standard NRC Health Physics Question. G-M detector is not sensitive to incident energy levels.

Section B Normal/Emergency Procedures & Radiological Controls

Question B.010 (1.00 point) {10.0}

During refueling operations the D_2O reflector would NOT be dumped if this would result in a decrease in

a. radiation shielding by 100 mr/hr

b. radiation shielding by 10 mr/hr

c. count rate below 100 cpm

d. count rate below 10 cpm

Answer: B.10 d.
Reference: PM 2.7

Question B.011 (1.00 point) {11.0}

Which **ONE** of the following conditions is a Reportable Occurrence per the Technical Specification definition?

a. Five shim blades are operable. The inoperable blade is fully out.

b. During operation at full power you find both Emergency cooling jumper hoses sabotaged.

c. Operation of the reactor with a height of water above the core 2" below the overflow pipe.

d. Operation of the reactor with one shield coolant flow rate scram channel failed. It has been out of service for five hours. Personnel working on it anticipate having it repaired within 2 hours.

Answer: B.11 b.
Reference: Technical Specification 3.9, 3.7, 3.6, 2.2.

Question B.012 (1.00 point) {12.0}

An accessible area within the facility has general radiation levels of 325 mrem/hour. What would be the EXPECTED posting for this area?

a. "Caution, Very High Radiation Area"

b. "Danger, Airborne Radioactivity Area"

c. "Danger, High Radiation Area"

d. "Caution, Radiation Area"

Answer: B.12 c.
Reference: Reactor Training Manual -10CFR20

Section B Normal/Emergency Procedures & Radiological Controls

Question B.013 (1.00 point) {13.0}
While working on an experiment, you receive the following radiation doses: 100 mrem (ß), 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.13 d.
Reference: Reactor Training Manual - Ionizing Radiation

Question B.014 (1.00 point) {14.0}
As permitted by 10 CFR 50.59, the MITR may:

a. Modify systems and change the Technical Specifications (TS) if the NRC is notified afterwards.

b. Redefine the boundaries of accidents previously analyzed in the Safety Analysis Report (SAR).

c. Perform new and little understood experiments when they are for research.

d. Determine the affects of modifications and their impact on TS.

Answer: B.14 d.
Reference: PM 1.4 & 10 CFR 50.59

Question B.015 (1.00 point) {15.0}
A small radioactive source is to be stored in an accessible area of the reactor building. The source reads 2 R/hr at 1 foot. Assuming no shielding is to be used, a Radiation Area barrier would have to be erected from the source at least a distance of approximately:

a. 400 feet

b. 40 feet

c. 20 feet

d. 10 feet

Answer: B.15 c.
Reference: DR1 DR 2 DR 2 2 2000 2 21 2 = X = XX =× 1 = 400 ft X = 20 ft
22 2 X2 X1 DR25

Section B Normal/Emergency Procedures & Radiological Controls

Question B.016 (1.00 point) {16.0}

In the event of an On-Site Evacuation, personnel should be directed to proceed to the:

a. Campus Police Headquarters (Bldg. W31)

b. Operations Office (NW12-116).

c. NW13 Receiving Room.

d. NW13 Machine Shop.

Answer: B.16 c. or d. per facility comment.
Reference: E-Plan 4.4.4.11

Question B.017 (1.00 point) {17.0}

You have not performed the functions of an RO or SRO in the past 6 months. Per the Regulations, prior to resuming activities authorized by your license, how many hours must you complete in that function under the direction of an RO or SRO as appropriate?

a. 4

b. 6

c. 12

d. 24

Answer: B.17 b.
Reference: 10CFR55.53(f)(2))

Question B.018 (1.00 point) {18.0}

A reactor startup is declared "non-routine" if:

a. a thermal power calibration has not been performed.

b. a significant shift has occurred in the radial power distribution.

c. the refueling sequence involved fuel flipping.

d. the startup is to be performed when xenon is peaking.

Answer: B.18 b.
Reference: PM 2.3.2

Section B Normal/Emergency Procedures & Radiological Controls

Question B.019 (1.00 point) {19.0}

While responding to a safety system scram alarm, you are required to perform a MAJOR scram of the reactor if:

a. any building area monitor is above the alarm point.

b. a low level in the primary core tank is verifed.

c. any plenum monitor is above the alarm point.

d. a safety limit was exceeded.

Answer: B.19 c.
Reference: PM 5.1.3

Question B.020 (1.00 point, 0.25 each) {20.0}

Identify whether each of the following plans and procedures are designated as Class A, Class B or Class C.

a. Administrative Procedure PM 1.10 *"Experiment Review and Approval"*

b. Abnormal Operating Procedure PM 5.3.3 *"Low Level D_2O Reflector"*

c. Administrative Procedure PM 1.16 *"Requalification Plan for Licensed Personnel"*

d. Standard Operating Plan PM 2.1 *"General Instructions"*

Answer: B.20 a. = B; b. = B; c. = A; d. = A
Reference: PM P1.4 "Review and Approval of Plans, Procedures, and Facility Equipment and Changes Thereto".

Section C Facility and Radiation Monitoring Systems

Question C.001 (1 point) {1.0}
Which one of the following statements describes the limitations imposed on the D2 concentration and recombiner operation? To ensure that the D2 concentration in the helium blanket does not exceed...

a. 6% by volume, the temperature of the middle of the recombiner must be >50°C and the flow rate between 1.5 and 8 cfm or reactor power shall be reduced to <100 kW.

b. 2% by volume, the temperature of the middle of the recombiner must be >50°C and the flow rate >1.5 or reactor power shall be reduced to <200 W.

c. 2% by volume, the temperature of the middle of the recombiner must be >50°C and the flow rate >8 cfm or reactor power shall be reduced to <200 kW.

d. 6% by volume, the temperature of the middle of the recombiner must be >80°C and the flow rate between 1.5 and 8 cfm or reactor power shall be reduced to <500 W.

Answer: C.01 a.
Reference: T.S. 3.3.3; RSM-3.3

Question C.002 (1 point) {2.0}
Which one of the following neutron flux monitoring channels provides a signal indicating the period of the reactor?

a. Channel 2

b. Channel 4

c. Channel 6

d. Channel 8

Answer: C.02 a.
Reference: RSM 5.1

Question C.003 (1 point) {3.0}
During a NORMAL reactor startup, which ONE of the following contributes to NORMALLY defeating the subcritical interlock?

a. Waiting for the power level to reach a stable level.
b. Pulling and holding the “subcritical-bypass” joystick.
c. Having all shim blades at the subcritical position.
d. Withdrawing the regulating rod to reach a critical power level.

Answer: C.03 c.
Reference: RSM 4.2

Section C Facility and Radiation Monitoring Systems

Question C.004 (1 point) {4.0}

A radiation survey performed 2 hours after the reactor has been shutdown has a contact reading of 2,000 mr/hr on the main heat exchangers. Is this reading normal or abnormal and what is the most likely cause?

a. Normal, N^{16}.

b. Normal, F^{18}.

c. Abnormal, H^{3}

d. Abnormal, Fission Products

Answer: C.04 d.
Reference: MITR-II Training Program Sample Question C.25, also AOP, PM 5.0

Question C.005 (1 point) {5.0}

The reactor is operating in automatic control at 80% power when the "**High Pressure Reactor Inlet**" alarm annunciates. Which one of the following changes, if occurring simultaneously, would NOT require the reactor to be scrammed?

a. Reactor period is slightly negative. Regulating rod moving out.

b. Core ΔT higher than normal.

c. MPS-3A (Heat exchanger outlet pressure) reads high.

d. Core purge flow reads 5 cfm.

Answer: C.05 d.
Reference: PM 5.2.11

Question C.006 (1 point) {6.0}

Question deleted during the administration of the examination.

~~Which ONE of the following is the reason for shutting down the reactor if the compressed air system pressure is less than 40 psig?~~

~~a. Personnel airlock cannot be operated.~~

~~b. Eventual loss of containment integrity.~~

~~c. Loss of ability to dump the reflector.~~

~~d. Prevent trip on low secondary flow indication.~~

~~Answer: C.06 b.~~
~~Reference: PM 5.5.4~~

Section C Facility and Radiation Monitoring Systems

Question C.007 (1 point, 0.167 each) {7.0}
Please identify each of the channel descriptions with the applicable oddly numbered channel (1, 3, 5, 7 or 9).

a. Uses **COMPENSATED** ion chamber with **NO** compensating voltage applied.
b. Uses two detectors an ion chamber and a fission chamber to detect neutrons.
c. Powered by a replaceable cell battery pack.
d. Supplies High Flux scram at level corresponding to 5.5 MW.
e. Supplies power signal to the automatic control circuit.
f. Uses a **COMPENSATED** ion chamber to detect neutron signal proportional to power level.

Answer: C.07 a. = 3; b. = 1; c. = ~~3~~ 9; d. = 5; e. = 9; ~~f. = 5~~ deleted – changes per facility comments.
Reference: Reactor Systems Manual, Chapter 5.

Question C.008 (1 point) {8.0}
What is one of the purposes for the subcritical interlock?

a. To prevent the reactor from being manipulated to a critical position before the startup channels are switched from fission chambers to uncompensated ion chambers.
b. To provide a reference point where all instruments undergo a check before the reactor is brought to a critical position.
c. To allow for all experiments to be installed before the reactor is critical.
d. To ensure that a steady rate of startup to the critical position is achieved.

Answer: C.08 b.
Reference: Reactor Systems Manual, Chapter 4.3

Question C.009 (1 point) {9.0}
Which one of the following conditions is NOT a cause of the “trouble radiation monitor alarm” occurring?

a. Loss of flow to any plenum monitor
b. Saturation of secondary water monitor
c. Low level on any effluent monitor
d. Loss of flow to any stack effluent monitor

Answer: C.09 b.
Reference: Reactor Systems Manual §§ 7.12 & 7.15 (Table 7.5-1)

Section C Facility and Radiation Monitoring Systems

Question C.010 (1 point) {10.0}

Which one of the following list the two radio-nuclides which will be seen by the detectors in the secondary water system signaling that there is a leak within the heat exchangers with the reactor operating normally (no fuel element failure)?

a. Xe^{135} and Ar^{41}

b. H^{3} and F^{18}

c. Ar^{41} and N^{16}

d. F^{18} and N^{16}

Answer: C.10 ~~b.~~ d. per facility comment
Reference: Reactor Systems Manual § 7.8

Question C.011 (1 point) {11.0}

What is the purpose of the coolant system for the lead thermal shields?

a. To prevent melting of the lead.

b. To prevent activation of lead by fast neutrons.

c. To maintain the thermal neutron shielding properties of the lead.

d. To maintain thermal equilibrium between the lead shields and the adjacent graphite reflector.

Answer: C.11 a.
Reference: Reactor Systems Manual § 3.16

Question C.012 (1 point, 0.333 each) {12.0}

Match the reactor location or feature from Column I with the gas from Column II which is used as the primary cover or operating gas. Items in Column I have only one correct answer and items in Column II may be used once, more than once or not at all.

Column I	Column II
a. Graphite Reflector	1. CO_2
b. Lead shutter region gas box	2. Ar^{40}
c. Cover gas for D_2O reflector tank	3. N_2
	4. He

Answer: C.12 a. = 1; b. = 1; c. = ~~3~~ 4 per facility comment
Reference: Reactor Systems Manual § 3.7

Section C Facility and Radiation Monitoring Systems

Question C.013 (1 point) {13.0}
Which ONE of the following statements correctly describes the "automatic rundown" interlock? With reactor control on …

a. automatic, if the regulating rod reaches the near-in limit the selected shim blade will run in after 30 seconds.

b. manual, if the regulating rod reaches the near-in limit the selected shim blade will run in after 30 seconds.

c. automatic, if the regulating rod reaches the near-in limit all shim blades will run in after 30 seconds.

d. automatic, if the regulating rod reaches the near-out limit, the selected shim blade will run in after 30 seconds.

Answer: C.13 a
Reference: Reactor Systems Manual § 4.5

Question C.014 (1 point) {14.0}
Which ONE of the following alarm conditions will result in an automatic scram?

a. High Temperature Reflector Outlet.

b. Low Voltage Chamber Power Supply

c. High Level Emergency Power Channel.

d. Low Level Shield Coolant Storage Tank.

Answer: C.14 b.
Reference: RSM-9.3 to 9.5

Question C.015 (1 point) {15.0}
Which ONE of the following describes an automatic response of the ventilation system?

a. If temperature of the outside air drops below freezing the intake fan will trip.

b. If the main intake damper fails to close within ten seconds of a trip signal, then the intake fan will trip.

c. If the auxiliary intake damper fails to close within ten seconds of a trip signal, then the main damper will close.

d. In the "weekend-open" position, if activity is detected by the plenum monitors, the inlet dampers and intake fan will trip.

Answer: C.15 d.
Reference: RSM-8.12

Section C Facility and Radiation Monitoring Systems

Question C.016 (1 point) {16.0}

If the radiation monitor in the off-gas system detects abnormal radiation levels, the pool ventilation will be automatically secured. Protection from overpressure of the coolant system in this condition is provided by:

a. a Blowout patch on the coolant storage tank.

b. a Vacuum breaker on suction side of the off-gas blower.

c. the sample line connections between the isolation valves.

d. a relief valve on the off-gas discharge piping which relieves to the main ventilation exhaust plenum.

Answer: C.16 a.
Reference: RSM-3.4, Section 3.2.5

Question C.017 (1 point) {17.0}

Which one of the following is the alarm setting on the core outlet temperature recorder?

a. 50 ºC

b. 53 ºC

c. 55 ºC

d. 60 ºC

Answer: C.17 b.
Reference: PM 5.2.6

Section C Facility and Radiation Monitoring Systems

Question C.018 (1 point, 0.125 each) {18.0}

Match the facility conditions in Column I with the type of response expected to occur from the Reactor Safety System in Column II. (Assume the reactor is critical.) Items in Column I have only one correct answer and items in Column II may be used once, more than once or not at all.

Column I (Condition)	Column II (Response)
a. Core tank level 2 inches below overflow pipe.	1. Alarm ONLY.
b. Shield coolant flow equals 55 gpm.	2. Rod withdrawal inhibited.
c. Reactor outlet temperature equals 50 ºC.	3. Scram.
d. Reactor building vacuum equals 1.2 inches water above atmospheric.	4. No safety system response
e. Primary cleanup system temperature equals 52 ºC.	
f. D_2O flow equals 88 gpm.	
g. Core Purge flow equals 2.0 cfm	
h. Secondary Water Monitor sample flow equals 1 gpm	

Answer: C.018 a. = 1; b. = 3; c. = 4; d. = 1; e. = 1; f. = 3; g. = 1; h. = 1
Reference: MIT RSM 9.9 & RSM 7.10 (7.5)

Question C.019 (1 point) {19.0}

The reactor is operating at 4.9 MW with an experiment loaded in the pneumatic system. How long after receiving a "Vacuum Off Pneumatic System" alarm will the temperature in the pneumatic tubes reach 100 ºC?

a. 30 seconds
b. 6 minutes
c. 45 minutes
d. 120 minutes

Answer: C.019 b.
Reference: PM 5.5.1

Section C Facility and Radiation Monitoring Systems

Question C.020 (1 point) {20.0}

What automatic action occurs when a high radiation alarm is received on the Sewer Monitor? Assume that the Sewer Monitor is in its normal mode of monitoring liquid radioactive waste being pumped from the sumps to the waste tanks.

a. The Radioactive Liquid Waste System Containment Isolation valve closes.

b. The Inlet City Water Solenoid valve closes.

c. The on-line Sewer pump trips.

d. The Sump pumps trip.

Answer: C.20 d.
Reference: RSM 7.7 and 8.24