October 25, 2011

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. NO. 50-020/OL-12-01, MASSACHUSETTS INSTITUTE OF TECHNOLOGY

Dear Dr. Moncton:

During the week of October 10, 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. 50-020

Enclosures:
1. Examination Report No. 50-020/OL-12-01
2. Facility comments with resolution
3. Written examination with facility comments incorporated

cc without enclosures: see next page

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

October 25, 2011

SUBJECT: EXAMINATION REPORT NO. NO. 50-020/OL-12-01, MASSACHUSETTS INSTITUTE OF TECHNOLOGY

Dear Dr. Moncton:

During the week of October 10, 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. 50-020

Enclosures:
1. Examination Report No. 50-020/OL-12-01
2. Facility comments with resolution
3. Written examination with facility comments incorporated

cc without enclosures: See next page
DISTRIBUTION w/ encls.:
PUBLIC PROB r/f JEads Facility File CRevelle (O07-F8)
ADAMS ACCESSION #: ML112940606

OFFICE	PROB:CE		IOLB:LA		PROB:BC	
NAME	PYoung		CRevelle		JEads	
DATE	10/25/2011		10/21/2011		10/25/2011	

OFFICIAL RECORD COPY

cc:

City Manager
City Hall
Cambridge, MA 02139

Department of Environmental Protection
One Winter Street
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-12-01

FACILITY DOCKET NO.: 50-20

FACILITY LICENSE NO.: R-37

FACILITY: Massachusetts Institute of Technology

SUBMITTED BY: /**RA/**
10/18/2011
Phillip T. Young, Chief Examiner Date

SUMMARY:

During the week of October 10 2011, the NRC administered license examinations to two Reactor Operator license and one Senior Reactor Operator Upgrade candidates. All 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	2/0	0/0	2/0
Operating Tests	2/0	1/0	3/0
Overall	2/0	1/0	3/0

3. Exit Meeting:
Phillip T. Young, NRC, Chief Examiner
John Foster, Superintendent
Leo Frank Warmsley, Asst. Superintendent and Training Supervisor

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

Hello Mr. Young,

Below please find our comments for the October 11, 2011 NRC written exam given at MIT Nuclear reactor lab. As always, we found the exam to be comprehensive, informative and complete. We would like to take this opportunity to thank you for your diligence as always and providing us with a well written exam.

Question B.07
Comment: this question refers to securing blowdown from the cooling towers. After the new towers were built and installed, there was no ability added to actually secure the blowdown. We request that this question be removed from the exam bank.
Justification: Please see above
NRC Resolution: Comment accepted, this question was removed from the examination.

Question B.11
Comment: This question has (A) as the correct answer. However, answer (B) is the only correct answer for this question. We request that the only answer accepted be (B).
Justification: Please see above
NRC Resolution: Comment accepted, answer 'b.' accepted as the correct answer.

Question B.15
Comment: The answers in this question are mislabled, additionally the new Tech Specs renumber those definitions.
Justification: Please see above
NRC Resolution: Comment accepted, Examination corrected to reflect the comment.

Question C.14
Comment: This question has two answers that are correct. Answer (A) and (D) are both correct. For this exam we request that both answers be accepted. For future exams if either answer (A) or (D) were to be changed to "Primary Flow" the question would then be acceptable. Additionally, in the question portion of the question, MIT has (3) ESC's, and ONLY the Ops Office ESC would be correct for this question. We suggest that "Operations Office" be added to the question portion so as not to be a point of confusion on future exams.
Justification: Please see above
NRC Resolution: Comment accepted, Examination corrected to reflect the comment.

Once again we would like to thank you for your time for preparing this well written exam. We look forward to any comments you have for us based on this exam, and look forward to your next visit.

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: 10/11/2011

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
22.00	33.3	_____	____	B. Normal and Emergency Operating Procedures and Radiological Controls
20.00	33.3	_____	____	C. Facility and Radiation Monitoring Systems
63.00		_____	____%	TOTALS
				FINAL GRADE

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

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

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

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

$$T_{½} = \frac{0.693}{\lambda}$$

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

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

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

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

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

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

Question A.01 (1.00 point) {1.0}

Given a source strength of 100 neutrons per second (N/sec) and a multiplication factor of 0.8, the expected stable neutron count rate would be?

a. 125 N/sec

b. 250 N/sec

c. 400 N/sec

d. 500 N/sec

Answer: A.01 d.
Reference: MIT Reactor Physics Notes, Reactor Startup; CR=S/(1-K)

Question A.02 (1.00 point) {2.0}

Which ONE of the following describes the reason for the constant rate of power change several minutes after a reactor scram from full power?

a. The decay of the longer-lived delayed neutron precursors.

b. The decay of the shorter-lived delayed neutron precursors.

c. The mean average decay of the delayed neutron precursors.

d. The decay of fission product gammas producing photoneutrons.

Answer: A.02 a.
Reference: Glasstone & Sesonske, Nuclear Reactor Engineering, Chapter 5, Sect 5.47

Question A.03 (1.00 point) {3.0}

The following data was obtained during a reactor fuel load.

No. of Elements	Detector A (cps)
0	20
8	28
16	30
24	32
32	42
40	80

Which one of the following represents the number of fuel elements predicted to reach criticality?

a. 48

b. 52

c. 56

d. 60

Answer: A.03 a.
Reference: Glasstone, S. & Sesonske, pages 190 & 191.

Question A.04 (1.00 point) {4.0}

Which one of the following is the effect due to an INCREASE in water temperature?

a. Neutron spectrum hardens due to less moderation.

b. Neutron spectrum softens due to increased leakage.

c. Reactivity increases due to less leakage.

d. Reactivity decreases due to more moderation.

Answer: A.04 a.
Reference: Glasstone, S. & Sesonske, pages 465 through 472.

Question A.05 (1.00 point) {5.0}

With the reactor critical at 50% power, the reactor operator withdraws the regulating rod. As power increases, a stable doubling time (DT) of 24 seconds is recorded. (Assume a λ of 0.1 sec-1 and a β of .0070) Which one of the following is the reactivity added to the core by the operator?

a. 0.14% ΔK/K

b. 0.16% ΔK/K

c. 0.18% ΔK/K

d. 0.20% ΔK/K

Answer: A.05 b.
Reference: $T = (\beta-\rho)/\lambda\rho$ $T = t/\ln 2 = 24/.693 = 34.6$ seconds
$34.6 = .0070 - \rho/0.1 \times \rho$ $3.46 = .007-\rho/\rho$ $\rho(3.46+1)= .007$
$\rho = .007/4.46 = .00157 = .16\%\ \Delta K/K$

Question A.06 (1.00 point) {6.0}

Which of the following power manipulations would take the longest to complete assuming the same period is maintained?

a. 1 MW to 2 MW

b. 2 MW to 3.5 MW

c. 3.5 MW to 4.5 MW

d. 4.5 MW to 5 MW

Answer: A.06 a.
Reference: MITR II Reactor Physics Notes - Reactor Kinetics Section (g)

Question A.07 (1.00 point) {7.0}

If 100 millibeta of positive reactivity is suddenly introduced into a stable MITR-II core, what will be the steady period that is obtained? Assume the effective prompt neutron lifetime is 10^{-4} seconds and the effective delayed neutron decay constant is 0.08 s^{-1}.

a. 14.7 seconds

b. 53.5 seconds

c. 112.5 seconds

d. 147 seconds

Answer: A.07 c.
Reference: MITR II Reactor Physics Notes - Reactor Kinetics Section (d)

Question A.08 (1.00 point) {8.0}

The speed of the prompt drop occurring after a large amount of negative reactivity is suddenly inserted into the core is directly correlated to what factor?

a. Prompt neutron lifetime

b. Delayed neutron lifetime

c. Effective prompt neutron fraction

d. Effective delayed neutron fraction

Answer: A.08 a.
Reference: MITR II Reactor Physics Notes - Reactor Kinetics (e)

Question A.09 (1.00 point) {9.0}

Which ONE of the following is the definition of the multiplication factor (K)?

a. The number of neutrons absorbed divided by the number of neutrons leaked.

b. The number of neutrons available to fission with the fuel material divided by the total number of neutrons.

c. The number of neutrons born at high energies divided by the number of neutrons born at low energies.

d. The number of neutrons produced in one generation divided by the number of neutrons produced in the previous generation.

Answer: A.09 d.
Reference: MITR II Reactor Physics Notes - Reactor Startup and Reactor Subcritical Multiplication

Question A.10 (1.00 point) {10.0}

What is the reactivity for a reactor that is exactly critical?

a. 0

b. 0.0768

c. 1

d. 1000

Answer: A.10 a.
Reference: MITR II Reactor Physics Notes - Reactor Kinetics Section (a)

Question A.11 (1.00 point) {11.0}
What effect does Doppler Broadening for U-238 have on neutrons in a critical core?

a. More absorption
b. More scattering
c. More leakage
d. More fission

Answer: A.11 a.
Reference: MITR II Reactor Physics Notes - Reactor Feedback Section (5)(b)

Question A.12 (1.00 point) {12.0}
Xe-135, which is one of the largest poisons in an operating reactor, is created mostly through the decay of Te-135. Where does Te-135 come from?

a. Structural materials in the core.
b. Burnable poison in the fuel.
c. Delayed neutron precursor.
d. Fission of U-235.

Answer: A.12 d.
Reference: MITR II Reactor Physics Notes - Reactor Feedback Section(e)

Question A.13 (1.00 point) {13.0}
Which ONE of the following is the correct reason that delayed neutrons enhance control of the reactor?

a. There are more delayed neutrons than prompt neutrons.
b. Delayed neutrons take longer to reach thermal equilibrium.
c. Delayed neutrons increase the average neutron generation time.
d. Delayed neutrons are born at higher energies than prompt neutrons and therefore have a greater effect.

Answer: A.13 c.
Reference: MITR II Reactor Physics Notes - Reactor Kinetics

Question A.14 (1.00 point) {14.0}

Which ONE of the following parameter changes will require control rod INSERTION to maintain constant power level following the change?

a. Removal of an experiment containing cadmium.

b. Insertion of a void into the core.

c. Pool water temperature increase.

d. Buildup of samarium in the core.

Answer: A.14 a.

Reference: Standard NRC Question...

Question A.15 (1.00 point) {15.0}

The reactor is at a power of 1 watt, with a 26 second stable period. How long will it take for power to reach 1000 watts?

a. ~78 seconds

b. ~121 seconds

c. ~153 seconds

d. ~180 seconds

Answer: A.15 d.

Reference: MITR II Reactor Physics Notes - Reactor Kinetics Section (g) - Reactor Period

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

Question A.16 (1.00 point) {16.0}

An Integral Rod Worth (IRW) curve is _____, while a Differential Rod Worth (DRW) curve is _____.

a. the slope of the DRW curve at the point of withdrawal; the area under the IRW curve up to the point of withdrawal.

b. the total reactivity worth of the rod up to the point of withdrawal; the reactivity change per unit movement of the rod.

c. the reactivity change per unit movement of the rod; the total reactivity worth of the rod up to the point of withdrawal.

d. at its maximum value when the rod is approximately half-way out of the core; at its maximum value when the rod is fully withdrawn from the core.

Answer: A.16 b.
Reference: MITR II Reactor Physics Notes - Reactor Feedback - Control Rod Calibration Experiment

Question A.17 (1.00 point) {17.0}

What type of reactivity effect will occur if heavy water leaks from the reflector into the light water reflector at the top of the core and eventually into the core proper?

a. Negative

b. Positive

c. Negative then strongly positive

d. Positive then strongly negative

Answer: A.17 d.
Reference: MITR-II RSM Pg. 10-11

Question A.18 (1.00 point) {18.0}

What type of reaction forms the Ar^{41} that we worry about from reactor operations?

a. $_{16}S^{38}$ (γ, n) $_{18}Ar^{41}$

b. $_{18}Ar^{40}$ (n, γ) $_{18}Ar^{41}$

c. $_{19}K^{42}$ (γ, p) $_{18}Ar^{41}$

d. $_{19}K^{41}$ (n, p) $_{18}Ar^{41}$

Answer: A.18 b.
Reference: Standard NRC Question

Question A.19 (1.00 point, 0.20 each) {19.0}

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

Question A.20 (1.00 point) {20.0}

The MITR-II is normally refueled when the xenon-equilibrium shim bank height is 16-17 inches, in order to:

a. maintain a uniform axial flux profile for the 3GV irradiation facilities.

b. avoid blade withdrawal above the 18 inch height of the regulating rod.

c. avoid the possibility of being xenon-precluded should a restart following a scram be necessary.

d. avoid burnup of the upper portion of each element, thereby minimizing power peaking at the top of the core.

Answer: A.20 c.
Reference: Examination of MITR-II Shim Bank and Xenon Reactivity Worth Curves

Question B.01 (1.00 point) {1.0}

A sample reading 1 R/hour is placed behind a 2-centimeter lead shield. What will be the resulting exposure rate? Assume no buildup and a linear attenuation equal to 0.52 cm-1.

a. 36 R/hr

b. 3.60 R/hr

c. 0.63 R/hr

d. 0.36 R/hr

Answer: B.01 d.
Reference: $I=I_o e^{-\mu X} \rightarrow I=1R/hr\ e^{(-0.52 \times 2)} = 0.36$ R/hr

Question B.02 (1.00 point) {2.0}

Which ONE of the following statements specifies a condition which satisfies the Technical Specification Shutdown Margin requirements?

a. The reflector dump time must be at least twice the initial measured value.

b. Variable reactivity effects (samples) shall be in their most negative reactive state.

c. No less than five shim blades are operable and the inoperable blade is at the operating position or higher.

d. With the most reactive blade and regulating rod fully withdrawn the reactor can be made at least 1% deltaK/K subcritical from the cold Xenon equilibrium critical condition.

Answer: B.02 c.
Reference: TS 3.9

Question B.03 (1.00 point) {3.0}

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 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.03 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.04 (1.00 point) {4.0}
Which one of the following is the definition for Annual Limit on Intake (ALI)?

a. 10 CFR 20 derived limit, based on a Committed Effective Dose Equivalent of 5 rems whole body or 50 rems to any individual organ, for the amount of radioactive material inhaled or ingested in a year by an adult worker.

b. The concentration of a radionuclide in air which, if inhaled by an adult worker for a year, results in a total effective dose equivalent of 100 millirem.

c. The effluent concentration of a radionuclide in air which, if inhaled continuously over a year, would result in a total effective dose equivalent of 50 millirem for noble gases.

d. Projected dose commitment values to individuals, that warrant protective action following a release of radioactive material.

Answer: B.04 a.
Reference: 10CFR20.1003

Question B.05 (1.00 point) {5.0}
In order to ensure the health and safety of the public, 10CFR50 allows the operator to deviate from Technical Specifications. What is the minimum level of authorization needed to deviate from Tech. Specs?

a. USNRC

b. Reactor Supervisor

c. Licensed Senior Reactor Operator.

d. Licensed Reactor Operator.

Answer: B.05 c.
Reference: 10CFR50.54(y)

Question B.06 (1.00 point) {6.0}
All of the radiation monitor control units alarm at what radiation level? (Excluding the secondary hot cell monitor and medical room monitors)

a. 1 mR/hr

b. 5 mR/hr

c. 25 mR/hr

d. 100 mR/hr

Answer: B.06 b.
Reference: PM 3.1.1.1 Page 4 of 14

QUESTION DELETED FROM EXAMINATION – NO LONGER APPLICABLE

~~**Question** B.07 (1.00 point) {7.0}~~

~~The normal shutdown procedures instruct the operator to secure blowdown from the cooling towers. Why is this step included in the procedures?~~

~~a. Conservation of energy that is used to operate the cooling tower fans.~~
~~b. It prevents damage to secondary coolant pumps since there will be no water makeup.~~
~~c. Shutting down the secondary cooling system will reduce the run time on the secondary pumps.~~
~~d. There is no mechanism to detect a leak in the primary to secondary when the reactor is shutdown.~~

~~Answer: B.07 d.~~
~~Reference: RSM 7-8~~

Question B.08 (1.00 point) {8.0}

What is the highest emergency classification level that can be implemented at the MITR-II?

a. Alert
b. General Emergency
c. Notification of Unusual Event
d. Site Area Emergency

Answer: B.08 d.
Reference: PM 4.4 Pg. 4 of 7

Question B.09 (1.00 point) {9.0}

The SRO classifies an event as a ***Notification of Unusual Event***. The emergency procedure dictates that you (the reactor operator) are to coordinate emergency response from the control room. An example given is to have any available staff assist checking the containment evacuated, escort experimenters out of the building to the machine shop, and to check that all core heat removal equipment is functioning. While performing these task the staff should limit their exposure to a maximum of:

a. 100 mrem
b. 500 mrem
c. 1000 mrem
d. 5000 mrem

Answer: B.09 c.
Reference: PM 4.4.4.14 Pg. 5 of 14

Question B.10 (1.00 point) {10.0}
How is the emergency core cooling system (ECCS) prepared in case the system needs to be activated to prevent further tank level degradation? The ECCS needs to have its water supply connected to the _____.

a. secondary coolant cooling towers outlet lines.
b. primary coolant reactor inlet lines.
c. primary coolant storage tank.
d. city water lines.

Answer: B.10 d.
Reference: PM 5.2.3 Pg. 1&2

Question B.11 (1.00 point) {11.0}
As a licensed reactor operator at the MITR-II, who is allowed to operate the controls of the reactor under your direction?

a. A health physicist who is trying to gain a certified health physicist (CHP) license.
b. A new student taking a reactor experiments class in the nuclear engineering department at MIT.
c. A local college newspaper reporter who wants to write a story on the safety of nuclear reactors.
d. An NRC inspector trying to make sure that all set points of the reactor are the same as those in the technical specifications.

Answer: B.11 ~~a.~~ "b." accepted as correct answer per facility comment.
Reference: 10 CFR 55.13; PM 1.14

Question B.12 (1.00 point) {12.0}
An unshielded Cs^{137} source gives a field reading of 250 mrem/hr at a distance of 30 cm. What thickness of lead shielding will be needed to lower the radiation level to values acceptable for a Radiation Area? The HVL (half-thickness) for Cs^{137} and lead is 6.5 mm.

a. 6.5 mm
b. 13 mm
c. 19.5 mm
d. 26 mm

Answer: B.12 b.
Reference: Standard NRC question. 10 CFR 20.1003

Question B.13 (1.00 point) {13.0}
What is the definition of an emergency action level (EAL) in the emergency plan/procedures?

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

c. A procedure that details the implementation actions and methods required to achieve the objectives of the emergency plan.

d. A class of accidents for which predetermined emergency measures should be taken or considered.

Answer: B.13 d.
Reference: PM 4.2 Pg. 2 of 6

Question B.14 (1.00 point) {14.0}
What is the primary concern if there are fission products circulating in the primary coolant?

a. Radiation levels, especially in the equipment room, may be excessively high.

b. Corrosiveness of fission products will lead to a leak in the primary coolant system.

c. Cooling of the fuel elements will be decreased due to lower thermal conductivity.

d. Release of fission products to the environment can expose the public to radiation.

Answer: B.14 a.
Reference: PM 5.2.3 - Follow-Up Action - Step 1

Question B.15 (1.00 point) {15.0}
Which ONE of the following situations would illustrate a time when the reactor is shutdown but ***NOT*** secured?

a. All control rods are fully inserted and fuel is being rearranged in the fuel storage pool.

b. The control rods are withdrawn to the subcritical position and the core is subcritical by 1% ΔK/K.

c. All control rods are fully inserted and an experiment having a negative reactivity effect is installed in the reactor.

d. One of the control rods is removed for inspection while the other control rods are fully inserted and all fuel remains in the same configuration.

Answer: B.15 c
Reference: Technical Specifications 1.3.29 and 1.3.39

Question B.16 (1.00 point) {16.0}
When doing a normal reactor startup, the procedures requires reactor power to be maintained at 1 MW for 5 minutes. What is the reason for this?

a. Excess reactivity must be measured before full power is reached.
b. The method of cooling tower flow must be switched to spray.
c. Thermal equilibrium between the core and the coolant reduces stress on fuel cladding.
d. Compensating voltage on some power channels must be adjusted due to increased temperatures.

Answer: B.16 c.
Reference: PM 2.3.1 - Step 21

Question B.17 (1.00 point) {17.0}
Which **ONE** of the following is the definition of a **CHANNEL TEST**?

a. an adjustment of the channel such that it output corresponds with acceptable accuracy to known values of the parameter which the channel measures.
b. the combination of sensor, line, amplifier, and output devices which are connected for the purpose of measuring the value of a parameter.
c. a qualitative verification of acceptable performance by observation of channel behavior.
d. the introduction of a signal into the channel for verification that It Is operable.

Answer: B.17 d
Reference: Technical Specifications § 1.3.4

Question B.18 (1.00 point) {18.0}
Removing a warning tag requires approval from a _____ and removing a lockout requires direction from a _____.

a. Senior operator; senior operator
b. Senior operator; console operator
c. Console operator; console operator
d. Console operator; senior operator

Answer: B.18 d.
Reference: PM 1.14.3 - Step 4 and Step 6

Question B.19 (1.00 point) {19.0}
When is the regulating rod withdrawn during a reactor startup?

a. After the B-10 counter is secured and the power range instrumentation is on scale.
b. When reactor power reaches 10 watts.
c. After all control blades are withdrawn to the subcritical position.
d. After the third control blade is withdrawn to subcritical position.

Answer: B.19 c.
Reference: PM 2.3.1 - Step 6

Question B.20 (1.00 point, 0.25 points each) {20.0}
Match the following activities with the placement of the SRO:

a. Recovery from an unplanned shutdown.
b. Routine Insertion/Removal of a graphite thimble sample. (Reactor is S/D)
c. Operation at a steady power level.
d. Normal reactor startup to full power.

1. Must be in control room
2. Must be within allowable distance
3. Does not have to be in facility or on call

Answer: B.20 a. = 1; b. = 2; c. = 2; d. = 1
Reference: PM 2.3.3 PM 1.14.2.3 - Step 5&6 PM 1.14.1 - Step 2
PM 2.3.1 - Precondition # 3

Question B.21 (1.00 point) {21.0}
The air purge above the reactor is secured. If H^2 concentration increases to above 3.5% Technical Specifications require you to …

a. insert a Major Scram.
b. insert a Minor Scram.
c. reduce power to less than 100 Kw.
d. perform a normal reactor shutdown.

Answer: B.21 c
Reference: MITR-II Tech. Spec. § 3.3.2

Question B.22 (1.00 point) {22.0}

Which ONE of the following lists the correct values for the limiting safety system settings with 2 primary pumps operating?

a. W_T = 1800 gpm; P_T = 7.4 MW; L = 4" below overflow pipe; T_{OUT} = 60°C

b. W_T = 900 gpm; P_T = 3.0 MW; L = 4" below overflow pipe; T_{OUT} = 50°C

c. W_T = 900 gpm; P_T = 3.0 MW; L = 4" below overflow pipe; T_{OUT} = 60°C

d. W_T = 1800 gpm P_T = 6.0 MW L = 4" below overflow pipe; T_{OUT} = 50°C

Answer: B.22 a.
Reference: TS 2.2

Question B.23 (1.00 point, 0.25 each) {23.0}

Identify whether each of the following experiments has no special requirements (NR), requires Double encapsulation (**DBL**), requires Pressure Test (**PT**) or is Not Authorized (**NA**). (Note choices may be used more than once or not at all.)

a. Corrosive Materials

b. Metastable Materials

c. contains 3 milligrams of explosive material, and will not cause rearrangement or damage to the reactor.

d. the calculated surface temperature of a submerged experiment will be high enough to cause nucleate boiling within the coolant, but not cause bulk boiling.

Answer: B.23 a. = DBL; b. = PT; c. = PT; d. = NA
Reference: Tech Spec's Table 6.1-1

Section C Facility and Radiation Monitoring Systems

Question C.01 (1.00 point) {1.0}

The resin used to remove impurities from the reflector system is:

a. Mixed bed H - OH resin.

b. Mixed bed D - OD resin.

c. Segregated bed D - OD resin.

d. Segregated bed H - OH resin.

Answer: C.01 b.
Reference: MIT Reactor Systems Manual, Section 3.3.3

Question C.02 (1.00 point) {2.0}

Which one of the following statements is NOT a purpose of the D_2O helium cover gas system?

a. It provides an inert, non-radioactive vehicle to circulate the disassociated D_2 and O_2 from the reflector tank to the recombiner.

b. It prevents the corrosion that would be caused by nitrous-oxide formation from air in the presence of high radiation fields.

c. It prevents air with entrained H_2O moisture from entering the system, coming in contact with and degrading the D_2O.

d. It provides an **oil-filled loop** seal to minimize contamination of the D_2O in the reflector tank.

Answer: C.02 d.
Reference: RSM-3.16 (3.7.1)

Question C.03 (1.00 point) {3.0}

Which neutron flux monitoring channel controls the regulating control rod in automatic control mode?

a. Channel 3

b. Channel 5

c. Channel 7

d. Channel 9

Answer: C.03 d.
Reference: RSM 5-11

Question C.04 (1.00 point, 0.25 each) {4.0}

List the order of placement of the following reactor components starting from the reactor core position moving outward.

a. Dense concrete shield 1
b. Graphite reflector 2
c. Lead thermal shield 3
d. D_2O reflector 4

Answer: C.04 a. = 4; b. = 2; c. = 3; d. = 1
Reference: RSM 1-2; 1-3

Question C.05 (1.00 point) {5.0}

Which three shutters in the fission convertor facility ensure the safety of the staff in the building?

a. Cadmium converter control shutter, water shutter, and lead shutter
b. Water converter control shutter, paraffin shutter, and cadmium shutter
c. Lead converter control shutter, paraffin shutter, and cadmium shutter
d. Paraffin converter control shutter, lead shutter, and water shutter

Answer: C.05 a.
Reference: License Amendment #31 Safety Evaluation Pg. 11

Question C.06 (1.00 point) {6.0}

In the event of an extended reactor shutdown, which ONE of the following neutron sources would be used for a reactor startup?

a. AmBe
b. PoBe
c. PuBe
d. SbBe

Answer: C.06 c.
Reference: SAR 4.2.4 Neutron Startup Source Pd 4-19

Question C.07 (1.00 point) {7.0}
Where does overflow from the D_2O reflector tank go?

a. Heat exchanger HE-D1.

b. Reflector cleanup loop.

c. Reflector storage tank.

c. Reflector dump tank.

Answer: C.07 d.
Reference: SAR 5.3.1.5 Pg. 5-26

Question C.08 (1.00 point) {8.0}
A CO_2 purge is maintained to the Vertical Thimbles during reactor operation. Which ONE of the following is the reason for maintaining this purge?

a. To maintain a positive pressure in the thimbles to prevent filling with water in the event of a seal leak.

b. To reduce the production of Argon-41 and prevent formation of Nitric acid.

c. To limit the amount of tritium produced during reactor operation.

d. To provide cooling to the samples during irradiation.

Answer: C.008 b.
Reference: RSM 2.4

Question C.09 (1.00 point) {9.0}
Which one of the following is the correct value for the alarm setpoint for the high temperature D_2O reflector cleanup system?

a. 40°C

b. 50°C

c. 60°C

d. 70°C

Answer: C.09 b.
Reference: MITR-II, Reactor Systems Manual, § 9.2.1, p, 9.4

Question C.10 (1.00 point) {10.0}

A trainee accidentally depresses the **ALL-ABSORBERS-IN** pushbutton. Which one of the following actions will stop the inward motion of the control blades?

a. Depressing the Reactor Start pushbutton.

b. Going to the out position on the regulating rod.

c. Depressing the Alarm Acknowledge pushbutton.

d. Depressing the Alarm Acknowledge pushbutton followed by the Alarm Reset pushbutton.

Answer: C.10 a.
Reference: MITR-II, Reactor System Manual, Chapter 4, p. 4.5, first paragraph.

Question C.11 (1.00 point) {11.0}

The Exhaust Air Effluent Monitor picks up radiation levels in excess of operating limits. Which **ONE** of the following actions will NOT occur immediately as a result?

a. Intake Fans will stop.

b. Exhaust Fans will stop.

c. Intake Backup Damper will close.

d. Intake Butterfly Damper will close.

Answer: C.11 c.
Reference: MITR-II, Reactor Systems Manual § 7.4.2.

Question C.12 (1.00 point) {12.0}

The fuel element dummies are constructed of …

a. Titanium

b. Stainless-Steel

c. Aluminum

d. Hafnium

Answer: C.12 c.
Reference: PM 3.3.1

Question C.13 (1.00 point) {13.0}
Which ONE of the following is **NOT** a function of the primary cleanup system?

a. Provide emergency core cooling spray.
b. Maintain level with the core tank.
c. Remove decay heat during reactor shutdown.
d. Supply cooling for the lead thermal doors.

Answer: C.13 d.
Reference: MITR-II RSM pg. 6-35

Question C.14 (1.00 point) {14.0}
Which ONE of the following indications is NOT provided in the Emergency Support Center?

a. Reactor Power. (for future exams change this to Primary Flow)
b. Reactor Floor Radiation Level.
c. Wind Direction and Speed.
d. Core Tank Level.

Answer: C.14 a. or d. acceptable per facility comment
Reference: MITR-II SRM pg. 2-31

Question C.15 (1.00 point) {15.0}
At what building pressure should the containment pressure relief system be placed on line?

a. 3.0 psi
b. 2.5 psi
c. 2.0 psi
d. 1.5 psi

Answer: C.15 c.
Reference: RSM 8.4, AOP PM 5.5.7

Question C.16 (1.00 point) {16.0}

A major concern when responding to any casualty that affects the reflector is:

a. possible tritium exposure.
b. toxicity of the heavy water.
c. corrosiveness of irradiated heavy water.
d. possible N-16 exposure.

Answer: C.16 a.
Reference: RSM, Page 8.31

Question C.17 (1.00 point) {17.0}

Which ONE of the following describes decay heat removal capability while on Emergency Power?

a. Primary coolant system auxiliary pump MM2 can be restarted after resetting the low-voltage protection.

b. Primary coolant system pump MM1 can be restarted after resetting the low-voltage protection.

c. Standby Transfer Pump DM-2 will automatically start on high temperature.

d. Natural circulation provides cooling since pumping power is not available.

Answer: C.17 a.
Reference: RSM, Page 8.31

Question C.18 (1.00 point) {18.0}

If the reactor hold-down grid latch is opened, then the interlock associated with the grid latch will:

a. trip the primary pumps.
b. dump the reflector.
c. trip the D2O pumps.
d. initiate emergency core cooling.

Answer: C.18 a.
Reference: PM 2.7, p 3.

Question C.19 (1.00 point) {19.0}

Which of the following indications, will automatically actuate, outside of the control room when the 'trouble NW-12 gamma monitor' scam alarms.

a. A red light and a warning horn in operations office.
b. A blue light and a bell at the reception area.
c. A siren and backlighted signs in the containment building.
d. A horn in building NW12 and backlighted signs at entrances.

Answer: C.19 b.
Reference: AOP PM 5.6.4, RSM 7.6

Question C.20 (1.00 point) {20.0}

The reason for limiting cleanup system temperature to less than 50° C is to:

a. minimize gaseous release when sampling the primary.
b. prevent damage to the mixed-bed ion exchanger resin.
c. prevent coolant flashing when passing through filters.
d. limit the inaccuracy of the conductance probes, which are not temperature compensated.

Answer: C.20 b.
Reference: RSM, Page 3.3