March 11, 2011

Dr. John A. Bernard, Jr.
Director of Reactor Operations
Massachusetts Institute of Technology
Research Reactor
MITNRL-NW 12
138 Albany Street
Cambridge, MA 02139

SUBJECT: INITIAL EXAMINATION REPORT NO. 50-020/OL-11-01,
MASSACHUSETTS INSTITUTE OF TECHNOLOGY

Dear Dr. Bernard:

During the week of January 31, 2011, the NRC administered operator licensing examinations at your Massachusetts Institute of Technology reactor. The examinations were conducted according to NUREG-1478, "Operator Licensing Examiner Standards for Research and Test Reactors," Revision 2. Examination questions and preliminary findings were discussed 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 (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 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 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. Initial Examination Report No. 50-020/OL-11-01
2. Written examination comments with resolution.
3. Written examination with facility comments incorporated.

cc w/o enclosures: See next page

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DISTRIBUTION w/ encls.:
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RidsNRRDPRPRTB

ADAMS ACCESSION #: ML110560181 **TEMPLATE #:NRR-074**

OFFICE	PRTB:CE		IOLB:LA	E	PRTB:SC	
NAME	PYoung		CRevelle		JEads	
DATE	3/08/2011		3/09/2011		3/11/2011	

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-08-01

FACILITY DOCKET NO.: 50-20

FACILITY LICENSE NO.: R-37

FACILITY: MITR-II

EXAMINATION DATES: January 31 - February 2, 2011

SUBMITTED BY: _____**/RA/**_____ 3/8/11___
Phillip T. Young, Chief Examiner Date

SUMMARY:

During the week of January 31, 2011 the NRC administered licensing examinations to three RO applicants. All applicants passed these examinations.

REPORT DETAILS

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

2. Results:

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

3. Exit Meeting:
Phillip T. Young, Chief Examiner, NRC
Mr. Ed Lau, MIT, Reactor Superintendent (via phone on 2/09/2011)
Mr. Frank Warmsley, MIT, Training Supervisor

At the conclusion of the examinations the chief examiner thanked the facility for their support during the examinations. There were generic weaknesses noted in the Containment Ventilation System, Containment Air Lock door operating and seal systems and the backup battery system. The examiner thanked the facility for their comments on written exam questions A.007, B.015, B.019, C.003 and C.019.

ENCLOSURE 1

FACILITY COMMENTS WITH NRC RESOLUTION

Question A.007
Comment: We believe this question has the answer sheet incorrect as ‘a’ should be the only correct answer for this question.

NRC Resolution: Comment accepted, the exam was graded accepting ‘a’ as the correct answer.

Question B.015
Comment: This question has ‘c’ marked as the correct answer, however, we believe that ‘b’ could also be considered correct as a moveable sample is also non-secured. Suggestion is that the value of 1.5% $\Delta K/K$ be modified so as not to be an acceptable answer.
Additionally ‘c’ while correct leads to confusion in that corrosive liquids can be irradiated as long as they are doubly encapsulated which is done by the experimenter or the Irradiation Manager.

NRC Resolution: Comment accepted, the exam was graded accepting either ‘b’ or ‘c’ as correct.

Question B019
Comment: The question has ‘a’ marked as the correct answer, however, the difference in height is from the AVERAGE of the bank height and such it is possible to have a blade 3 inches in height from another blade and not violate that Technical Specification. We suggest that this question be removed from this year’s exam.

NRC Resolution: Comment accepted, the exam was graded with this question deleted.

Question C.003
Comment: This question refers to the old leak tape system of the reactor which has been replaced. We suggest that this question be removed from this year’s exam and future exams.

NRC Resolution: Comment accepted, the exam was graded with this question deleted.

Question C.019
Comment: This question has two correct answers. Answer ‘b’ is the correct answer as chosen in the exam, however, answer ‘c’ is also correct as there does not exist a second parallel sump pump.

NRC Resolution: Comment NOT accepted, the applicants are expected to know the configuration of facility systems. The exam was graded accepting only answer ‘b’.

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: 01/31/2011

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
19.00	33.3	_____	____	B. Normal and Emergency Operating Procedures and Radiological Controls
19.00	33.3	_____	____	C. Facility and Radiation Monitoring Systems
58.00		_____	____% 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.

Section A Reactor Theory, Thermo, and Facility Characteristic

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)
A 1/M plot is used to predict criticality during fuel bundle loading. From the data and graph provided below, criticality will occur after which fuel bundle is loaded?

a. 10th bundle
b. 12th bundle
c. 14th bundle
d. 15th bundle

Count Rate	# of Fuel Bundles
842	2
936	3
1090	5
1403	7
2406	9

Answer: A.001 b.
Reference: Glasstone, S. and Sesonske , 1991, §§ 3.161 — 3,163, pp. 190 & 191.

Question A.002 [1.0 point] (2.0)
Which one of the following statements is FALSE?

a. Xe-135 is produced both directly as a fission product and as the result of a decay chain from other fission products.

b. The removal rate of Xe-135 is due to the neutron absorption rate in Xe-135 atoms and due to the radioactive decay of Xe-135 atoms.

c. A good approximation for determining the production in a reactor core of Xe-135 is to assume that the Xe-135 is produced from the decay of Cs-135.

d. An increasing concentration in the reactor core of Xe-135 reduces the thermal utilization factor, f, and hence the multiplication factor, K_{eff}, of the reactor core.

Answer: A.002 c.
Reference: Glasstone, S. and Sesonske , 1991, §§ 5.56 — 5.80, pp. 250 — 260.

Section A Reactor Theory, Thermo, and Facility Characteristics

Question A.003 [1.0 point] (3.0)
Which ONE of the following describes the reactivity effect(s) that would occur if heavy water leaks from the reflector into the core periphery and into the core proper?

a. Only negative reactivity is added.

b. Only positive reactivity is added.

c. First negative then strongly positive reactivity is added.

d. First positive then strongly negative reactivity is added.

Answer: A.003 d.
Reference: RSM 10.9.2

Question A.004 [1.0 point] (4.0)
The temperature coefficient of reactivity for the MITR-II encompasses two (2) distinct phenomena. Both insert negative reactivity with an increase in temperature. Which is correct?

a. An increase in the light water temperature will insert negative reactivity by hardening the neutron spectrum.

b. An increase in the heavy water reflector temperature will insert positive reactivity by allowing more neutron leakage.

c. A decrease in the heavy water reflector temperature will insert negative reactivity by allowing more neutron leakage.

d. A decrease in the light water temperature will insert negative reactivity by hardening the neutron spectrum.

Answer: A.004 a.
Reference: RSM

Question A.005 [1.0 point] (5.0)
With a 30 second period, power would double in approximately:

a. 15 seconds

b. 21 seconds

c. 30 seconds

d. 60 seconds

Answer: A.005 b.
Reference: Glasstone, Nuclear Reactor Engineering, Chapter 5, Section 5.18;
MIT Reactor Physics Notes, Reactor Kinetics, Section 6 a Calculations.
P=PoE*t/T P=2Po 2=E*t/30 Ln2=t/30 0.693=t/30 t=20.8

Section A Reactor Theory, Thermo, and Facility Characteristic

Question A.006 [1.0 point] (6.0)
A source of delayed neutrons is from:

a. gamma interactions with structural materials.

b. alpha interactions with the reflector.

c. burnup of Xenon and Samarium.

d. decay of fission products.

Answer: A.006 d.
Reference: MIT Reactor Physics Notes, Reactor Kinetics

Question A.007 [1.0 point] (7.0)
During the neutron cycle from one generation to the next, several processes occur that may increase or decrease the available number of neutrons.
SELECT from the following the six-factor formula term that describes an INCREASE in the number of neutrons during the cycle.

a. Fast fission factor.

b. Thermal utilization factor.

c. Resonance escape probability.

d. Thermal non-leakage probability.

Answer: A.007 ~~d.~~ changed answer to a. per facility comment.
Reference: MIT Reactor Physics Notes, Reactor Startup and Subcritical Multiplication.

Question A.008 [1.0 point] (8.0)
The reactor has just been started up with power raised to 5 megawatts and rods are in auto control.
Which ONE of the following is the expected response of the regulating rod for the next half hour?

a. Drive in

b. Drive out

c. Not move

d. Drive out then back in

Answer: A.008 b.
Reference: MIT Reactor Physics Notes, Reactivity Feedback and Measurement of a Xenon Transient

Section A Reactor Theory, Thermo, and Facility Characteristics

Question A.009 [1.0 point] (9.0)
The reactor is shutdown by 0.05 ΔK/K, this would correspond to Keff of:

a. 0.9995.

b. 0.9524.

c. 0.7750.

d. 0.0500.

Answer: A.009 .b
Reference: Glasstone, S. and Sesonske, § 3.44, p. 149 & § 5.9, p. 231.
p=(k-1)/k; p= -0.05; -0.05k = k-1; 1 = k-(-0.05k) = k(1+0.05); k=1/1.05; k=0.9524

Question A.010 [1.0 point] (10.0)
A reactor is subcritical with a shutdown margin of 0.0526 ΔK/K. The addition of a reactor experiment increases the indicated count rate from 10 cps to 20 cps.

Which one of the following is the new Keff of the reactor?

a. 0.53

b. 0.90

c. 0.975

d. 1.02

Answer: A.010 c.
Reference: SDM = (1-Keff)/Keff Keff = 1/(SDM + 1) = 1/(.0526 + 1) Keff = .95
$CR_1/CR_2 = (1 - Keff_2) / (1 - Keff_1)$ 10/20 $= (1 - Keff_2) / (1 - 0.95)$
$(0.5) \times (0.05) = (1 - Keff_2)$ $Keff_2 = 1 - (0.5)(0.05) = 0.975$

Question A.011 [1.0 point] (11.0)
Which one of the following statements describes how fuel temperature affects the core operating characteristics?

a. Fuel temperature increase will decrease the resonance escape probability.

b. Decrease in fuel temperature will increase neutron absorption by U238 and Pu240.

c. Fuel temperature decrease results in Doppler Broadening of U238 and Pu240 resonance peaks and the decrease of resonance escape probability.

d. Fuel temperature increase results in Doppler Broadening of U238 and PU240 resonance peaks and the decrease of neutron absorption during moderation.

Answer: A.011 a.
Reference: Glasstone, S. and Sesonske, § 5.98, p. 264.

Section A Reactor Theory, Thermo, and Facility Characteristic

Question A.012 [1.0 point] (12.0)
The term "Shutdown Margin" describes:

a. the departure from Keff ≡ 1.00

b. the time required for the rods to fully insert

c. the amount of reactivity by which the reactor is subcritical

d. the amount of reactivity inserted by all the rods except the most reactive rod.

Answer: A.12 c.
Reference: Burn, R., Introduction to Nuclear Reactor Operations, © 1982, § 6.2.3, p. 3-4.

Question A.013 [1.0 point] (13.0)
The reactor is shutdown after an extended 24 hour run at 240 kilowatts. Which one of the following is the time it takes for the MAXIMUM Xenon concentration to be achieved?

a. 0 to 1 hours

b. 2 to 6 hours

c. 8 to 12 hours

d. 18 to 22 hours

Answer: A.013 b.
Reference: Burn, R., Introduction to Nuclear Reactor Operations, © 1988, §§ 8.1 —8.4, pp. 8-3 — 8-14.

Question A.014 [1.0 point] (14.0)
The MIT Reactor is operating at 5 MW and the reactor scram is set for 110% of full power. What will be the power at the time of the scram if a nuclear excursion creates a 0.5 second period and the scram delay time is 1.0 second after 110% is reached?

a. 9 MW

b. 15 MW

c. 32 MW

d. 40 MW

Answer: A.014 d.
Reference: $P_f = P_o$ et/T $P_f = 5.5$ MW e(1 sec/0.5 sec) = 40.6 MW

Section A Reactor Theory, Thermo, and Facility Characteristics

Question A.015 [1.0 point] (15.0)
The reactor has been operating at 100% power for the past 20 days. Which one of the following is the primary source of heat generation in the core 30 SECONDS following a reactor scram from 100% power?

a. Fission resulting from installed source neutrons.
b. Beta and gamma heating from fission decay products.
c. Fission from the longest lived delayed neutron precursors.
d. Beta and gamma heating from fission generated by installed neutron sources.

Answer: A.015 b.
Reference : Glasstone, S. and Sesonske, §§ 2.213 — 2.219, pp.122 — 125.

Question A.016 [1.0 point] (16.0)
Xenon and Samarium, have a marked effect on K_{eff} by decreasing which factor of the six factor formula?

a. L_T, the thermal non-leakage factor
b. h, the thermal reproductive factor
c. p, the resonance escape probability
d.. f, the thermal utilization factor

Answer: A.016 d
Reference: RSM 10-7

Question A.017 [1.0 point] (17.0)
What will the regulating rod do in automatic control if a void is replaced with water in the core?

a. Drive out adding positive reactivity.
b. Drive in adding positive reactivity.
c. Drive out adding negative reactivity.
d. Drive in adding negative reactivity.

Answer: A.017 d
Reference: RSM 10-9

Section A Reactor Theory, Thermo, and Facility Characteristic

Question A.018 [1.0 point] (18.0)
Delayed neutrons are born at _____ energies then prompt neutrons which leads to the effective delayed neutron fraction being _____ then the delayed neutron fraction.

a. higher; higher
b. higher; lower
c. lower; higher
d. lower; lower

Answer: A.018 c.
Reference: MITR II Reactor Physics Notes - Reactor Kinetics Section (c)

Question A.019 [1.0 point] (19.0)
Which ONE of the following will be seen when the reactor is at power between control rod 1 - a normal control rod; and control rod 2 - a control rod with twice as much poison content? (Assume that both rods are exposed to the same conditions - same core position and flux profile)
Control rod 2 will...

a. have twice the reactivity worth of control rod 1.
b. have half the reactivity worth of control rod 1.
c. last half as long as control rod 1.
d. last twice as long as control rod 1.

Answer: A.019 d.
Reference: MITR II Reactor Physics Notes - Reactor Feedback Section (1)

Section A Reactor Theory, Thermo, and Facility Characteristics

Question A.020 [1.0 point] (20.0)
Which ONE of the following atoms will cause a neutron to lose the most energy in an elastic collision?

a. U-238

b. Pb-208

c. C-12

d. H-1

Answer: A.020 d.
Reference: Glasstone and Sesonske, *Nuclear Reactor Engineering*, Chapter 3, Sect. 3.77

Section B Normal/Emergency Procedures & Radiological Controls

Question B.001 [1.0 point] (1.0)

Following an irradiation of a specimen, the resulting radioisotope is expected to equal 2,000 curies. The radioisotope will decay by the emission of two gamma rays per disintegration with energies of 1.10 Mev and 1.29 Mev. Which one of the following is the radiation exposure rate (R/hr) at one (1) foot from the specimen with no shielding?

a. 17,028 R/hr

b. 28,680 R/hr

c. 34,056 R/hr

d. 57,360 R/hr

Answer: B.001 b.
Reference: R = 6 C E n R = 6 (2000 ci) (1.10 + 1.29 Mev) (1 disintegration) = 28,680 R/hr

Question B.002 [1.0 point] (2.0)

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

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

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

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

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

Answer: B.002 b.
Reference: 10CFR20.1601(a)(3)

Question B.003 [1.0 point] (3.0)

Operator "A" works a standard forty (40) hour work week. His duties require him to work in a radiation area for (4) hours a day. The dose rate in the area is 10 mR/hour. Which one of the following is the MAXIMUM number of days Operator "A" may perform his duties without exceeding 10CFR20 limits?

a. 12 days

b. 25 days

c. 31 days

d. 125 days

Answer: B.003 d.
Reference: 10CFR20.1201(a)(1) [5000 mr x $\frac{1\ hr}{10\ mr}$ x $\frac{day}{4\ hr}$ = 125 days

Section B Normal/Emergency Procedures & Radiological Controls

Question B.004 [1.0 point] (4.0)

A safety function required by Technical Specifications as a Limiting Condition for Operation is to be temporarily bypassed (assume it is not a part of an approved procedure). Which one of the following statements is NOT a guideline to bypass the safety function as required by PM 1.9 "Bypass of Safety Functions and Jumper Control".

a. Such bypasses must be approved by Duty-Shift-Supervisor or Reactor Superintendent

b. Bypasses or jumpers may be installed for maintenance or testing purposes only when the reactor is shutdown.

c. If Jumpers are used, the jumper must be tagged and a warning tag is to be placed on the shim blade control handle.

d. If the reactor is to be operated with the bypass installed, a record of the authorizer's initial must be recorded on the bypass log.

Answer: B.004 d.
Reference: PM 1.9 pg. 1 of 2

Question B.005 [1.0 point] (5.0)

If the reactor core tank level is decreasing in a slow and uncontrollable manner such that level remains at the anti-syphon valves, what class of emergency would be declared?

a. General

b. Site Area

c. Alert

d. Event

Answer: B.005 c.
Reference PM 5.2.3 & PM 4.4.4.15

Section B Normal/Emergency Procedures & Radiological Controls

Question B.006 [1.0 point] (6.0)
In accordance with 10 CFR Part 50.54(x), under what conditions can an operator take reasonable action that departs from a license condition or a Technical Specification?

a. In any emergency.

b. In an emergency declared by the Emergency Director.

c. In an emergency, when the action is needed to protect health and safety and no other action is immediately apparent.

d. In an emergency declared by the Emergency Director along with the approval of the Senior Reactor Operator on site.

Answer: B.006 c.
Reference: 10CFR50.54 (x)

Question B.007 [1.0 point] (7.0)
The following measurements are made from a beta-gamma point source:
2 R/hr at six inches and 0.5 mR/hr at ten feet.

What are the relative fractions of betas and gammas emitted?

a. (1800/200) = 9

b. (2000/200) = 10

c. (1800/20) = 90

d. (2200/200) = 11

Answer: B.007 a.
Reference: Assume beta will not travel 10 feet in air, therefore 0.5 mr is gamma.
Gamma dose at ½ ft is: $(DR_1)(R_1^2) = (DR_2)(R_2^2) \rightarrow DR_2 = (DR_1)(R_1^2) / R_2^2$
$= 0.5 \text{ mr} \times 10 \text{ ft}^2 / 0.5 \text{ ft}^2 = 200 \text{ mr/hr}$
Therefore, beta contribution at ½ ft is 2000 - 200 = 1800 mr/hr.
Beta contribution/Gamma contribution = 1800/200 = 9

Section B Normal/Emergency Procedures & Radiological Controls

Question B.008 [1.0 point] (8.0)
At what core tank level would city water be utilized for emergency core cooling?

a. -48 inches
b. -52 inches
c. -36 inches
d. -72 inches

Answer: B.008 b.
Reference: RSM 3.2.7

Question B.009 [1.0 point] (9.0)
In accordance with Standard Operating Procedure PM 2.3.1, Normal Reactor Startup, what should be your immediate response if the reactor goes critical at a position more than 0.5 inches below the ECP?

a. Lower shim bank to subcritical interlock.
b. Lower the shim bank at least one inch.
c. Hold and recalculate ECP.
d. Shut down.

Answer: B.009 b.
Reference: PM 2.3.1

Question B.010 [1.0 point] (10.0)
The condition of “Notification of Unusual Event” encompasses all of the following **EXCEPT**:

a. No release of radioactive material requiring off-site response is expected.
b. There is time available to take precautionary corrective steps.
c. A significant hazard potential has been created.
d. The entire emergency organization is notified.

Answer: B.010 d.
Reference: MITR Training Program Sampling Category B:
Additional Questions, QUESTION #3

Section B Normal/Emergency Procedures & Radiological Controls

Question B.011 [1.0 point] (11.0)
When responding to a “High Level Radiation Monitor” alarm, which one of the following readings represents the minimum for notification of Unusual Event?

a. Stack Area Monitor reads 30 mR/h

b. Gaseous Monitor reads 6 kcpm

c. Stack Area Monitor reads 6 mR/h

d. Gaseous Monitor reads 30 kcpm

Answer: B.011 c.
Reference: PM 5.6.2

Question B.012 [1.0 point] (12.0)
A safety function required by Technical Specifications as a Limiting Condition for Operation is to be temporarily bypassed (assume it is not a part of an approved procedure). Which one of the following statements is NOT a guideline to bypass the safety function as required by PM 1.9 "Bypass of Safety Functions and Jumper Control".

a. Such bypasses must be approved by Duty-Shift-Supervisor or Reactor Superintendent

b. Bypasses or jumpers may be installed for maintenance or testing purposes only when the reactor is shutdown.

c. If Jumpers are used, the jumper must be tagged and a warning tag is to be placed on the shim blade control handle.

d. If the reactor is to be operated with the bypass installed, a record of the authorizer's initial must be recorded on the bypass log.

Answer: B.012 d.
Reference: PM 1.9 pg. 1 of 2

Section B Normal/Emergency Procedures & Radiological Controls

Question B.013 [1.0 point] (13.0)
If an experimenter suspects that he might be contaminated, according with the Contamination Control Measures in the Emergency Plan, what should he do?

a. Report directly to the Radiation Protection Office where he can be monitored.

b. Report directly to the MIT Radiation Protection Officer for assistance and then notify the control room.

c. Request that the control room contact the Radiation Protection Officer for assistance in decontamination.

d. Inform the person in charge of the experiment and report to the Director of Reactor Operations for monitoring.

Answer: B.013 c.
Reference: EOP 4.4.4

Question B.014 [1.0 point] (14.0)
Which one of the following may be described as a "Credible Accident Possibly Leading to an Off-Site Radiological Emergency" at MIT?

a. Loss of reactor shielding.

b. Blockage of fuel element channels.

c. Occurrence of a severe storm, flood, or earthquake.

d. Loss of coolant above the level of the anti-siphon valves.

Answer: B.014 b.
Reference: Chapter 4 (E-Plan) PM 4.5

Question B.015 [1.0 point] (15.0)
Which one of the following is a rule to be observed by personnel performing experiments in the MIT reactor

a. Combustible shall not be brought into the reactor building.

b. The total worth of all non-secured experiments is limited to 1.5% ΔK/K.

c. Corrosive liquids will not normally be irradiated in the reactor except when allowed by the Operations Superintendent.

d. The Operations Superintendent shall minimize the amount and concentration of Hydrochloric acid (HCl) irradiated in the reactor.

Answer: B.015 c. or b. per facility comment.
Reference: T.S. 6.1; PM 1.14.2

Section B Normal/Emergency Procedures & Radiological Controls

Question B.016 [1.0 point] (16.0)
Per Administrative Procedure 1.12, which ONE of the following is the lowest level of staff who may issue directives to an experimenter?

a. Any member of the operations staff.
b. All senior reactor operators on-site.
c. The experimenter's direct supervisor.
d. Only designated management staff members.

Answer: B.016 a.
Reference: Administrative Procedure 1.12

Question B.017 [1.0 point] (17.0)
What is the primary function of the "Weekend Open" selection on the intake damper control switch and when is it activated? When a high building vacuum alarm trips...

a. The ventilation will stop and the main intake damper will close; Done if the containment is to be secured and no personnel will be present.

b. The containment pressure relief system will be automatically activated; Done if the containment is to be secured and no personnel will be present.

c. The ventilation will stop and the main intake damper will close; Done if the containment is to be left unsecured and no personnel will be present.

d. The containment pressure relief system will be automatically activated; Done if the containment is to be left unsecured and no personnel will be present.

Answer: B.017 a.
Reference: PM 2.2 Pg. 9 of 11; RSM 9-20

Question B.018 [1.0 point] (18.0)
The technical specifications allow for the continued operation of the MITR-II under which ONE situation?

a. An inoperable control rod is fully inserted in the core.
b. H_2 concentration in the air space above the core is 4 volume percent.
c. The malfunction of an in-core experiment results in a reactivity insertion of 1.5 % $\Delta K/K$.
d. A surveillance check shows emergency power can supply backup power for 45 minutes.

Answer: B.018 c.
Reference: TS 3.2; TS 3.3.2; TS 3.1.1 & 6.1; TS 3.6

Section B Normal/Emergency Procedures & Radiological Controls

QUESTION DELETED PER FACILITY COMMENT.

~~**Question** B.019 [1.0 point] (19.0)~~

~~Which ONE of the following conditions requires immediate actions during normal reactor operations (Secondary is operating) as specified in the technical specifications?~~

~~a. The difference between the lowest and the highest blades in the banked positions is 3 inches.~~

~~b. The time from initiation of a scram signal to 80% of full insertion is 0.5 seconds for a shim blade.~~

~~c. One secondary water radiation monitor is inoperable.~~

~~d. D_2 concentration of 4% in the Helium blanket.~~

~~Answer: B.019 a.~~

~~Reference: TS 3.1.4~~

Question B.020 [1.0 point] (20.0)

Which ONE of the following interlocks is NOT required for medical therapy facility operations? Beam delivery control shutters:

a. cannot be opened unless the shield door is closed.

b. must be able to be closed from within the medical therapy facility.

c. must be able to be closed manually as well if they are pneumatically operated.

d. cannot be opened unless the console operator maintains control over the shutters.

Answer: B.020 d.

Reference: TS 6.5 (#5.a-f);

Section C Facility and Radiation Monitoring Systems

Question C.001 [1.0 point] (1.0)

What must be done in order to continue operation if a single plenum radiation monitor becomes inoperative due to a plugged flow line and the containment isolates?

a. Bypass by selecting a different plenum channel and restart ventilation.

b. Bypass affected channel using key switch and restart ventilation.

c. Replace plugged flow line and restart ventilation.

d. Operation is not allowed.

Answer: C.001 b.
Reference: PM 5.6.3

Question C.002 [1.0 point] (2.0)

Blowdown of the cooling tower basins is secured when the reactor is shutdown because:

a. secondary water monitors can no longer detect in-leakage.

b. it is no longer required when cooling tower spray is secured.

c. the efficiency of blowdown decreases without secondary flow.

d. the automatic makeup system is secured on reactor shutdown.

Answer: C.002 a.
Reference: RSM-7.6, Section 7.4.1

QUESTION DELETED PER FACILITY COMMENT EQUIPMENT NO LONGER IN USE.

~~**Question** C.003 [1.0 point] (3.0)~~

~~Which one of the following describes the operator action(s) required to determine the location of a leak in the D_2O Leak Detection System?~~

~~a. TV camera displays are viewed to check areas for leaks on receipt of a sump level detector alarm.~~

~~b. The neon lamp that is illuminated on the leak alarm console is compared to the leak tape location list.~~

~~c. The neon lamp that is illuminated on the leak alarm console is extinguished by depressing the pushbuttons above the light one at a time, then referring to the leak tape location list.~~

~~d. With more than one leak tape in the same channel shorted then an operator must be dispatched to the affected areas, since the alarm can not be cleared until the leak tapes are replaced.~~

~~Answer: C.003 c.~~
~~Reference: RSM-3.9, Section 3.3.6~~

Section C Facility and Radiation Monitoring Systems

Question C.004 [1.0 point] (4.0)
How do the airlocks maintain a gas tight seal?

a. Vacuum seals around all openings in the airlock

b. Negative pressure applied to the inside of the airlock

c. Solid metal construction that overlaps all penetrations in the airlock

d. Inflatable rubber gaskets around the seals of the doors in the airlock

Answer: C.004 d.
Reference: RSM 8-8

Question C.005 [1.0 point] (5.0)
At what level in the core tank are the anti-syphon valves located?

a. At the top of the core tank (at the top of the pool level)

b. At the top of the core shroud (primary coolant inlet level)

c. At the bottom of the core tank (below the reactor core level)

d. At the bottom of the core shroud (natural convection valve level)

Answer: C.005 b.
Reference: RSM 1-8

Question C.006 [1.0 point] (6.0)
What prevents the fuel elements from being carried out of the core by the water flow during reactor operation?

a. The heavy weight of the fuel elements (~8 lbs).

b. The hold-down grid plate, which is locked in place during reactor operations.

c. Sleek aerodynamic fins, which reduce the amount of drag on the surface of the fuel elements.

d. Grooves in the upper and lower grid that increase the coefficient of friction between the element and the grids.

Answer: C.006 b.
Reference: MITR-III SAR 4.2.5.2; RSM 1-5

Section C Facility and Radiation Monitoring Systems

Question C.007 [1.0 point] (7.0)
How is the regulating control rod attached to its rod drive during normal operations?

a. Welded
b. Shaft and pin
c. Electro-magnet
d. Solenoid gripper

Answer: C.007 a.
Reference: MITR-II RSM Pg. 1-11

Question C.008 [1.0 point] (8.0)
Which ONE of the following best describes the design of the fuel elements used in the MITR-II? (Neglect the notch on the element.)

a. The top and bottom are the same, and the element's sides can fit two ways into the grid plate.
b. The top and bottom are different, and the element's sides can fit two ways into the grid plate.
c. The top and bottom are the same, and the element's sides can only fit one way into the grid plate.
d. The top and bottom are different, and the element's sides can only fit one way into the grid plate.

Answer: C.008 a.
Reference: MITR-II RSM Pg. 1-5

Question C.009 [1.0 point] (9.0)
Which ONE of the following is TRUE, at full power, regarding the vertical thimbles in the graphite reflector?

a. There are a total of 8 vertical thimbles in the graphite reflector.
b. A Nitrogen gas purge is used to reduce the production of Ar-41.
c. The cooling water in the thimbles is provided by the shield coolant system.
d. The thimbles are designed to accommodate sample removal during reactor operations.

Answer: C.009 c.
Reference: MITR-II RSM Pg. 2-8

Section C Facility and Radiation Monitoring Systems

Question C.010 [1.0 point] (10.0)
What type of detector is used in the reactor floor Argon-41 monitor?

a. Geiger-Mueller
b. βeta Scintillation
c. Ionization chamber
d. Proportional counter

Answer: C.010 a
Reference: MITR-II RSM Pg. 7-7

Question C.011 [1.0 point] (11.0)
Which ONE of the following temperature measuring devices utilizes the presence of a temperature difference that can be seen by the voltage generated between two dissimilar metals?

a. Capillary tube type thermoswitch unit
b. Resistance temperature detector
c. Bimetallic thermometer
d. Thermocouple

Answer: C.010 d.
Reference: MITR-II RSM Pg. 6-3

Question C.012 [1.0 point] (12.0)
Which ONE of the following conditions in the thermal shield cooling system will cause a SCRAM of the reactor?

a. Low pressure
b. High pressure
c. Low temperature
d. High temperature

Answer: C.012 a.
Reference: MITR-II RSM Pg. 6-35

Section C Facility and Radiation Monitoring Systems

Question C.013 [1.0 point] (13.0)
Which of the following is the method by which gamma-ray compensation is accomplished in the nuclear instrumentation compensated ion chambers. Gamma-ray compensation is accomplished by:

a. varying the pressure of the detector Argon charge gas in conjunction with a low boron concentration coating the inside walls of the outer chamber.

b. the comparison of the currents generated in two concentric chambers in the detector, one sensitive only to gammas and one sensitive to neutrons and gammas.

c. a pulse height discriminator that eliminates (or discriminates) the pulses from the low energy gammas and allows only the higher energy neutron signals through.

d. varying the amount and concentration of the boron trifluoride gas in the compensated ion chamber thus reducing the detector's sensitivity to gamma induced ionizations.

Answer: C.013 b.
Reference: RSM-5.2.2

Question C.014 [1.0 point] (14.0)
Which ONE of the following actions should be performed to determine if the ion column resin is exhausted?

a. Measure the inlet and outlet ion column conductivities, if both are increasing then the ion column is exhausted.

b. Determine if the temperature of the ion column has reached 53 degrees C, if so then the ion column is exhausted.

c. Bypass the ion column flow and if the primary coolant conductance increases then the ion column is not exhausted.

d. Measure the differential pressure drop across the ion column, if normal then the ion column resin is not exhausted.

Answer: C.014 a.
Reference: PM 5.2.12

Section C Facility and Radiation Monitoring Systems

Question C.015 [1.0 point] (15.0)
The voltage scrams associated with the nuclear instruments are set to trip if:

a. console power is lost.

b. compensating voltage is lost.

c. the voltage becomes too high, driving the detector into the continuous discharge region.

d. the voltage drops below the value required to maintain the detector in the ion chamber plateau region.

Answer: C.015 d.
Reference: PM 5.1.5 and MIT Notes on Nuclear Instrumentation, Sections 5.3, 5.4

Question C.016 [1.0 point] (16.0)
During startup, after channel 3 starts reading you must shift channels 1 and 2 from their fission chamber inputs to their ion chamber inputs. How do you do this? For the channel you _____ the overall gain and for the fission chamber you ____ the discriminator setting.

a. Increase, Increase

b. Increase, Decrease

c. Decrease, Increase

d. Decrease, Decrease

Answer: C.016 c.
Reference: MITR-II Reactor Systems Manual, § 5.3.1, p 5.5

Question C.017 [1.0 point] (17.0)
Which one of the following loads on Electrical Panel #1 will shift to emergency power on a loss of normal power?

a. Startup Channels

b. Recombiner Heaters

c. Medical Therapy Control Panel

d. Recorders, Clock and Front Panel Outlets

Answer: C.017 d.
Reference: MITR-II Reactor Systems Manual Table 8-8B, p. 8.34

Section C Facility and Radiation Monitoring Systems

Question C.018 [1.0 point] (18.0)
Which one of the following is correct with respect to maintaining the D_2O reflector dump valve closed when air compressor CM-2 is tagged out for maintenance?

a. As long as solenoid valves CV-90 and CV-91 remain as is, the dump valve will remain shut.

b. When air in the header decreases below 95 psig, a check valve will open supplying air from the backup air receiver.

c. On a low pressure signal a solenoid valve will automatically shift the dump valve air supply to a bank of air cylinders.

d. A dedicated air receiver just upstream of CV-90 and CV-91, contains sufficient air volume to maintain the dump valve shut for eight hours.

Answer: C.018 b.
Reference: MITR-II, Reactor Systems Manual, § 8.6.2, p. 8-27.

Question C.019 [1.0 point] (19.0) Facility comment not accepted.
Which ONE of the following statements concerning interlocks associated with the Liquid Waste System is INCORRECT?

a. On a high sump level signal, the inlet city water solenoid valve will close.

b. On a high Waste Tank level in one tank, both sump pumps will be shut off.

c. On a high sump level signal a second parallel sump pump will automatically start.

d. On a high Waste Tank level in one tank, the inlet city water solenoid valve will close.

Answer: C.019 b.
Reference: MITR-II Reactor Systems Manual, § 8.5 p. 8.24.

Question C.020 [1.0 point] (20.0)
The ventilation system filtering unit (coarse and absolute filters) is located …

a. after the stack exhaust fans.

b. at the entrance to the plenum.

c. before the fast-closing exhaust butterfly damper.

d. before the two inlet bleeder ducts for the stack exhaust fan.

Answer: C.020 d.
Reference: MITR-II RSM pg. 9-21