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

REPORT NO.: 50-020/OL-95-01

FACILITY DOCKET NO.: 50-020

FACILITY LICENSE NO.: R-37

FACILITY: Massachusetts Institute of Technology

EXAMINATION DATES: September 5-6, 1995

EXAMINER: Patrick J. Isaac, Chief Examiner

SUBMITTED BY: Patrick J. Isaac, Chief Examiner — 10/2/95 Date

APPROVED BY: Anthony J. Mendiola, Deputy Chief — 10/5/95 Date
Operator Licensing Branch
Division of Reactor Controls
and Human Factors
Office of Nuclear Reactor Regulation

SUMMARY:

During the week of September 5, 1995, the NRC administered Operator Licensing Examinations to three Reactor Operator (RO) and three Senior Reactor Operator Instant (SROI) candidates. All candidates passed the examinations.

ENCLOSURE 1

REPORT DETAILS

1. Examiners:

   Patrick J. Isaac, Chief Examiner
   Paul V. Doyle

2. Results:

	RO (Pass/Fail)	SRO (Pass/Fail)	Total (Pass/Fail)
NRC Grading:	3/0	3/0	6/0

3. Written Examination:

   The NRC administered written examinations to three RO and three SROI candidates. A copy of the master "as given" examination with answer key was forwarded to the licensee's training staff for their formal review.

   During the conduct of the examination, the NRC examiner realized that question B-04 could not be answered correctly and he informed the candidates to disregard the question. Question B-04 was deleted from the examination. The examiner also informed the candidates to make a typographical correction to question C-17.

4. Operating Tests:

   The NRC administered operating tests to three RO and three SROI candidates. All six candidates passed this portion of the examination.

5. Exit Meeting:

   Patrick Isaac, NRC, Chief Examiner
   Paul Doyle, NRC Examiner
   Dr. John Bernard, MIT, Director of Reactor Operations
   Edward S. Lau, MIT, Superintendent for Reactor Operations
   Thomas Newton, MIT, Asst. Superintendent for Engineering
   Frank Warmsley, MIT, Operations Coordinator

   The exit meeting was conducted on September 6, 1995. The facility examination comments were discussed as noted in Enclosure 2.

   The NRC thanked the MIT staff for their efforts in support of the examination.

NRC RESOLUTIONS - WRITTEN EXAMINATION

Question A-13:

Which one of the following describes the reactivity effect and associated reason if heavy water was mixed with the light water reflector?

a. negative reactivity due to higher moderating power of heavy water.

b. positive reactivity due to the higher absorption cross-section of light water.

c. negative reactivity due to the higher moderating power of light water.

d. positive reactivity due to the higher absorption cross-section of heavy water.

Answer: b

Facility Comment:

The small light water region surrounding the core is not normally referred to as the reflector (the term "reflector" refers to the larger heavy water region surrounding the core tank). Thus, there was considerable confusion as to the meaning of the question. We suggest this question be removed.

NRC Resolution:

Comment accepted. Your Reactor System Manual, page RSM-10.11, refers to the light water region above the top of the core as a reflector. The staff understand the possible confusion if the term "reflector" is not normally used to describe the light water region above the top of the core. The staff agrees to delete this question from the examination.

Question B-17:

The fuel management pattern of the MITR-II usually calls for refueling (following operation at full power for a long period of time) when the shim bank position reaches 16 inches. Approximately what is the core excess reactivity at this time?

a. Approximately 200 mbeta of excess reactivity

b. Approximately 0.2 Beta of excess reactivity

c. Approximately 1 Beta of excess reactivity

d. Approximately 2 Beta of excess reactivity

Answer: d

Facility Comment:

According to the blade worth curves, the excess reactivity is about 1 Beta with the blades at 16.00 inches. However an old NRC exam (with the answer of 2 Beta) had been studied by several of the trainees. Therefore both answers (c) and (d) should be counted as correct.

NRC Resolution:

The staff understands that, with the blades at 16 inches, the excess reactivity is about 1 Beta. The only correct answer is "c".

The answer key will be modified to reflect "c" as the correct answer.

Question C-03:

Which one of following radiation monitors is most affected by the use of the Blanket Test Facility?

a. Gaseous and Particulate Plenum Monitors

b. Argon-41 Monitor

c. Area Monitors and Containment Vault

d. Secondary Coolant Water Monitors

Answer: d

Facility Comment:

Although the secondary coolant water monitors show the highest rise, both the Argon-41 monitor and secondary coolant water monitors are fully affected by use of the Blanket Test Facility. Therefore both answers (b) and (d) should be counted as correct.

NRC Resolution:

Comment accepted. The answer key will be modified to reflect both "b" and "d" as correct.

Question C-05:

Match the facility conditions in Column I with the type of automatic 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)

a. Core tank level 2 inches below overflow pipe.

b. Shield coolant flow equals 55 gpm.

c. Reactor outlet temperature equals 50 °C.

d. Reactor building vacuum equals 1.2 inches water above atmospheric.

e. Primary cleanup system temperature equals 52 °C.

f. D_2O flow equals 88 gpm.

g. Core Purge flow equals 3.0 cfm

h. Secondary Water Monitor sample flow equals 1 gpm

Column II (Automatic Response)

1. Alarm ONLY.
2. Rod withdrawal inhibited.
3. Scram.
4. No safety system response

Answer: a. 2 b. 3 c. 4 d. 2

e. 1 f. 3 g. 1 h. 1

Facility Comment:

Given that the reactor is critical as stated in the problem, there would be no inhibition of rod withdrawal. So conditions (Column I) (a) and (d) would only give an alarm (Answer (1) in Column II). However, these conditions do cause an inhibition of rod withdrawal with the blades fully inserted (i.e., prior to depression of the reactor start pushbutton), so both answers (1) and (2) are acceptable for conditions (a) and (d).

Also, condition (g) is exactly on the alarm set point, so answers (1) and (4) in Column II would both be acceptable.

NRC Resolution

Comment accepted. For conditions (a) and (d) the answer key will be modified to accepted both (1) and (2) as correct. For condition (g), the answer key will be modified to accept both (1) and (4) as correct.

Question C-12:

Match the location or feature from Column I with the gas from Column II which is used as a cover or operating fluid. 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. Carbon Dioxide
b.	Lead shutter region gas box	2. Argon
c.	Vertical Thimbles	3. Air
d.	Thermal Column	4. Helium
		5. Nitrogen

Answer: a. 4 b. 1 c. 1 d. 1

Facility Comment:

The graphite reflector cover gas was replaced with CO_2 in 1989. Therefore, the correct answer to item (a) of Column I is item (1) of Column II.

NRC Resolution:

Comment accepted. The answer key will be modified to accept item (1) as the correct answer to (a).

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

FACILITY: MIT

REACTOR TYPE: MITR-II

DATE ADMINISTERED: 1995/09/05

REGION: 1

CANDIDATE: ______________________

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

CATEGORY VALUE	% OF TOTAL	CANDIDATE'S SCORE	% OF CATEGORY VALUE		CATEGORY
19.00	33.3	________	________	A.	REACTOR THEORY, THERMODYNAMICS AND FACILITY OPERATING CHARACTERISTICS
19.00	33.3	________	________	B.	NORMAL AND EMERGENCY OPERATING PROCEDURES AND RADIOLOGICAL CONTROLS
20.00	33.3	________	________	C.	PLANT 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 not received or 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.

6. Fill in the date on the cover sheet of the examination (if necessary).

7. Print your name in the upper right-hand corner of the first page of each section of your answer sheets.

8. Before you turn in your examination, consecutively number each answer sheet, including any additional pages inserted when writing your answers on the examination question page.

9. The point value for each question is indicated in brackets after the question number.

10. Partial credit will NOT be given.

11. If the intent of a question is unclear, ask questions of the examiner only.

12. When you are done and have turned in your examination, leave the examination area as defined by the examiner. If you are found in this area while the examination is still in progress, your license may be denied or revoked.

EQUATION SHEET

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

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

$$\ell^* = 1 \times 10^{-4} \text{ seconds}$$

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

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

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

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

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

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

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

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

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

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

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

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

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

$$T_{½} = \frac{0.693}{\lambda}$$

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

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

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

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

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

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

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.1) [1.0]
Shortly after a reactor trip, reactor power indicates 0.5% where a stable negative period is attained. Reactor power will be reduced to 0.05% in approximately _______ seconds.

a. 90

b. 180

c. 270

d. 360

QUESTION (A.2) [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?

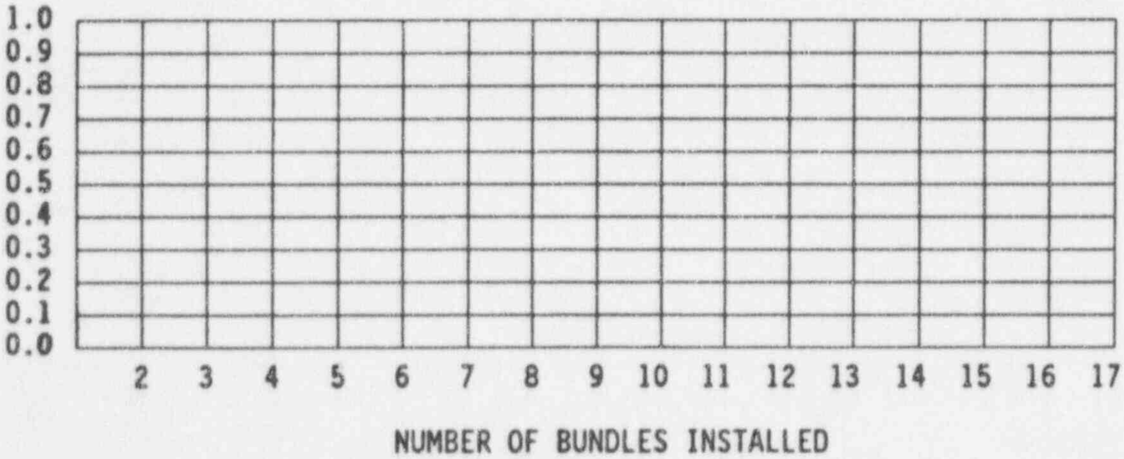
a. 10th bundle

b. 12th bundle

c. 14th bundle

d. 15th bundle

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



QUESTION (A.3) [1.0]
An initial count rate of 100 is doubled five times during startup. Assuming an initial K_{eff} = 0.950, what is the new K_{eff}?

a. 0.957

b. 0.979

c. 0.988

d. 0.998

QUESTION (A.4) [1.0]
Which one of the following is [illegible]XIMUM amount of reactivity that can be promptly inserted into the reac[illegible] WITHOUT causing the reactor to go "Prompt Critical"?

a. 100 mβ

b. 500 mβ

c. 750 mβ

d. 1900 mβ

QUESTION (A.5) [1.0]
The reactor is shutdown by 0.05 $\Delta K/K$, this would correspond to K_{eff} of:

a. 0.9995.

b. 0.9524.

c. 0.7750.

d. 0.0500.

QUESTION (A.6) [1.0]
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.

QUESTION (A.7) [1.0]
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 K_{eff} of the reactor?

a. .53

b. .90

c. .975

d. 1.02

QUESTION (A.8) [1.0]
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. Fuel temperature decrease results in Doppler Broadening of U238 and Pu240 resonance peaks and the decrease of resonance escape probability.

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

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

QUESTION (A.9) [1.0]
Which statement illustrates a characteristic of Subcritical Multiplication?

a. As K_{eff} approaches unity (1), for the same increase in K_{eff}, a greater increase in neutron population occurs.

b. The number of neutrons gained per generation gets larger for each succeeding generation.

c. The number of fission neutrons remain constant for each generation.

d. The number of source neutrons decreases for each generation.

QUESTION (A.10) [1.0]
Select the statement that describes why neutron sources are used in reactor cores.

a. Increase the count rate by an amount equal to the source contribution.

b. Increase the count rate by 1/M (M = Subcritical Multiplication Factor).

c. Provide the source neutrons to initiate the chain reaction when first starting-up the reactor.

d. Provide a neutron level high enough to be monitored by source range instrumentation.

QUESTION (A.11) [1.0]
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% $\Delta K/K$

b. 0.16% $\Delta K/K$

c. 0.18% $\Delta K/K$

d. 0.20% $\Delta K/K$

QUESTION (A.12) [1.0]
The term "Shutdown Margin" describes:

a. the time required for the rods to fully insert

b. the departure from $K_{eff} = 1.00$

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.

QUESTION (A.13) [1.0] **DELETED**
Which one of the following describes the reactivity effect and associated reason if heavy water was mixed with the light water reflector?

a. negative reactivity due to higher moderating power of heavy water.

b. positive reactivity due to the higher absorption cross-section of light water.

c. negative reactivity due to the higher moderating power of light water.

d. positive reactivity due to the higher absorption cross-section of heavy water.

QUESTION (A.14) [1.0]
Assuming the Samarium worth is 0.006 ΔK/K at full power, which one of the following is the Samarium worth 10 days after shutdown from full power?

a. Essentially zero.

b. It increases by a factor of 2.

c. Less than 0.006 ΔK/K but greater than zero.

d. Greater than 0.006 ΔK/K

QUESTION (A.15) [1.0]
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.

QUESTION (A.16) [1.0]
Which one of the following figures most closely depicts the reactivity versus time plot for xenon for the following series of evolutions:

TIME	EVOLUTION
1	500 KW startup, clean core;
2	Operation at 500 KW for 24 hours;
3	Shutdown for 15 hours;
4	250 Kw for 12 hours.

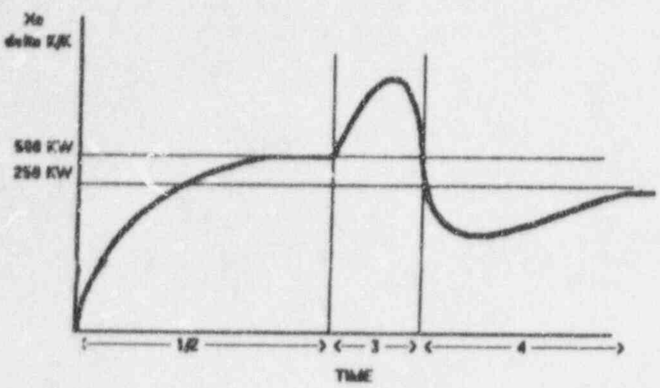
a. a

b. b

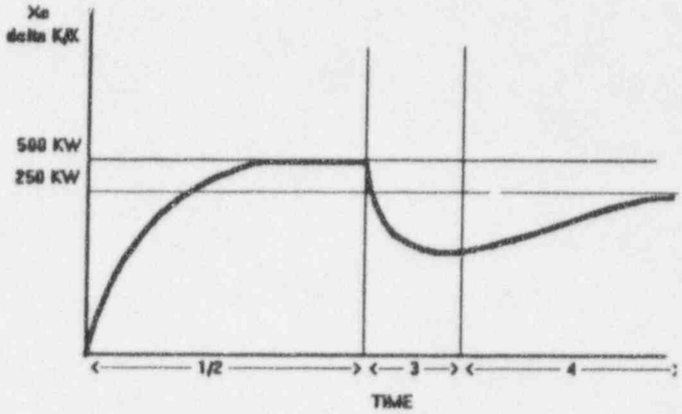
c. c

d. d

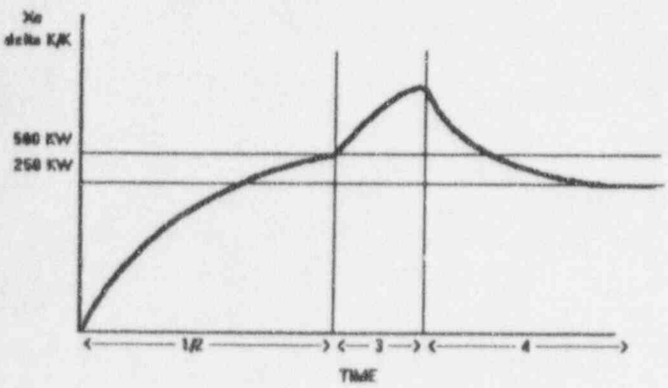
(See attached figures on following page for choice selections.)


Xe
delta K/K
500 KW
250 KW
1/2
3
4
TIME

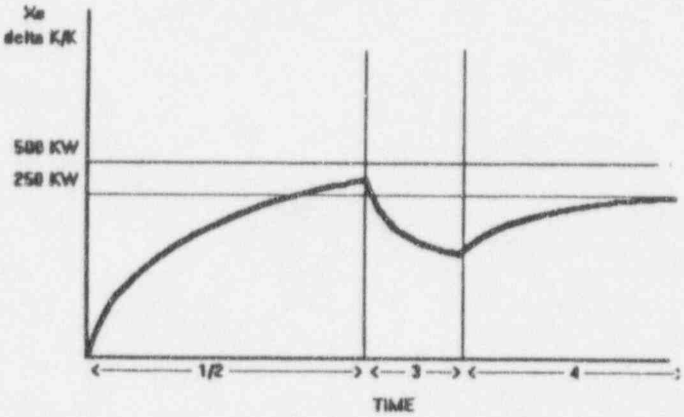
a


Xe
delta K/K
500 KW
250 KW
1/2
3
4
TIME

b


Xe
delta K/K
500 KW
250 KW
1/2
3
4
TIME

c


Xe
delta K/K
500 KW
250 KW
1/2
3
4
TIME

d

QUESTION (A.17) [1.0]
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

QUESTION (A.18) [1.0]
Which ONE of the following is the reason why it takes approximately 24 hours of constant power operation before thermal equilibrium is attained in the MITR-II reactor?

a. The time required for equilibrium Xenon and Samarium conditions to be established.

b. The time required for the large volume of the Deuterium tank to heat up.

c. The graphite reflector has a large heat capacity and is slow to reach equilibrium temperature distribution.

d. The shield coolant system has a small flowrate to accomplish adequate mixing before temperature is uniformly stabilized.

QUESTION (A.19) [1.0]
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 <u>30 SECONDS</u> following a reactor scram from 100% power?

a. Fission from the longest lived delayed neutron precursors.

b. Fission resulting from installed source neutrons.

c. Beta and gamma heating from fission decay products.

d. Beta and gamma heating from fission generated by installed neutron sources.

QUESTION (A.20) [1.0]
Which one of the following statements is FALSE?

a. 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.

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

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. 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.

(*** End of Section A ***)

QUESTION (B.1) [1.0]
During reactor operation, there is an unanticipated negative reactivity addition to the core from an unknown source. Which one of the following describes the required immediate actions, per the appropriate Emergency Operating Procedure?

a. Manually scram the reactor.

b. Take manual control of the reactor and maintain steady power.

c. Take manual control of the reactor and do NOT add any positive reactivity.

d. Allow the reactor to scram automatically on power-set/actual power deviation.

QUESTION (B.2) [1.0]
Administrative controls for rabbit irradiations state that all samples after irradiation must be handled by tongs. Which one of the following is the reason there must be no direct contact with fingers on the irradiated container or samples?

a. high gamma radiation

b. high beta radiation

c. to prevent the spread of contamination

d. high probable surface temperature of polyethylene container.

QUESTION (B.3) [1.0]
Which one of the following Film Badge colors identifies the wearer as someone who is permitted to escort members of the general public through the reactor building?

a. Blue

b. Red

c. Yellow

d. Green

QUESTION (B.4) [1.0] **DELETED**
You wish to store a small radioactive source temporarily in the reactor building. The source strength is estimated to be 5 curies and it emits gamma rays of an average energy of 1.3 Mev. Assuming no shielding is to be used, a Radiation Area barrier would have to be erected from the source at a distance of approximately:

a. 3 feet

b. 6 feet

c. 8 feet

d. 12 feet

QUESTION (B.5) [1.0]
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. Equip the room with a device to visually display the current dose rate within the room.

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

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

QUESTION (B.6) [1.0]
Based on 10CFR55, which one of the following is the MINIMUM requirement that must be met to retain an "active" license?

a. Must perform license duties at least 4 hours per calendar quarter.

b. Must perform license duties a minimum of 8 hours per month.

c. Must perform license duties a minimum of 5 eight-hour shifts per calendar quarter.

d. Must perform license duties at least 40 hours per calendar year.

QUESTION (B.7) [1.0]
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

QUESTION (B.8) [1.0]
A 4 inch thickness of steel reduces a gamma radiation dose rate from 60 mrem/hr to 6 mrem/hr. What is the dose rate if an additional 1 inch thickness of steel is added?

a. 0.56 mrem/hr

b. 1.50 mrem/hr

c. 2.62 mrem/hr

d. 3.37 mrem/hr

QUESTION (B.9) [1.0]
A reactor containment evacuation is required. The Reactor Operator performs the Immediate Actions necessary to evacuate personnel from Containment. If the radiation level in the control room is 150 mrem/hr, what is the Reactor Operator's MAXIMUM stay time?

a. 40 minutes

b. 3.2 hours

c. 6.7 hours

d. 13.3 hours

QUESTION (B.10) [1.0]
Which one of the following statements is <u>NOT</u> a violation of Technical Specifications?

a. Operating with one inoperable shim blade fully inserted.

b. Reactor power is 2 MW, one primary pump in service, and the total coolant flow rate is 1000 gpm.

c. Reactor power is 150 kW with the emergency cooling system inoperable.

d. Reactor power is 100 kW and emergency power is not available.

QUESTION (B.11) [1.0]
Per Technical Specifications, what is the maximum allowed power level if a Pu-Be source is in the core?

a. 100 W

b. 500 W

c. 100 kW

d. 250 kW

QUESTION (B.12) [1.0]
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.

QUESTION (B.13) [1.0]
Which one of the following statements regarding reactor operations is TRUE?

a. Reactor operations may continue if a required member of the shift must leave for emergency personal problems. An adequate replacement shall be secured as soon as possible.

b. If a reactor startup is scheduled for 3.00 PM, the morning surveillance checksheet shall be completed at least 1 hour prior to the startup.

c. Work shall not be conducted in the reactor building unless a reactor supervisor or a reliable person appointed by a reactor supervisor is present at the facility.

d. The shift supervisor may grant permission to an experimenter to irradiate acids or other corrosive liquids.

QUESTION (B.14) [1.0]
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. Bypasses or jumpers may be installed for maintenance or testing purposes only when the reactor is shutdown.

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

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

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.

QUESTION (B.15) [1.0]
Which one of the following statements is a requirement when performing maintenance on a system that could jeopardize personnel safety?

a. Circuit breakers should be padlocked open and the person who will be performing the work shall retain the key to the padlock on his person until completion of the work.

b. Tags may be removed by any member of the NRL/RPO staff. If there is doubt as to whether the tag should be cleared, the Operator-in-Charge should be consulted.

c. The on-duty console operator or a licensed operator shall observe the performance of the system lock out and verify that the system is in a safe condition.

d. Any member of the NRL/RPO staff including electronics and maintenance may remove lockouts when under the direction of a licensed senior operator.

QUESTION (B.16) [1.0]
If an experimenter suspects that he might be contaminated, according with the Contamination Control Measures in the Emergency Plan, what should he do?

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

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

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

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

QUESTION (B.17) [1.0]
The fuel management pattern of the MITR-II usually calls for refueling (following operation at full power for a long period of time) when the shim bank position reaches 16 inches. Approximately what is the core excess reactivity at this time?

a. Approximately 200 mbeta of excess reactivity

b. Approximately 0.2 Beta of excess reactivity

c. Approximately 1 Beta of excess reactivity

d. Approximately 2 Beta of excess reactivity

QUESTION (B.18) [1.0]
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

QUESTION (B.19) [1.0]
In response to a "COOLING TOWER FANS OFF" alarm an attempt to restart the fans was unsuccessful. With the reactor operating at 4 MW the immediate action required is to:

a. perform a minor scram.

b. perform a major scram.

c. shut the secondary blowdown valves and monitor primary coolant flow.

d. depress the "ALL RODS IN" pushbutton and lower power to 1 MW or less.

QUESTION (B.20) [1.0]
During continuous power operation with the automatic control system it may be necessary for the operator to reshim the control blades to maintain the regulating rod within its useful range.

Which ONE of the following describes the requirements associated with this reshim of control blades?

a. Reactor power is to be maintained within 2.5% of the desired level while reshimming.

b. All shim blades must be maintained within 2.5 inches of each other during the reshim and within 1.0 inch following the reshim.

c. The first motion of any control absorber during a reshim should be inward so as to lower reactor power.

d. The duty supervisor must approve all reshims prior to performance.

(*** End of Section B ***)

QUESTION (C.1) [1.0]
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.

QUESTION (C.2) [1.0]
During refueling of the core the indicated neutron level has increased by a factor of 2.5. Which ONE of the following operator actions is required to be taken?

a. Evacuate personnel from the reactor top.

b. Dump the reflector, if not already dumped.

c. Notify Radiation Protection to perform a radiation survey of the reactor top area.

d. Notify personnel on the reactor top to insert a dummy element in place of the fuel element just removed.

QUESTION (C.3) [1.0]
Which one of following radiation monitors is most affected by the use of the Blanket Test Facility?

a. Gaseous and Particulate Plenum Monitors

b. Argon-41 Monitor

c. Area Monitors and Containment Vault

d. Secondary Coolant Water Monitors

QUESTION (C.4) [1.0]
Which ONE of the following describes the operator action(s) required to determine the location of a leak in the D2O Leak Detection System?

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

b. 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.

c. 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.

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

QUESTION (C.5) [2.0, 0.25 each]
Match the facility conditions in Column I with the type of automatic 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 (Automatic 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 °C.	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 °C.	
f. D_2O flow equals 88 gpm.	
g. Core Purge flow equals 3.0 cfm	
h. Secondary Water Monitor sample flow equals 1 gpm	

QUESTION (C.6) [1.0]
The MITR-II is operating at 4.9 MW. Due to higher than normal radioactivity in the off-gas system, the space above the primary water pool is isolated. Which one of the following describes subsequent operations?

a. H_2 analysis shall be performed every hour. When greater than 1.5% [H_2], reactor power should be reduced to less than 1 MW to prevent H_2 concentration from exceeding the T.S. limit of 3.5%.

b. H_2 analysis shall be performed every 1.5 hours. When greater than 1.0% [H_2], reactor power should be reduced to less than 200 kW to prevent H_2 concentration from exceeding the T.S. limit of 3.5%.

c. H_2 analysis shall be performed every hour. When greater than 1.5% [H_2], reactor power should be reduced to less than 1 MW to prevent H_2 concentration from exceeding the T.S. limit of 4.1%.

b. H_2 analysis shall be performed every 1.5 hours. When greater than 1.0% [H_2], reactor power should be reduced to less than 200 kW to prevent H_2 concentration from exceeding the T.S. limit of 4.1%.

QUESTION (C.7) [1.0]
Why is blowdown of the cooling tower basins required to be secured whenever the reactor is shutdown?

a. The secondary water monitors cannot detect leakage when the reactor is shutdown due to short-lived isotopes.

b. Secondary system level cannot be adequately measured when shutdown due to thermal expansion during operation.

c. Shutdown cooling system efficiency may be adversely affected due to blowdown.

d. The cooling tower level detectors and automatic makeup system is not energized when the reactor is shutdown.

QUESTION (C.8) [1.0]
If during an accident the Containment Building begins to approach its design pressure, what design feature provides for containment protection?

a. A pressure relief blower automatically initiates at 2.0 psig.

b. A containment relief valve will automatically open at 1.75 psig.

c. A manually operated relief valve may be opened to protect containment.

d. The main damper will cycle open and closed to maintain containment pressure less than 1.75 psig.

QUESTION (C.9) [1.0]
Which one of the following statements describes the limitations imposed on the D_2 concentration and recombiner operation? To ensure that the D_2 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 <200 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 <500 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.

QUESTION (C.10) [1.0]
Which one of the following statements is <u>NOT</u> a purpose of the D_2O helium cover gas system?

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

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

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

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

QUESTION (C.11) [1.0]
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 °C?

a. 30 seconds

b. 6 minutes

c. 45 minutes

d. 120 minutes

QUESTION (C.12) [2.0, 0.5 each]
Match the location or feature from Column I with the gas from Column II which is used as a cover or operating fluid. 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. Carbon Dioxide
b. Lead shutter region gas box	2. Argon
c. Vertical Thimbles	3. Air
d. Thermal Column	4. Helium
	5. Nitrogen

QUESTION (C.13) [1.0]
With a nominal battery load of 72 amps, the Emergency Power Distribution System batteries have the capacity to supply power to selected instruments and pumps for approximately (______) following the loss of both external electrical power feeders.

a. 2 hour

b. 4 hours

c. 6 hours

d. 8 hours

QUESTION (C.14) [1.0]
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 Sump pumps trip.

d. The on-line Sewer pump trips.

QUESTION (C.15) [1.0]
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 that normal.

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

d. Core purge flow reads 5 cfm.

QUESTION (C.16) [1.0]
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.

QUESTION (C.17) [1.0]
Rod withdrawal times are measured at least annually. The blade system must be adjusted if the time to withdraw a blade a distance of 8.5 inches is measured to be other than:

a. 7 minutes ± 1%

b. 5 minutes ± 10%

c. 2 minutes ± 10%

d. 1 minutes ± 10%

QUESTION (C.18) [1.0]
Which one of the following sensors uses a flow nozzle?

a. Shield flow PF-1.

b. Primary flow MF-1

c. Secondary flow HF-1A

d. Reflector flow DF-1

(*** End of Section C ***)

ANSWER (A.1)
b
REFERENCE (A.1)
Glasstone, S. and Sesonske, A, Nuclear Reactor Engineering, Kreiger Publishing, Malabar, Florida, 1991, § 5.47, p. 246.
Lamarsh, J.R., Introduction to Nuclear Engineering, Addison-Wesley Publishing, Reading, Massachusetts, 1983. § 7.1, p. 289.

ANSWER (A.2)
b
REFERENCE (A.2)
Glasstone, S. and Sesonske, A, Nuclear Reactor Engineering, Kreiger Publishing, Malabar, Florida, 1991, §§ 3.161 — 3,163, pp. 190 & 191.

ANSWER (A.3)
d
REFERENCE (A.3)
Glasstone, S. and Sesonske, A, Nuclear Reactor Engineering, Kreiger Publishing, Malabar, Florida, 1991, § 3.161 — 3.163, pp. 190 — 191.
Burn, R., Introduction to Nuclear Reactor Operations, — 1982, § 5.7, pp. 5-28 — 5-38.
$CR_1/CR_2 = (1 - K_{eff2})/(1 - K_{eff1})$
$1/32\ (1 - 0.95) = 1 - K_{eff2}$
$1 - 0.05/32 = K_{eff2}$
$K_{eff2} = 0.9984$

ANSWER (A.4)
c
REFERENCE (A.4)
Glasstone, S. and Sesonske, A, Nuclear Reactor Engineering, Kreiger Publishing, Malabar, Florida, 1991, § 5.55, p. 250.
Lamarsh, J.R., Introduction to Nuclear Engineering, Addison-Wesley Publishing, Reading, Massachusetts, 1983. § 7.1, p. 286.
$k = 1 / (1- \beta)$ $k = 1$ when $\rho = \beta$

ANSWER (A.5)
b
REFERENCE (A.5)
Glasstone, S. and Sesonske, A, Nuclear Reactor Engineering, Kreiger Publishing, Malabar, Florida, 1991, § 3.44, p. 149 & § 5.9, p. 231.
Lamarsh, J.R., Introduction to Nuclear Engineering, Addison-Wesley Publishing, Reading, Massachusetts, 1983. § 4,1, p. 102 & § 7.1, p. 282.
Burn, R., Introduction to Nuclear Reactor Operations, © 1982, § 3.3.4, p. 3-21.
$p=(k-1)/k$; $p= -0.05$; $-0.05k = k-1$; $1 = k-(-0.05k) = k(1+0.05)$; $k=1/1.05$; $k=0.9524$

ANSWER (A.6)
a
REFERENCE (A.6)
Glasstone, S. and Sesonske, A, Nuclear Reactor Engineering, Kreiger Publishing, Malabar, Florida, 1991, §§ 7.131 — 7.155, pp. 465 — 472.
Lamarsh, J.R., Introduction to Nuclear Engineering, Addison-Wesley Publishing, Reading, Massachusetts, 1983. § 5.10, p. 213 — 215.

ANSWER (A.7)
c
REFERENCE (A.7)

$SDM = (1-K_{eff})/K_{eff}$
$K_{eff} = 1/(SDM + 1)$
$K_{eff} = 1/(.0526 + 1)$
$K_{eff} = .95$

$CR_1/CR_2 = (1 - K_{eff2}) / (1 - K_{eff1})$
$10/20 = (1 - K_{eff2}) / (1 - 0.95)$
$(0.5) \times (0.05) = (1 - K_{eff2})$
$K_{eff2} = 1 - (0.5)(0.05) = 0.975$

ANSWER (A.8)
a
REFERENCE (A.8)
Glasstone, S. and Sesonske, A, Nuclear Reactor Engineering, Kreiger Publishing, Malabar, Florida, 1991, § 5.98, p. 264.

ANSWER (A.9)
a
REFERENCE (A.9)
Glasstone, S. and Sesonske, A, Nuclear Reactor Engineering, Kreiger Publishing, Malabar, Florida, 1991, §§ 3.161 — 3.163, pp. 190 — 191.

ANSWER (A.10)
d
REFERENCE (A.10)
Glasstone, S. and Sesonske, A, Nuclear Reactor Engineering, Kreiger Publishing, Malabar, Florida, 1991, §§ 2.70 — 2.74, pp. 65 -- 66.

ANSWER (A.11)
b
REFERENCE (A.11)
Glasstone, S. and Sesonske, A, Nuclear Reactor Engineering, Kreiger Publishing, Malabar, Florida, 1991, § 5.18, p. 234.

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

ANSWER (A.12)
c
REFERENCE (A.12)
Burn, R., *Introduction to Nuclear Reactor Operations*, © 1982, § 6.2.3, p. 3-4.

ANSWER (A.13) **DELETED**
b
REFERENCE (A.13)
RSM-10.10

ANSWER (A.14)
d.
REFERENCE (A.14)
Glasstone, S. and Sesonske, A, *Nuclear Reactor Engineering*, Kreiger Publishing, Malabar, Florida, 1991, § 5.81 — 5.83, p. 260.
Lamarsh, J.R., *Introduction to Nuclear Engineering*, Addison-Wesley Publishing, Reading, Massachusetts, 1983. § 7.4, pp. 323 — 326.
Burn, R., *Introduction to Nuclear Reactor Operations*, © 1982, § 8.5 — 8.7, pp. 8-15 — 8-18.

ANSWER (A.15)
a
REFERENCE (A.15)

ANSWER (A.16)
a
REFERENCE (A.16)
Glasstone, S. and Sesonske, A, *Nuclear Reactor Engineering*, Kreiger Publishing, Malabar, Florida, 1991, §§ 5.56 — 5.80, pp. 250 — 260.
Lamarsh, J.R., *Introduction to Nuclear Engineering*, Addison-Wesley Publishing, Reading, Massachusetts, 1983. § 7.4, pp. 316 — 322.

ANSWER (A.17)
d
REFERENCE (A.17)
$P_f = P_0 e^{t/T}$
$P_f = 5.5\ MW\ e^{(1\ sec/0.5\ sec)} = 40.6\ MW$

ANSWER (A.18)
c
REFERENCE (A.18)
RSM 6.4

ANSWER (A.19)
c
REFERENCE (A.19)
Glasstone, S. and Sesonske, A, *Nuclear Reactor Engineering*, Kreiger Publishing, Malabar, Florida, 1991, §§ 2.213 — 2.219, pp. 122 — 125.
Lamarsh, J.R., *Introduction to Nuclear Engineering*, Addison-Wesley Publishing, Reading, Massachusetts, 1983. § 8.2, pp. 350 — 351.
Burn, R., *Introduction to Nuclear Reactor Operations*, © 1982, § 4.9, pp. 4-23 — 4-26.

ANSWER (A.20)
c
REFERENCE (A.20)
Glasstone, S. and Sesonske, A, *Nuclear Reactor Engineering*, Kreiger Publishing, Malabar, Florida, 1991, §§ 5.56 — 5.80, pp. 250 — 260.

(*** End of Section A ***)

ANSWER (B.1)
c
REFERENCE (B.1)
PM 4.4.4.8, p. 1 of 2.

ANSWER (B.2)
b
REFERENCE (B.2)
PM 1.10, p. 10

ANSWER (B.3)
c
REFERENCE (B.3)
PM 1.12, p. 1

ANSWER (B.4) **DELETED**
c
REFERENCE (B.4)
Radiation area = 5 mr/hr
$DR = 6CE/f^2$
$f^2 = 6 \times 5 \times 1.3/0.05 = 7800$
$f = 7800^{1/2} = 88$ inches ÷ 12 inches/ft = 7.4 feet

ANSWER (B.5)
d
REFERENCE (B.5)
10CFR20.1601(a)(3)

ANSWER (B.6)
a
REFERENCE (B.6)
10CFR55.53(e)

ANSWER (B.7)
d
REFERENCE (B.7)
10CFR20.1201(a)(1)
$$5000 \text{ mr} \times \frac{1 \text{ hr}}{10 \text{ mr}} \times \frac{\text{day}}{4 \text{ hr}} = 125 \text{ days}$$

ANSWER (B.8)
d
REFERENCE (B.8)
4 inches = 1/10 (6/60) shielding value layer.
1 inch = 10E (-0.25)
= .56 shielding value layer OR: I/Io = e (-ux)
Shielded dose = 6 mrem/hr X .56
= 3.37 mrem/hr

ANSWER (B.9)
c
REFERENCE (B.9)
PM 4.4.4.12, p. 2
1000mr/150mr/hr = 6.7 hrs

ANSWER (B.10)
b
REFERENCE (B.10)
T.S. p. 2-5 (LSSS)

ANSWER (B.11)
b
REFERENCE (B.11)
T.S. 3.11.3

ANSWER (B.12)
a
REFERENCE (B.12)
PM 1.5

ANSWER (B.13)
c
REFERENCE (B.13)
MITR PM 1.14

ANSWER (B.14)
d
REFERENCE (B.14)
PM 1.9 pg. 1 of 2

ANSWER (B.15)
a
REFERENCE (B.15)
PM 1.14 pg 9 of 9

ANSWER (B.16)
a
REFERENCE (B.16)
EOP 4.4.4

ANSWER (B.17)
c
REFERENCE (B.17)
RSM 10.8
MIT Question Bank Cat. B

ANSWER (B.18)
c
REFERENCE (B.18)
PM 5.2.3 & SR #0-90-4

ANSWER (B.19)
d
REFERENCE (B.19)
PM 5.4.12

ANSWER (B.20)
c
REFERENCE (B.20)
PM 2.4, Step 3(a), p 3.

(*** End of Section B ***)

ANSWER (C.1)
a
REFERENCE (C.1)
RSM-8.37

ANSWER (C.2)
b
REFERENCE (C.2)
PM 3.3.1.1, Step 39, p 3.

ANSWER (C.3)
b, d
REFERENCE (C.3)
PM 5.6.2 pg. 1

ANSWER (C.4)
b
REFERENCE (C.4)
RSM-3.9, Section 3.3.6

ANSWER (C.5)
a. 1, 2
b. 3
c. 4
d. 1, 2
e. 1
f. 3
g. 1, 4
h. 1
REFERENCE (C.5)
MIT RSM 9.9 & RSM 7.10 (7.5)

ANSWER (C.6)
b
REFERENCE (C.6)
T.S. 3.4
RSM 3.4-(3.2.5)

ANSWER (C.7)
a
REFERENCE (C.7)
RSM 7.4.1

ANSWER (C.8)
c
REFERENCE (C.8)
RSM - 8.23

ANSWER (C.9)
a
REFERENCE (C.9)
T.S. 3.3
RSM-3.16 (3.7.1)

ANSWER (C.10)
c
REFERENCE (C.10)
RSM-3.16 (3.7.1)

ANSWER (C.11)
b
REFERENCE (C.11)
PM 5.5.1

ANSWER (C.12)
a. 1
b. 1
c. 1
d. 1
REFERENCE (C.12)
RSM 1.1, 2.9, 2.10

ANSWER (C.13)
d
REFERENCE (C.13)
RSM - 8.35

ANSWER (C.14)
c
REFERENCE (C.14)
RSM 7.7 and 8.24

ANSWER (C.15)
d
REFERENCE (C.15)
PM 5.2.11

ANSWER (C.16)
b
REFERENCE (C.16)
RSM-5.2.2

ANSWER (C.17)
c
REFERENCE (C.17)
MIT Question Bank Sect. B pg. 6 of 13

ANSWER (C.18)
b
REFERENCE (C.18)
MIT Question Bank Sect. C pg 7 of 19
RSM 6.4.1 & 6.4.2

(*** End of Section C ***)

A.1 b

A.2 b

A.3 d

A.4 c

A.5 b

A.6 a

A.7 c

A.8 a

A.9 a

A.10 d

A.11 b

A.12 c

A.13 b **DELETED**

A.14 d.

A.15 a

A.16 a

A.17 d

A.18 c

A.19 c

A.20 c

B.1 c

B.2 b

B.3 c

B.4 c **DELETED**

B.5 d

B.6 a

B.7 d

B.8 d

B.9 c

B.10 b

B.11 b

B.12 a

B.13 c

B.14 d

B.15 a

B.16 a

B.17 c

B.18 c

B.19 d

B.20 c

C.1 a

C.2 b

C.3 b, d

C.4 b

C.5 a. 1, 2

b. 3

c. 4

d. 1, 2

e. 1

f. 3

g. 1, 4

h. 1

C.6 b

C.7 a

C.8 c

C.9 a

C.10 c

C.11 b

C.12 a. 1

b. 1

c. 1

d. 1

C.13 d

C.14 c

C.15 d

C.16 b

C.17 c

C.18 b

(*** End of Section C ***)

ANSWER SHEET

A.1	a b c d ___	A.11	a b c d ___
A.2	a b c d ___	A.12	a b c d ___
A.3	a b c d ___	A.13	a b c d ___
A.4	a b c d ___	A.14	a b c d ___
A.5	a b c d ___	A.15	a b c d ___
A.6	a b c d ___	A.16	a b c d ___
A.7	a b c d ___	A.17	a b c d ___
A.8	a b c d ___	A.18	a b c d ___
A.9	a b c d ___	A.19	a b c d ___
A.10	a b c d ___	A.20	a b c d ___

(*** End of Section A ***)

A N S W E R S H E E T

B.1 a b c d ___

B.2 a b c d ___

B.3 a b c d ___

B.4 a b c d ___

B.5 a b c d ___

B.6 a b c d ___

B.7 a b c d ___

B.8 a b c d ___

B.9 a b c d ___

B.10 a b c d ___

B.11 a b c d ___

B.12 a b c d ___

B.13 a b c d ___

B.14 a b c d ___

B.15 a b c d ___

B.16 a b c d ___

B.17 a b c d ___

B.18 a b c d ___

B.19 a b c d ___

B.20 a b c d ___

(*** End of Section B ***)

ANSWER SHEET

C.1 a b c d ___

C.2 a b c d ___

C.3 a b c d ___

C.4 a b c d ___

C.5 a 1 2 3 4 ___
b 1 2 3 4 ___
c 1 2 3 4 ___
d 1 2 3 4 ___
e 1 2 3 4 ___
f 1 2 3 4 ___
g 1 2 3 4 ___

C.6 a b c d ___

C.7 a b c d ___

C.8 a b c d ___

C.9 a b c d ___

C.10 a b c d ___

C.11 a b c d ___

C.12a 1 2 3 4 5 ___
b 1 2 3 4 5 ___
c 1 2 3 4 5 ___
d 1 2 3 4 5 ___

C.13 a b c d ___

C.14 a b c d ___

C.15 a b c d ___

C.16 a b c d ___

C.18 a b c d ___

(*** End of Section C ***)