October 3, 2002

Dr. John Bernard, Director
of Reactor Operations
Nuclear Reactor Laboratory
Massachusetts Institute of Technology
138 Albany Street
Cambridge, MA 02139

SUBJECT: INITIAL EXAMINATION REPORT, NO. 50-020/OL-02-01, MASSACHUSETTS INSTITUTE OF TECHNOLOGY

Dear Dr. Bernard:

During the week of September 2, 2002, the NRC administered initial examinations to employees of your facility who had applied for a license to operate your Massachusetts Institute of Technology Reactor. The examination was conducted in accordance with NUREG-1478, "Non-Power Reactor Operator Licensing Examiner Standards," Revision 1. At the conclusion of the examination, the examination questions and preliminary findings were discussed with those members of your staff identified in the enclosed report.

In accordance with 10 CFR 2.790 of the NRC's "Rules of Practice," a copy of this letter and its enclosure will be available electronically for public inspection in the NRC Public Document Room or from the Publicly Available Records (PARS) component of NRC's document system (ADAMS). ADAMS is accessible from the NRC Web site at (the Public Electronic Reading Room) http://www.nrc.gov/NRC/ADAMS/index.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 Patrick Isaac at 301-415-1019 or pxi@nrc.gov.

Sincerely,

/RA/

Patrick M. Madden, Section Chief
Research and Test Reactors Section
Operating Reactor Improvements Program
Division of Regulatory Improvement Programs
Office of Nuclear Reactor Regulation

Docket No. 50-020

Enclosures: 1. Initial Examination Report No. 50-020/OL-02-01
2. Examination and answer key

cc w/enclosures:

Please see next page

cc:

City Manager
City Hall
Cambridge, MA 02139

Department of Environmental
Quality Engineering
100 Cambridge Street
Boston, MA 02202

Test, Research, and Training
Reactor Newsletter
University of Florida
202 Nuclear Sciences Center
Gainesville, FL 32611

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ADAMS ACCESSION #: ML022700535 **TEMPLATE #: NRR-074**

OFFICE	**RORP:CE**		**IEHB:LA**		**RORP:SC**	
NAME	**PIsaac:rdr**		**EBarnhill**		**PMadden**	
DATE	**09/ 27 /2002**		**10/ 03 /2002**		**10/ 03 /2002**	

C = COVER **E = COVER & ENCLOSURE** **N = NO COPY**

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

REPORT NO.: 50-020/OL-02-01

FACILITY DOCKET NO.: 50-020

FACILITY LICENSE NO.: R-37

FACILITY: Massachusetts Institute of Technology

EXAMINATION DATES: September 3 - 6, 2002

EXAMINER: Patrick Isaac, Chief Examiner

SUBMITTED BY: ***/RA/*** 09/20/02
Patrick Isaac, Chief Examiner Date

SUMMARY:

During the week of September 2, 2002, the NRC administered Operator Licensing Examinations to three Senior Reactor Operator Upgrade (SROU) and six Reactor Operator (RO) candidates. One SROU and one RO candidate failed the operating tests. All the other candidates passed their respective portions of the examinations.

ENCLOSURE 1

REPORT DETAILS

1. Examiners:

Patrick Isaac, Chief Examiner

2. Results:

	RO PASS/FAIL	SRO PASS/FAIL	TOTAL PASS/FAIL
Written	**6/0**	**N/A**	**6/0**
Operating Tests	**5/1**	**2/1**	**7/2**
Overall	**5/1**	**2/1**	**7/2**

3. Exit Meeting:

Personnel attending:

Frank Warmsley, Operations and Training Coordinator, NRL
Patrick Isaac, NRC, Chief Examiner

The Chief Examiner agreed with Mr. Warmsley to make the following changes to the written examination:

Question A.10 - Accept both "c" and "d" as correct.
Question B.09 - Delete the question (The Safety Limits graph was not provided).
Question C.03 - Delete the question (The BTF no longer exists).

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

FACILITY: MIT

REACTOR TYPE: MITR-II

DATE ADMINISTERED: 2002/09/03

CANDIDATE: ______________________________

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

CATEGORY VALUE	% OF TOTAL	CANDIDATE'S SCORE	% OF CATEGORY VALUE		CATEGORY
20.00	**34.5**	____________	____	**A.**	**REACTOR THEORY, THERMODYNAMICS AND FACILITY OPERATING CHARACTERISTICS**
19.00	**32.8**	____________	____	**B.**	**NORMAL AND EMERGENCY OPERATING PROCEDURES AND RADIOLOGICAL CONTROLS**
19.00	**32.8**	____________	____	**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 2

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.

EQUATION SHEET

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

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

$\dot{Q} = \dot{m} \Delta h$

$SCR = S/(1-Keff)$

$\dot{Q} = UA \Delta T$

$CR_1 (1-Keff)_1 = CR_2 (1-Keff)_2$

$SUR = \frac{26.06 (\lambda_{eff}\rho)}{(\bar{\beta} - \rho)}$

$M = \frac{(1-Keff)_0}{(1-Keff)_1}$

$SUR = 26.06/\tau$

$M = 1/(1-Keff) = CR_1/CR_0$

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

$SDM = (1-Keff)/Keff$

$P = P_0 \, e^{(t/\tau)}$

$Pwr = W_f \dot{m}$

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

$\ell^* = 1 \times 10^{-5}$ seconds

$\tau = (\ell^*/\rho) + [(\bar{\beta}-\rho)/\lambda_{eff}\rho]$

$\tau = \ell^*/(\rho-\bar{\beta})$

$\rho = (Keff-1)/Keff$

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

$\rho = \Delta Keff/Keff$

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

$\bar{\beta} = 0.0070$

$DR_1 D_1^2 = DR_2 D_2^2$

$DR = DR_o e^{-\lambda t}$

$DR = \frac{6CiE(n)}{R^2}$ DR ≡ R/hr, Ci ≡ Curies, E ≡ Mev, R ≡ feet

---

1 Curie = 3.7×10^{10} dps

1 kg = 2.21 lbm

1 hp = 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)

A. RX THEORY, THERMO & FAC OP CHARS

A N S W E R   S H E E T

Multiple Choice (Circle or X your choice)
If you change your answer, write your selection in the blank.

MULTIPLE CHOICE

001 a b c d ___

002 a b c d ___

003 a b c d ___

004 a b c d ___

005 a b c d ___

006 a b c d ___

007 a b c d ___

008 a b c d ___

009 a b c d ___

010 a b c d ___

011 a b c d ___

012 a b c d ___

013 a b c d ___

014 a b c d ___

015 a b c d ___

016 a b c d ___

017 a b c d ___

018 a b c d ___

019 a b c d ___

020 a b c d ___

(***** END OF CATEGORY A *****)

A N S W E R   S H E E T

Multiple Choice   (Circle or X your choice)
If you change your answer, write your selection in the blank.

MULTIPLE CHOICE

001 a b c d ___

002 a b c d ___

003 a b c d ___

004 a b c d ___

005 a b c d ___

006 a b c d ___

007 a b c d ___

008 a b c d ___

009 a b c d ___

010 a b c d ___

011 a b c d ___

012 a b c d ___

013 a b c d ___

014 a b c d ___

015 a b c d ___

016 a b c d ___

017 a b c d ___

018 a b c d ___

019 a b c d ___

020 a b c d ___

(***** END OF CATEGORY B *****)

C. PLANT AND RAD MONITORING SYSTEMS

A N S W E R S H E E T

Multiple Choice (Circle or X your choice)
If you change your answer, write your selection in the blank.

MULTIPLE CHOICE

001 a b c d ___

002 a b c d ___

003 a b c d ___

004 a b c d ___

005 a ___ b ___ c ___ d ___

006 a b c d ___

007 a b c d ___

008 a b c d ___

009 a b c d ___

010 a b c d ___

011 a b c d ___

012 a ___ b ___ c ___ d ___

013 a b c d ___

014 a b c d ___

015 a b c d ___

016 a b c d ___

017 a b c d ___

018 a b c d ___

(***** END OF CATEGORY C *****)
(********** END OF EXAMINATION **********)

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]
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

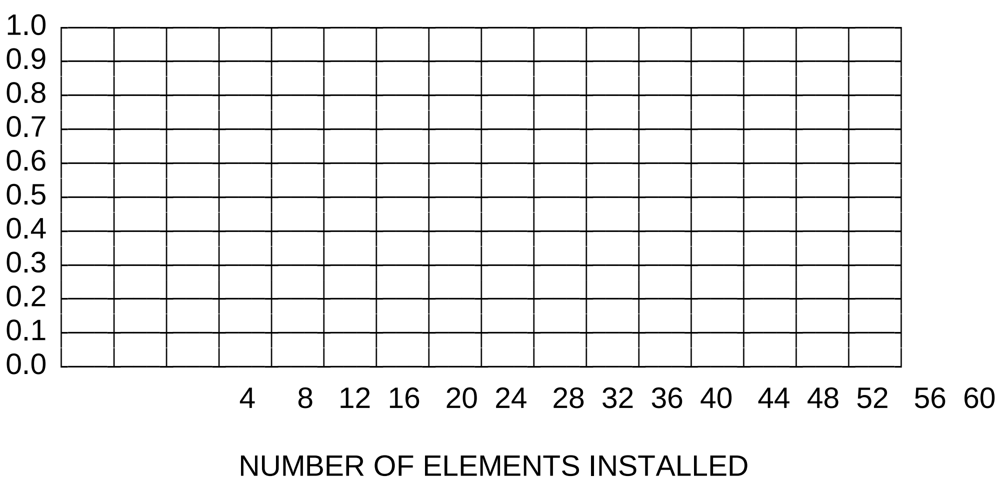
Which one of the following represents the number of fuel elements predicted to reach criticality?

a. 48

b. 52

c. 56

d. 60



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

a. 0.957

b. 0.979

c. 0.988

d. 0.998

QUESTION (A.4) [1.0]
Which one of the following is the MAXIMUM amount of reactivity that can be promptly inserted into the reactor 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 ΔK/K, this would correspond to Keff 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 Keff 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 Keff approaches unity (1), for the same increase in Keff, 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% ΔK/K

b. 0.16% ΔK/K

c. 0.18% ΔK/K

d. 0.20% ΔK/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 Keff ≡ 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]
An experiment to be placed in the central thimble has been wrapped in cadmium. Which one of the following types of radiation will be most effectively blocked by the cadmium wrapping?

a. Thermal neutrons

b. Fast neutrons

c. Gamma rays

d. X-rays

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]
The reactor is shutdown after an extended, 24 hours, 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

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 30 SECONDS 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, Keff, 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]
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 one 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

QUESTION (B.2) [1.0]
A small radioactive source is to be stored in the reactor bay with no shielding. The source reads 2 R/hr at 1 foot. A “Radiation Area” barrier would have to be erected approximately ___ from the source.

a. 400 feet

b. 40 feet

c. 20 feet

d. 10 feet

QUESTION (B.3) [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. Lock the room to prevent inadvertent entry into the room.

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

QUESTION (B.4) [1.0]
Consider two point sources, each having the same curie strength. Source A's gammas have an energy of 1 MEV whereas Source B's gamma have an energy of 2 MEV. You obtain a reading from the same Geiger counter 10 feet from each source. Concerning the two readings, which one of the following statements is correct?

a. Both readings are the same.

b. The reading from Source B is half that of Source A.

c. The reading from Source B is twice that of Source A.

d. The reading from Source B is four times that of Source A.

QUESTION (B.5) [1.0]
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.

QUESTION (B.6) [1.0]
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.

QUESTION (B.7) [1.0]
The condition of "Notification of Unusual Events" encompasses all of the following except:

a. There is time available to take precautionary corrective steps.

b. No release of radioactive material requiring off-site response is expected.

c. The entire emergency organization is notified.

d. A significant hazard potential has been created.

QUESTION (B.8) [1.0]
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

QUESTION (B.9) [1.0]
Which one of following is the maximum reactor outlet temperature that will prevent exceeding the MITR-II safety limit? Assume the following core conditions:

Reactor Power = 4.9 MW
Primary Flow = 1960 gpm
Core Tank level = 8 ft.

a. 82 °C

b. 78 °C

c. 73 °C

d. 68 °C

QUESTION (B.10) [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.11) [1.0]
In the event of a large tritiated water spill, what type of action should be followed for operation of the ventilation system?

a. Continue to operate the ventilation system as normal, except do not blow air directly on the spill.

b. Close the dampers, thus securing the ventilation system.

c. Turn up the trips on the gas and particulate monitors so that the dampers will not close unless done so manually.

d. Turn off the ventilation system until radiation levels decrease.

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]
The ________________ for the MIT Research Reactor is taken to be a 100 meter zone that forms an annulus about the facility's containment building.

Which one of the following terms fits in the blank?

a. Restricted Area

b. Site Boundary

c. Emergency Planning Zone

d. Operations Boundary

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

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

QUESTION (B.18) [1.0]
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 Operations Superintendent shall minimize the amount and concentration of Hydrochloric acid (HCl) irradiated in the reactor.

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

d. The total worth of all non-secured experiments is limited to 1.5% $\Delta K/K$.

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]
Shim blade withdrawal motion is limited to four inches by the "sub-critical position" interlock circuit. Which of the following is NOT a reason for incorporating the subcritical interlock into the shim blade circuit?

a. To maintain the shim blade bank at a uniform height during final approach to criticality.

b. To establish a level, below the critical position, to which the shim blades may be individually withdrawn in one step.

c. To provide a convenient reference point at which the operator can pause to make a complete instrument check before bringing the reactor to criticality.

d. To maintain the shim blade bank at a uniform height sufficient to maintain subcritical multiplication on the startup channels.

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

Section C Plant and Rad Monitoring Systems

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. Set-Up Area Vault

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 D_2O 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 response expected to occur from the Reactor Safety System in Column II. (Assume the reactor is critical.)

Items in Column I have only one correct answer and items in Column II may be used once, more than once or not at all.

	Column I (Condition)	Column II (Response)
a.	Core tank level 2 inches below overflow pipe.	1. Alarm ONLY.
b.	Shield coolant flow equals 55 gpm.	2. Rod withdrawal inhibited.
c.	Reactor outlet temperature equals 50 °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 2.0 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. H2 analysis shall be performed every hour. When greater than 1.5% [H2], reactor power should be reduced to less than 1 MW to prevent H2 concentration from exceeding the T.S. limit of 3.5%.

b. H2 analysis shall be performed every 1.5 hours. When greater than 1.0% [H2], reactor power should be reduced to less than 200 kW to prevent H2 concentration from exceeding the T.S. limit of 3.5%.

c. H2 analysis shall be performed every hour. When greater than 1.5% [H2], reactor power should be reduced to less than 1 MW to prevent H2 concentration from exceeding the T.S. limit of 4.1%.

b. H2 analysis shall be performed every 1.5 hours. When greater than 1.0% [H2], reactor power should be reduced to less than 200 kW to prevent H2 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 D2 concentration and recombiner operation? To ensure that the D2 concentration in the helium blanket does not exceed...

a. 6% by volume, the temperature of the middle of the recombiner must be >50°C and the flow rate between 1.5 and 8 cfm or reactor power shall be reduced to <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 NOT 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.

ANSWER (A.2)
a
REFERENCE (A.2)
Glasstone, S. and Sesonske, §§ 3.161 — 3,163, pp. 190 & 191.

ANSWER (A.3)
d
REFERENCE (A.3)
Glasstone, S. and Sesonske,§ 3.161 — 3.163, pp. 190 — 191.
$1/32\ (1 - 0.95) = 1 - Keff_2$
$1 - 0.05/32 = Keff_2$
$Keff_2 = 0.9984$

ANSWER (A.4)
c
REFERENCE (A.4)
Glasstone, S. and Sesonske, § 5.55, p. 250.
$k = 1 / (1- \beta)$ $k = 1$ when $\rho = \beta$

ANSWER (A.5)
b
REFERENCE (A.5)
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

ANSWER (A.6)
a
REFERENCE (A.6)
Glasstone, S. and Sesonske §§ 7.131 — 7.155, pp. 465 — 472.

ANSWER (A.7)
c
REFERENCE (A.7)
SDM = (1-Keff)/Keff
Keff = 1/(SDM + 1) = 1/(.0526 + 1)
Keff = .95
$CR_1/CR_2 = (1 - Keff_2) / (1 - Keff_1)$
$10/20 = (1 - Keff_2) / (1 - 0.95)$
$(0.5) \times (0.05) = (1 - Keff_2)$
$Keff_2 = 1 - (0.5)(0.05) = 0.975$

ANSWER (A.8)
a
REFERENCE (A.8)
Glasstone, S. and Sesonske, § 5.98, p. 264.

ANSWER (A.9)
a

REFERENCE (A.9)
Glasstone, S. and Sesonske, §§ 3.161 — 3.163, pp. 190 — 191.

ANSWER (A.10)
c, d
REFERENCE (A.10)
Glasstone, S. and Sesonske, §§ 2.70 — 2.74, pp. 65 -- 66.

ANSWER (A.11)
b
REFERENCE (A.11)
$T = (\beta-\rho)/\lambda\rho$ $T = t/\ln 2 = 24/.693 = 34.6$ 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)
a
REFERENCE (A.13)
Glasstone, S. and Sesonske, 1991, § 10.34, pp. 639.

ANSWER (A.14)
d.
REFERENCE (A.14)
Glasstone, S. and Sesonske, § 5.81 — 5.83, p. 260.

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

ANSWER (A.16)
b
REFERENCE (A.16)
Burn, R., Introduction to Nuclear Reactor Operations, © 1988, §§ 8.1 —8.4, pp. 8-3 — 8-14.

ANSWER (A.17)
d
REFERENCE (A.17)
$P_f = P_o\ et/T$
$P_f = 5.5\ MW\ e(1\ sec/0.5\ sec) = 40.6\ MW$

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

ANSWER (A.19)
c
REFERENCE (A.19)
Glasstone, S. and Sesonske, §§ 2.213 — 2.219, pp. 122 — 125.

ANSWER (A.20)
c
REFERENCE (A.20)
Glasstone, S. and Sesonske, §§ 5.56 — 5.80, pp. 250 — 260.

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

ANSWER (B.1)
c
REFERENCE (B.1)
$R = \frac{6\,C\,E\,n}{6^2} = \frac{6\,(12\text{ ci})\,(1.36 + 1.14\text{ Mev})}{36} = 5$ R/hr.

ANSWER (B.2)
c
REFERENCE (B.2)

$$\frac{R_1}{X_2^2} = \frac{DR_2}{X_1^2} \rightarrow X_2^2 = \frac{DR_1}{DR_2} X_1 \qquad = \frac{2000}{5} \times 1^2 = 400ft^2 = 20ft$$

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

ANSWER (B.4)
a
REFERENCE (B.4)
GM is not sensitive to energy.

ANSWER (B.5)
a
REFERENCE (B.5)
10CFR20.1003

ANSWER (B.6)
c
REFERENCE (B.6)
10CFR50.54(y)

ANSWER (B.7)
c
REFERENCE (B.7)
MITR Training Program Sampling Category B: Additional Questions QUESTION #3

ANSWER (B.8)
c
REFERENCE (B.8)
PM 5.6.2

~~ANSWER (B.9)~~ **DELETED**
b
REFERENCE (B.9)
T.S. 2.1 (Safety Limits); PM 5.1.3 (Follow-up Action Step 7)

ANSWER (B.10)
d
REFERENCE (B.10)
PM 5.4.12

ANSWER (B.11)
a
REFERENCE (B.11)
MIT Comments to 1997 written examination.

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)
c
REFERENCE (B.15)
Chapter 4 (E-Plan) PM 4.6

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

ANSWER (B.17)
b
REFERENCE (B.17)
Chapter 4 (E-Plan) PM 4.5

ANSWER (B.18)
c
REFERENCE (B.18)
T.S. 6.1; PM 1.14.2

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

ANSWER (B.20)
d
REFERENCE (B.20)
RSM 4.3

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

Section C Plant and Rad Monitoring Systems

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)~~ **DELETED**
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
b. 3
c. 4
d. 1
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