U.S. NUCLEAR REGULATORY COMMISSION REGION I
OPERATOR LICENSING EXAMINATION REPORT

EXAMINATION REPORT NO:	89-03 (OL)
FACILITY DOCKET NO:	50-20
FACILITY LICENSE NO:	R-37
LICENSEE:	Massachusetts Institute of Technology
FACILITY:	Massachusetts Institute of Technology Reactor
EXAMINATION DATES:	September 11-13, 1989

CHIEF EXAMINER: _____ 11-9-89
David Wallace Date
Operations Engineer (Examiner)

APPROVED BY: _____ 11-27-89
Peter W. Eselgroth, Chief Date
PWR Section, Operations Branch, DRS

Written and operating examinations were administered to one Reactor Operator (RO) and three Senior Reactor Operator (SRO) candidates. The RO candidate and one of the three SRO candidates passed their examinations.

DETAILS

TYPE OF EXAMINATIONS: 1 RO, 1 SROI, 2 SROU

EXAMINATION RESULTS:

	RO Pass/Fail	SRO Pass/Fail
WRITTEN	1/0	2/1
OPERATING	1/0	2/1
OVERALL	1/0	1/2

1. Chief Examiner At Site: David Wallace

2. Personnel Present at Exit Meeting

U.S. NUCLEAR REGULATORY COMMISSION

David Wallace

Massachusetts Institute of Technology

Prof. Otto Harling
Dr. John Bernard
Kwon Kwok
Frederick McWilliams

3. Summary of Exit Meeting comments and conclusions based on written and operating examinations results.

During the examinations, it was observed that all the SRO candidates experienced some difficulty transitioning from Abnormal Operating Procedures to Emergency Procedures, although the severity of these difficulties varied widely between candidates. It was noted that the Abnormal Operating Procedures do not always refer the operator to the appropriate Emergency Procedure. The difference between a good and poor candidate

appeared to be their ability to recollect which Emergency Procedure was appropriate for such conditions, since there is not always a transition statement in the Abnormal Operating Procedures. Inadequate transitioning lead to an unacceptably fragmented recovery approach for one of the candidates. However, all of the candidates passing the operating examinations were able to cope with the scenarios in a way that protected both the facility and personnel. The interrelationship between Abnormal Operating Procedures and Emergency Procedures is an area which warrants additional attention.

Weaknesses were also noted in some of the SRO candidate's ability to classify emergencies. These weaknesses appear to be due in part to unfamiliarity with the procedures used to classify such events. Again, all passing candidates were able to classify and respond to the scenarios in an adequate time frame.

Thirdly, the examiner observed weaknesses in the area of personal radiological safety. Inadequate frisking and disregard for radiation boundaries was noted during the operating examinations for some of the candidates.

All of the above items were discussed with facility management during the Exit Meeting held on September 13, 1989. Management took note of these items and indicated that adequate review, and changes to procedures and training, as appropriate, will be undertaken. A reply to these concerns is requested. In particular, a description of the reviews and/or changes which will appropriately circumvent future weaknesses in these areas.

The examiner stated that, in general, the candidates were well prepared for the examinations although some deficiencies were observed as discussed above.

Attachments:
1. Updated RO Written Examination and Answer Key
2. Updated SRO Written Examination and Answer Key

MIT 9/11/89
Master Exam (RO)

Attachment
#1

Nuclear Regulatory Commission
Operator Licensing
Examination

This document is removed from
Official Use Only category on
date of examination.

U. S. NUCLEAR REGULATORY COMMISSION
REACTOR OPERATOR LICENSE EXAMINATION
REGION 1

FACILITY: Mass. Inst. of Tech.

REACTOR TYPE: MITR-II

DATE ADMINSTERED: 89/09/11

CANDIDATE: _____

INSTRUCTIONS TO CANDIDATE:

Use separate paper for the answers. Write answers on one side only. Staple question sheet on top of the answer sheets. Points for each question are indicated in parentheses after the question. The passing grade requires at least 70% in each category. Examination papers will be picked up six (6) hours after the examination starts.

CATEGORY VALUE	% OF TOTAL	CANDIDATE'S SCORE	% OF CATEGORY VALUE	CATEGORY
~~14.75~~ 13.75	~~14.75~~			A. PRINCIPLES OF REACTOR OPERATION
~~15.50~~ 14.5	~~15.50~~			B. FEATURES OF FACILITY DESIGN
14.50	~~14.50~~			C. GENERAL OPERATING CHARACTERISTICS
13.00	~~13.00~~			D. INSTRUMENTS AND CONTROLS
~~13.00~~ 12.00	~~13.00~~			E SAFETY AND EMERGENCY SYSTEMS
14.25	~~14.25~~			F. STANDARD AND EMERGENCY OPERATING PROCEDURES
15.00	~~15.00~~			G. RADIATION CONTROL AND SAFETY
~~100.00~~ 97.0			%	TOTALS
		FINAL GRADE		

All work done on this examination is my own. I have neither given nor received aid.

_____
Candidate's Signature

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. You may write your answers on the examination question page or on a separate sheet of paper. USE ONLY THE PAPER PROVIDED AND DO NOT WRITE ON THE BACK SIDE OF THE PAGE.

8. If you write your answers on the examination question page and you need more space to answer a specific question, use a separate sheet of the paper provided and insert it directly after the specific question. DO NOT WRITE ON THE BACK SIDE OF THE EXAMINATION QUESTION PAGE.

9. Print your name in the upper right-hand corner of the first page of each section of your answer sheets whether you use the examination question pages or separate sheets of paper. Initial each page.

10. 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.

11. If you are using separate sheets, number each answer as to category and number (i.e. 1.04, 6.10) and skip at least 3 lines between answers to allow space for grading.

12. Write "End of Category " at the end of your answers to a category.

13. Start each category on a new page.

14. Write "Last Page" on the last answer sheet.

15. Use abbreviations only if they are commonly used in facility literature. Avoid using symbols such as < or > signs to avoid a simple transposition error resulting in an incorrect answer. Write it out.

16. The point value for each question is indicated in parentheses after the question. The amount of blank space on an examination question page is NOT an indication of the depth of answer required.

17. Show all calculations, methods, or assumptions used to obtain an answer.

18. Partial credit may be given. Therefore, ANSWER ALL PARTS OF THE QUESTION AND DO NOT LEAVE ANY ANSWER BLANK. NOTE: partial credit will NOT be given on multiple choice questions.

19. Proportional grading will be applied. Any additional wrong information that is provided may count against you. For example, if a question is worth one point and asks for four responses, each of which is worth 0.25 points, and you give five responses, each of your responses will be worth 0.20 points. If one of your five responses is incorrect, 0.20 will be deducted and your total credit for that question will be 0.80 instead of 1.00 even though you got the four correct answers.

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

21. When turning in your examination, assemble the completed examination with examination questions, examination aids and answer sheets. In addition, turn in all scrap paper.

22. To pass the examination, you must achieve an overall grade of 80% or greater and at least 70% in each category.

23. There is a time limit of (6) hours for completion of the examination. (or some other time if less that the full examination is taken.)

24. 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.

QUESTION A.01 (1.00)

WHICH one of the following is true concerning Delayed and/or Prompt Neutrons?

A) Delayed Neutrons are born at higher energies than Prompt Neutrons.

B) The average energy of a Delayed Neutron is 2 MeV.

C) Delayed Neutrons are more likely to be lost by leakage and parasitic absorption than Prompt Neutrons.

D) In the process of slowing down, the fraction of Prompt Neutrons that are lost is larger than the fraction of ~~Thermal~~ Delayed Neutrons that are lost.

(***** CATEGORY A CONTINUED ON NEXT PAGE *****)

QUESTION A.02 (1.00)

WHICH one of the following accurately describe the effect that Moderator Temperature has on core physics?

A) As moderator temperature increases, the mean free path between scattering collisions decreases.

B) Less neutrons will exit the core as moderator temperature increases.

C) As moderator temperature increases, neutrons are more likely to be absorbed by Uranium 238 and Plutonium-240.

D) Rod Worth will increase as moderator temperature decreases.

(***** CATEGORY A CONTINUED ON NEXT PAGE *****)

QUESTION A.03 (1.00)

WHICH one of the following accurately describe the effect that Fuel Temperature has on core physics?

A) A fuel temperature decrease results in Doppler Broadening of U-238 and Pu-240 resonance peaks and the decrease of resonance escape probability.

B) A decrease in fuel temperature will increase neutron absorption by U-238 and Pu-240.

C) A fuel temperature increase results in Doppler Broadening of U-238 and Pu-240 resonance peaks and the decrease of neutron absorption during moderation.

D) A fuel temperature increase will decrease the resonance escape probability.

(***** CATEGORY A CONTINUED ON NEXT PAGE *****)

QUESTION A.04 (1.00) Question Deleted

With the reactor critical, a Source is introduced to the core. WHICH one of the following is an accurate statement 50 generations AFTER the source is inserted?

A) The new countrate will be the original countrate PLUS 50 times the sources' contribution per generation.

B) The reactor will be supercritical, and the countrate will be increasing in an exponential fashion.

C) The countrate will be identical to the countrate before the source was added.

D) The board operator could notice a positive period on the available period instrumentation.

(***** CATEGORY A CONTINUED ON NEXT PAGE *****)

QUESTION A.05 (1.00)

With the reactor at 25% power the control board operator scrams the reactor. WHICH one of the following most closely represents the resulting reactor behavior? Assume "zero power" is equal to or less than .001%.

A) A prompt drop followed by a -80 second period decay to zero power.

B) A prompt drop followed by a -26 second period decay to zero power

C) A prompt drop followed by a -26 second period decay, followed by a -80 second period decay to zero power.

D) A prompt drop to essentially zero power.

(***** CATEGORY A CONTINUED ON NEXT PAGE *****)

QUESTION A.06 (1.00)

Over a period of time while the reactor is operating in the automatic mode at 800 KW, the fuel temperature increased from 400 degrees to 405 degrees C. Assuming the temperature coefficient for the reactor is -1.4 x 10**-4 delta k/k/degree C, the regulating rod is worth 0.1% delta k/k/inch, and none of the other control elements move.

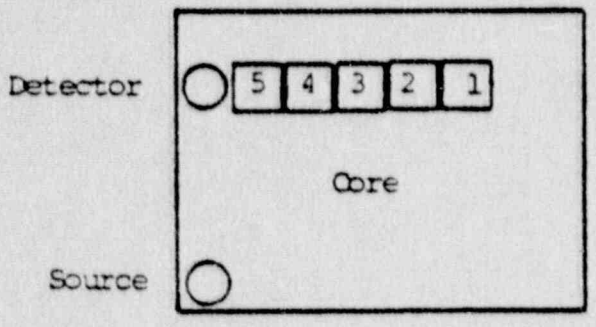
a) HOW FAR would the regulating rod move to compensate for the temperature change? (.75)

b) In What direction would the regulating rod move? (.25)

(***** CATEGORY A CONTINUED ON NEXT PAGE *****)

QUESTION A.07 (1.00)

What would be the expected consequence of loading fuel in the manner depicted in the figure below. (Fuel element 1 is loaded first, fuel element 2 loaded second, etc).



A) The 1/M plot would be concave, and would predict critical mass in an unconservative manner.

B) The 1/M plot would be convex, and would predict critical mass in a conservative manner.

C) The 1/M plot would be concave, and would predict critical mass in a conservative manner.

D) The 1/M plot would be convex, and would predict critical mass in an unconservative manner.

(***** CATEGORY A CONTINUED ON NEXT PAGE *****)

QUESTION A.08 (1.00)

WHICH one of the following accurately details a factor contributing to Xenon balance within the reactor.

A) Most Xe-135 is formed by fission.

B) Tellurium-135 is a fission product which quickly decays to I-135.

C) Within approximately 8 hours after startup to full power, Xe-135 has reached its equilibrium value.

D) Several minutes following a reactor shutdown, Xe level is increasing because I-135 is not being produced.

(***** CATEGORY A CONTINUED ON NEXT PAGE *****)

QUESTION A.09 (2.00)

Given the following information:

Time	Power	Rod Position
0	50 W	50%
25 sec	100 W	55%

Determine the DIFFERENTIAL ROD WORTH between rod positions of 50% and 55%.
(L=.1 sec-1, Beff=.00786)
(X)

(***** CATEGORY A CONTINUED ON NEXT PAGE *****)

QUESTION A.10 (1.75)

The reactor is subcritical by -.6667 delta k/k with an inserted source contributing 1000 neutrons per generation.

A) What is the reactor countrate? (1.0)

B) Some time later, control rods insert reactivity worth +.50 delta k/k. WHAT will be the resulting Countrate. (.75)

(***** CATEGORY A CONTINUED ON NEXT PAGE *****)

QUESTION A.11 (1.00)

WHICH one of the following statements accurately describe the effect that different operations will have on Shutdown Margin (SDM)?

A) As primary light water temperature increases, SDM will INCREASE.

B) Following a shutdown, as fuel temperature cools, SDM will INCREASE.

C) Replacing an old fuel element with a fresh element will INCREASE SDM.

D) Reducing the temperature of the D2O Tank would INCREASE SDM.

E) A facility modification, which increased rod travel speed, would also INCREASE SDM.

(***** CATEGORY A CONTINUED ON NEXT PAGE *****)

QUESTION A.12 (2.00)

The following information has been recorded concerning a particular heat exchanger:

	Tube Side	Shell Side
Temp in	95 F	75 F
Temp out	91.6 F	78.6 F
Flow	1600 gpm	-------

a) WHAT is the shell side flowrate? Show all work. (1.0)

b) HOW MUCH heat is being transferred through this heat exchanger? Show all work. (1.0)

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

QUESTION B.01 (1.00)

WHY are the MITR-II fuel elements finned?

(***** CATEGORY B CONTINUED ON NEXT PAGE *****)

QUESTION B.02 (1.00)

WHERE in the core may Orificed Sample Assemblies be utilized?

(***** CATEGORY B CONTINUED ON NEXT PAGE *****)

QUESTION B.03 (1.00)

WHY is the D2O Tank blanketed with a helium cover gas?

(***** CATEGORY B CONTINUED ON NEXT PAGE *****)

QUESTION B.04 (1.00)

WHICH one of the following most accurately describes the materials encountered if one were to penetrate the facility in a radial direction away from the core?

A) Steel, Aluminum, Graphite, Lead, Poly

B) Aluminum, Graphite, Concrete, Lead

C) Aluminum, Aluminum, Graphite, Steel, Lead

D) Stainless Steel, Aluminum, Lead, Graphite

E) Aluminum, Graphite, Steel, Poly, Lead, Concrete

(***** CATEGORY B CONTINUED ON NEXT PAGE *****)

QUESTION B.05 (1.50)

The following concern the Thermal Shield:

a) WHAT is the chief phenomenon that causes heating of the Thermal Shield?

b) HOW is the Thermal Shield cooled?

c) WHAT automatic action will occur if Thermal Shield Cooling is lost while the reactor is operating?

(***** CATEGORY B CONTINUED ON NEXT PAGE *****)

QUESTION B.06 (1.00)

WHAT is the purpose of the Holhraum?

(***** CATEGORY B CONTINUED ON NEXT PAGE *****)

QUESTION B.07 (1.00) Question Deleted

WHAT Burnable Poison is used in the core, AND WHY is burnable poison used?

(***** CATEGORY B CONTINUED ON NEXT PAGE *****)

QUESTION B.08 (1.00)

WHAT are Two (2) purposes of the Core Shroud?

(***** CATEGORY B CONTINUED ON NEXT PAGE *****)

QUESTION B.09 (1.00)

Upon a Scram, HOW are the Shim Blades prevented from impacting into their lower positions with potentially damaging force?

(***** CATEGORY B CONTINUED ON NEXT PAGE *****)

QUESTION B.10 (1.00)

WHAT is the major difference between the Shim Blade moving mechanisms and the Regulating Rod moving mechanism?

(***** CATEGORY B CONTINUED ON NEXT PAGE *****)

QUESTION B.11 (2.50)

MATCH the location or feature from Column I with the gas from Column II which is utilized as a cover or operating fluid. (Each Column I entry utilizes what Column II gas?) Column II entries may be used more than once.

Column I	Column II
1) Void above Primary Water Pool	A) Carbon Dioxide
2) Pneumatic Tube Operating Gas	B) Argon
3) Vertical Thimbles	C) Air
4) Thermal Column	D) Helium
5) Graphite Reflector	E) Nitrogen

(***** CATEGORY B CONTINUED ON NEXT PAGE *****)

QUESTION B.12 (1.50)

WHAT are the THREE (3) sources of cooling water available to the cleanup heat exchanger, HE-2?

(***** CATEGORY B CONTINUED ON NEXT PAGE *****)

QUESTION B.13 (1.00)

WHICH of the following most closely approximates the Capacity of the D2O Reflector Dump Tank?

A) 750 gal

B) 600 gal

C) 450 gal

D) 150 gal

E) 90 gal

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

QUESTION C.01 (3.00)

The questions below concern operating characteristics following a reactor startup to 4.9 MW without any subsequent changes in experiment loadings or experimental facilities. Assume the reactor had been shutdown for 3 months.

a) As normal operation continues, WHAT Two (2) effects must be compensated for by Shim Bank movement? (1.5)

b) As normal operation continues, HOW will the flux profile of the core be affected? (.5)

c) As normal operation continues, and if no adjustment of Nuclear Instrumentation is made, WILL the Nuclear Instrumentation yield a conservative or non-conservative reading? Explain your answer.

(***** CATEGORY C CONTINUED ON NEXT PAGE *****)

QUESTION C.02 (3.00)

Assume a reactor startup to 4.9 MW is performed Ten (10) hours after a reactor scram from 4.9 MW. Rod control is in automatic and no manual operator actions are performed.

a) As operation at 4.9 MW continues, Initially HOW will Regulating Rod Position be affected? Explain your answer.

b) WHAT will be the final position of the Regulating Rod?

c) WHAT final position(s) will the Shim Blades attain? Explain your answer.

(***** CATEGORY C CONTINUED ON NEXT PAGE *****)

QUESTION C.03 (1.50)

WHAT Variable Parameters are needed to calculate the Thermal Power of the Reactor?

(***** CATEGORY C CONTINUED ON NEXT PAGE *****)

QUESTION C.04 (2.25)

WHAT Three (3) operating limits or safety system setpoints must be observed or modified respectively if the reactor is to be operated with ONE primary coolant pump and heat exchanger on line. Include values/setpoints as applicable.

(***** CATEGORY C CONTINUED ON NEXT PAGE *****)

QUESTION C.05 (1.00)

Approximately HOW LONG does it take for the reactor to reach THERMAL equilibrium after being started up to full power? Explain your answer.

(***** CATEGORY C CONTINUED ON NEXT PAGE *****)

QUESTION C.06 (1.25)

WHAT facility feature(s) allow Natural Circulation Cooling to occur? HOW do these feature(s) contribute to sustaining natural circulation?

(***** CATEGORY C CONTINUED ON NEXT PAGE *****)

QUESTION C.07 (1.50)

HOW are fast neutrons generated in the Fast Neutron Spectrum Facility? HOW is the reactor involved?

(***** CATEGORY C CONTINUED ON NEXT PAGE *****)

QUESTION C.08 (1.00)

The Medical Therapy Facility utilizes Four (4) shutters to block and/or attenuate neutron flux, WHAT are these Four (4) shutters?

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

QUESTION D.01 (3.00)

The following concern reactor scrams:

a) WHAT system responses occur when a MINOR Scram is actuated? (.75)

b) WHERE can a MINOR Scram be initiated? (.75)

c) WHAT system responses occur when a MAJOR Scram is actuated? (.75)

d) WHERE can a MAJOR Scram be initiated? (.75)

(***** CATEGORY D CONTINUED ON NEXT PAGE *****)

QUESTION D.02 (1.00)

Operating the Dump Valve Switch will cause WHAT actuations?

(***** CATEGORY D CONTINUED ON NEXT PAGE *****)

QUESTION D.03 (1.00)

A reactor startup is underway, and the "Reactor Ready" light has energized; WHICH one of the following (A-D) accurately describe plant operation?

A) If the reflector tank level decreases, such that the reflector tank is not at overflow, a minor scram will result.

B) The regulating rod can be moved to any position of travel.

C) Shim Blade withdrawal motion is unlimited.

D) The "subcritical-bypass" pushbutton should be depressed to continue a normal startup.

(***** CATEGORY D CONTINUED ON NEXT PAGE *****)

QUESTION D.04 (1.00)

Once all shim blades have been withdrawn to the subcritical position, WHAT must be performed to continue withdrawing any given blade?

(***** CATEGORY D CONTINUED ON NEXT PAGE *****)

QUESTION D.05 (1.00)

WHICH one of the following is required in order to initiate the Automatic Control Mode?

A) The regulating rod must be withdrawn beyond its near-in position.

B) Deviation between power-set and actual power must not exceed 4%.

C) At least two (2) shim blades must be above the subcritical interlock position.

D) The main tank is at overflow level.

(***** CATEGORY D CONTINUED ON NEXT PAGE *****)

QUESTION D.06 (3.00)

For each Nuclear Instrumentation channel listed in Column I, select the function(s) and type(s) respectively from Columns II and III which are associated with the Nuclear Channel listed. Items A-I may be used more than once.

Column I Nuc. Instr. Channel	Column II Function	Column III Type
#1	A) Automatic Rod Contrl	G) Fission Chamber
#3	B) Power indication in power range	H) Uncompensated Ion Chamber
#5	C) Period Indication	I) Compensated Ion Chamber
#7	D) Countrate Indication	
#8	E) Scram Input	
	F) Operable During Offsite Power Outage	

(***** CATEGORY D CONTINUED ON NEXT PAGE *****)

QUESTION D.07 (1.00)

WHICH one of the following most accurately describes the operating principle of a Conductivity Cell?

A) The capacitance of the cell varies INVERSELY with the conductivity of the solution in which it is immersed.

B) The resistance of the cell varies DIRECTLY with the conductivity of the solution in which it is immersed.

C) A varying voltage across a conductivity cell is used to drive the conductivity indication.

D) The resistance of the cell varies INVERSELY with the conductivity of the solution in which it is immersed.

(***** CATEGORY D CONTINUED ON NEXT PAGE *****)

QUESTION D.08 (1.00)

HOW would a failure of the Primary Coolant Outlet Temperature Detector (MT-5A), such that an open circuit in the detector occured, affect the temperature indication from the detector?

(***** CATEGORY D CONTINUED ON NEXT PAGE *****)

QUESTION D.09 (1.00)

Primary Coolant Flow is measured by a differential pressure transmitter that is connected across a flow nozzle. WHICH one of the following would most closely represent the new flow rate if the differential pressure decreased by a factor of four (4)?

A) New flow rate is 1/16 the old flow rate.

B) New flow rate is 1/2 the old flow rate.

C) New flow rate is 2 times the old flow rate.

D) New flow rate is 16 times the old flow rate.

E) New flow rate is 4 times the old flow rate.

F) New flow rate is 1/4 the old flow rate.

QUESTION E.01 (1.00)

WHAT will occur if the radiation monitor in the off-gas pipe detects an abnormal activity?

(***** CATEGORY E CONTINUED ON NEXT PAGE *****)

QUESTION E.02 (1.00)

WHAT is the purpose of the Blowout Patch on the primary coolant storage tank?

(***** CATEGORY E CONTINUED ON NEXT PAGE *****)

QUESTION E.03 (1.00)

WHAT facility feature(s) minimize the loss of coolant due to a primary pipe break? WHERE are these feature(s) located?

(***** CATEGORY E CONTINUED ON NEXT PAGE *****)

QUESTION E.04 (1.00)

WHEN is a "Loss of Coolant Accident" alarm actuated? Include Setpoint.

(***** CATEGORY E CONTINUED ON NEXT PAGE *****)

QUESTION E.05 (1.00)

If a large primary coolant leak occurs exterior to the core tank and is not isolable, WHERE will core tank level eventually stabilize?

(***** CATEGORY E CONTINUED ON NEXT PAGE *****)

QUESTION E.06 (1.00)

If the containment pressure relief system is utilized, HOW would effluent passing through the system be processed?

(***** CATEGORY E CONTINUED ON NEXT PAGE *****)

QUESTION E.07 (1.00)

a) WHAT source of compressed air is available during a power outage?

b) WHAT plant equipment is supplied by emergency compressed air?

(***** CATEGORY E CONTINUED ON NEXT PAGE *****)

QUESTION E.08 (1.00)

Approximately HOW LONG can the Emergency Power Distribution System supply its loads during a power outage?

(***** CATEGORY E CONTINUED ON NEXT PAGE *****)

QUESTION E.09 (1.00)

WHAT must be performed before the Primary Coolant System Auxiliary Pump can be started on Emergency Power?

(***** CATEGORY E CONTINUED ON NEXT PAGE *****)

QUESTION E.10 (1.00)

WHICH one of the following can be powered from Emergency Power?

A) Recombiner Heaters

B) Personnel Lock

C) Startup Channels

D) Pneumatic Tube

(***** CATEGORY E CONTINUED ON NEXT PAGE *****)

QUESTION E.11 (1.00)

WHAT will cause the Emergency Power Motor-Generator Set to auto-stop?

(***** CATEGORY E CONTINUED ON NEXT PAGE *****)

QUESTION E.12 (1.00)

WHERE do the fire alarm boxes inside containment initiate an alarm?

(***** CATEGORY E CONTINUED ON NEXT PAGE *****)

QUESTION E.13 (1.00)

WHAT should automatically occur if both liquid waste tanks are alarming at the "high level"?

(***** END OF CATEGORY E *****)

QUESTION F.01 (1.50)

a) WHEN (under what condition) would City Water be utilized for emergency core cooling?

b) WHY is Cooling Tower Makeup secured when City Water is being used for Emergency Core Cooling?

(***** CATEGORY F CONTINUED ON NEXT PAGE *****)

QUESTION F.02 (2.00)

a) HOW would an operator manually initiate make-up to the primary storage tank if the make-up water system is operating?

b) How would an operator manually initiate make-up to the primary storage tank if the make-up water system is not operating?

(***** CATEGORY F CONTINUED ON NEXT PAGE *****)

QUESTION F.03 (1.00)

WHAT is the minimum complement of licensed personnel necessary in order to operate the reactor?

(***** CATEGORY F CONTINUED ON NEXT PAGE *****)

QUESTION F.04 (1.25)

WHAT are the four (4) Emergency Classifications for the MIT reactor?
ARRANGE these classifications from least severe to most severe.

(***** CATEGORY F CONTINUED ON NEXT PAGE *****)

QUESTION F.05 (1.00)

While the reactor is operating, an unknown cause adds negative reactivity such that reactor power begins to decrease. WHY should the shim blades or regulating rod NOT be withdrawn to compensate for the negative reactivity? WHAT could occur if the rods were withdrawn?

(***** CATEGORY F CONTINUED ON NEXT PAGE *****)

QUESTION F.06 (1.50)

A "Low Flow Primary Coolant" alarm has actuated:

a) WHAT protective action should automatically initiate in response to the above alarm?

b) WHY is the operator cautioned not to restart either or both primary coolant pumps or restore secondary flow to any heat exchanger that was secured unless all blades and the regulating rod are fully inserted?

(***** CATEGORY F CONTINUED ON NEXT PAGE *****)

QUESTION F.07 (1.00)

After operating at full power for a long time, the reactor scrams. The console operator observes that the "Low Pressure Shield Coolant" alarm has illuminated. Even though a scram has actuated, WHY is the operator directed to reestablish shield flow as quickly as possible?

(***** CATEGORY F CONTINUED ON NEXT PAGE *****)

QUESTION F.08 (1.00)

WHAT is the objective of establishing Technical Specification Safety Limits?

(***** CATEGORY F CONTINUED ON NEXT PAGE *****)

QUESTION F.09 (1.00)

WHAT are the two (2) administrative requirements that must be met before a routine sample can be inserted into the reactor?

(***** CATEGORY F CONTINUED ON NEXT PAGE *****)

QUESTION F.10 (1.00)

WHO is authorized to escort members of the general public through the reactor building?

(***** CATEGORY F CONTINUED ON NEXT PAGE *****)

QUESTION F.11 (1.00)

WHICH one of the following accurately describes requirements for the use of procedures by an operator?

A) Verbatim adherence to approved procedures is strictly enforced.

B) Every attempt should be made to follow approved procedures as written.

C) If an MIT procedure is less conservative than the Technical Specifications, the adequacy of the procedure can be approved by MIT reactor management.

D) Approved procedures are guides, and do not require compliance.

(***** CATEGORY F CONTINUED ON NEXT PAGE *****)

QUESTION F.12 (1.00)

WHOSE permission is required before a "Warning Tag" can be posted?

(***** END OF CATEGORY F *****)

QUESTION G.01 (1.00)

WHAT Two (2) types of dosimetry are all personnel working at the MIT reactor required to wear?

(***** CATEGORY G CONTINUED ON NEXT PAGE *****)

QUESTION G.02 (1.00)

WHICH one of the following most closely represents the exposure rate on top of the reactor (above the shielding) when the reactor is operating at 4.9 MW?

A) 1 mrem/hr

B) 10 mrem/hr

C) 20 mrem/hr

D) 50 mrem/hr

(***** CATEGORY G CONTINUED ON NEXT PAGE *****)

QUESTION G.03 (2.50)

WHAT Five (5) things will occur if the Exhaust Air Effluent Monitoring System picks up radiation levels in excess of operating limits?

(***** CATEGORY G CONTINUED ON NEXT PAGE *****)

QUESTION G.04 (1.50)

a) WHAT type of detector(s) monitor liquid waste effluent from the waste storage tanks to the sanitary sewer?

b) WHAT will occur if the liquid waste effluent monitor(s) alarm on high radiation?

(***** CATEGORY G CONTINUED ON NEXT PAGE *****)

QUESTION G.05 (1.50)

WHAT type of contamination is associated with D2O AND WHAT should be avoided when working with D2O in order to minimize any exposure hazard?

(***** CATEGORY G CONTINUED ON NEXT PAGE *****)

QUESTION G.06 (1.50)

HOW can it be confirmed if an individual has been exposed to neutron radiation?

(***** CATEGORY G CONTINUED ON NEXT PAGE *****)

QUESTION G.07 (1.00)

You have discovered some contamination on your hand during a frisk. HOW would you FIRST attempt to remove this contamination?

(***** CATEGORY G CONTINUED ON NEXT PAGE *****)

QUESTION G.08 (1.50)

WHAT are the quarterly NRC limits for radiation exposure of individuals in restricted areas?

(***** CATEGORY G CONTINUED ON NEXT PAGE *****)

QUESTION G.09 (1.00)

WHERE are the NRC limits for airborne radioactivity documented?

(***** CATEGORY G CONTINUED ON NEXT PAGE *****)

QUESTION G.10 (1.50)

WHAT Three (3) precautions can be taken by a radiation worker to minimize their exposure from a radiation source?

(***** CATEGORY G CONTINUED ON NEXT PAGE *****)

QUESTION G.11 (1.00)

A sample reading 1 Rem/hour is placed behind a 2 centimeter lead shield. WHAT will be the resulting exposure rate? Assume no buildup and a linear attenuation coefficients equal to .52 cm-1.

(***** END OF CATEGORY G *****)
(********** END OF EXAMINATION **********)

MIT 9/11/89
MASTER ANSWER KEY (RO)

ANSWER A.01 (1.00)

D (1.0)

REFERENCE

MITR-II, Rx Physics Notes, Reactor Kinetics

ANSWER A.02 (1.00)

C (1.0)

REFERENCE

MITR-II, Rx Physics Notes, Reactivity Feedback

ANSWER A.03 (1.00)

D (1.0)

REFERENCE

MITR-II, Rx Physics Notes, Reactivity Feedback

ANSWER A.04 (1.00) Deleted

A (1.0)

REFERENCE

MITR-II, Rx Physics Notes, Reactor Startup

ANSWER A.05 (1.00)

A (1.0)

REFERENCE

Robert Reed Burn, Intro. To Nuc. Reactor Operations, pgs 4-14 to 4-24

(***** CATEGORY A CONTINUED ON NEXT PAGE *****)

ANSWER A.06 (1.00)

a) (-1.4E-4 * 5 degrees = -7E-4 delta k/k (.25)

(-7E-4 delta k/k) / (.001 delta k/k/inch) [.25] = .7 inches [.25]

b) The control rod moves out (.25)

REFERENCE

~~CAP~~ RSM

ANSWER A.07 (1.00)

D (1.0)

REFERENCE

Robert Reed Burn, Intro. To Nuc. Reactor Operations, page 5-18

ANSWER A.08 (1.00)

B (1.0)

REFERENCE

MITR-II, Reactor Systems Manual, Chapter 10

ANSWER A.09 (2.00)

From inspection, Doubling Time = 25 seconds (.5)
T=DT/ln2 T=36.07 sec (.5)

Using Inhour Equation and neglecting the prompt contribution,
T= (Beff-p)/Lp reduces to p= Beff/(1+TL) (.25)

p = .00786/(1+36.07 *.1) = .0017 delta k/k (.5)

Therefore, differential Rod Worth is .0017 delta k/k between 50 and 55%.
(.25)

(***** CATEGORY A CONTINUED ON NEXT PAGE *****)

REFERENCE

MITR-II, Rx Physics Notes, Control Rod Calibration

ANSWER A.10 (1.75)

a)

Keff1 = 1/ 1-p (.25) Keff1 = 1/(1-(-.6667)) = .60 (.25)

CR= S/ 1-Keff (.25) CR = 1000/ 1-.60 = 2500 (.25)

b)

New core reactivity = -.6667 + .50 = -.1667 delta k/k (.25)
Keff = 1/ 1-p = 1/ (1-(-.1667)) = .8571 (.25)
CR= 1000/ 1-.8571 = 6998 (.25)

REFERENCE

MITR-II Rx Physics Notes, Subcritical Multiplication

ANSWER A.11 (1.00)

A (1.0)

REFERENCE

Technical Specifications

ANSWER A.12 (2.00)

a) (tube flow)*(tube delta T) = (shell flow)* (shell delta T) (.25)

shell flow = 1600 * (95-91.6)/ (78.6-75) (.5)

shell flow = 1511 gpm (.25)

b) Q=mCp(dT) (.25)
=(1600 gpm * 1min/60sec * 1cuft/7.48gal * 62.41b/cuft) * (1btu/1b*F)
*(3.4F) (.5)

Q=756.4 BTU/sec (.25)

(***** CATEGORY A CONTINUED ON NEXT PAGE *****)

REFERENCE

CAF

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

ANSWER B.01 (1.00)

To increase the surface available for heat transfer (1.0)

REFERENCE

Reactor Systems Manual, page 1.2

ANSWER B.02 (1.00)

In the A-ring and or B-ring (1.0) OR, IN THE 27 Fuel Element Positions.

REFERENCE

Reactor Systems Manual-1.2

ANSWER B.03 (1.00)

To maintain D2O purity (1.0)

REFERENCE

Reactor Systems Manual-1.2

ANSWER B.04 (1.00)

C (1.0)

REFERENCE

Reactor Systems Manual-1.3

ANSWER B.05 (1.50)

a) Gamma Radiation Heating (.5)

b) (Demineralized) water is circulated through cooling coils in the lead (.5)

c) A reactor scram will result (.5)

(***** CATEGORY B CONTINUED ON NEXT PAGE *****)

REFERENCE

Reactor Systems Manual- 1.3 and 3.13

ANSWER B.06 (1.00)

To create a large uniform flux of thermal neutrons (1.0)

REFERENCE

Reactor Systems Manual-1.3

ANSWER B.07 (1.00) Question Deleted

Boron (.5), to permit more fuel to be loaded into the core (.5)

REFERENCE

Reactor Systems Manual-1.4

ANSWER B.08 (1.00)

To provide an outer flow path for primary coolant (.5)
To support the fuel storage liner (.5)

REFERENCE

RSM-1.7 and figure 1.4

ANSWER B.09 (1.00)

Hydraulic Resistance in the guide tube (.5) acts as a damping force on the shim blade assembly (.5)

REFERENCE

Reactor Systems Manual-1.10

ANSWER B.10 (1.00)

The regulating rod mechanism has no electro-magnet assembly (1.0)

(***** CATEGORY B CONTINUED ON NEXT PAGE *****)

REFERENCE

Reactor Systems Manual-1.10

ANSWER B.11 (2.50)

1) C (.5 each)
2) C
3) A
4) A
5) ~~X~~A Due to facility modification

REFERENCE

Reactor Systems Manual-2.10

ANSWER B.12 (1.50)

Secondary Cooling System (.5)
~~Air-Conditioning Cooling System (.5)~~
City Water (.5)

REFERENCE

Reactor Systems Manual-3.4

ANSWER B.13 (1.00)

D, 150 gal (1.0)

REFERENCE

Reactor Systems Manual figure 3.3-1

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

ANSWER C.01 (3.00)

a) Short lived fission product poisons (.75)
Fuel burnup (.75)
OR Temperature Increase

b) The axial flux profile moves upward in the core (max flux moves upward) (.5)

c) Non-Conservative (.25). Flux redistribution decreases the flux seen by the detectors (.40) even though total power is still the same (or greater) (.35)

REFERENCE

Procedures Manual-2.4 page 1

ANSWER C.02 (3.00)

a) The regulating rod will drive in to compensate for Xe burnup (.5)

b) Fully inserted (.5)

c) One Shim Blade (the one selected) will rundown (.5) (30 seconds) after the Regulating Rod reaches its near-in position (.5). The other Shim Blades will maintain their original position (.5), because they are not affected by the rundown (.5).

REFERENCE

Procedures Manual-2.4 page 3

ANSWER C.03 (1.50)

Primary Flow Rate (.25) and delta T across core (.25)
Reflector (D20) Flow Rate (.52) and Reflector delta T (.25)
Shield Flow Rate (.25) and Shield delta T (.25)

REFERENCE

Procedures Manual-2.4

(***** CATEGORY C CONTINUED ON NEXT PAGE *****)

ANSWER C.04 (2.25)

Power (.5) <= 2.5 MW (.25)
Scram setpoint (.5) set to 2.75 MW (.25)
Flow Scram (.5) set to 900 gpm (.25)

REFERENCE

Procedures Manual-2.4

ANSWER C.05 (1.00)

24 hours (.5), the graphite reflector takes a long time to reach thermal equilibrium (.5).

REFERENCE

Reactor Systems Manual-6.4

ANSWER C.06 (1.25)

Four convection valves on the lower part of the core shroud (.5) will open when pressure above the core exceeds the presssure below the core (.75) allowing natural circulation cooling to occur.

REFERENCE

Reactor Systems Manual-1.15

ANSWER C.07 (1.50)

Neutrons produced by the reactor (.25) ~~are thermalized in the Thermal Column (.25) and enter the Hohlraum Area (.25). The Converter Cart (.25), which contains a lattice of slightly enriched U 235 (.25), is irradiated and produces fast neutrons from fission (.25).~~ impinge low enriched fuel (.25) in the GCHI facility, producing fast neutrons via fission. (1.0)

REFERENCE

Reactor Systems Manual-2.3

(***** CATEGORY C CONTINUED ON NEXT PAGE *****)

ANSWER C.08 (1.00)

D2O Blister Tank (.25)
H2O Shutter Tank (.25)
Boral Shutter (.25)
Lead Shutter (.25)

REFERENCE

Reactor Systems Manual-2.11

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

ANSWER D.01 (3.00)

a) all six blades drop into the core (.25) and drives run in (.25)
regulating rod drives in (.25)

b) reactor console (.4) or medical therapy room (.35).

c) all six blades drop into core and drives run in } (minor scram)
regulating rod drives in }

Dump D2O reflector (.25)
Seal the containment (.25)

d) reactor console (.40) or utility room (.35)

REFERENCE

Reactor Systems Manual-4.1

ANSWER D.02 (1.00)

Dump the D2O reflector (.5) and
Cause a minor scram (.5)

REFERENCE

reactor systems manual-4.1

ANSWER D.03 (1.00)

B (1.0)

REFERENCE

Reactor Systems Manual, 4.1-4.3

ANSWER D.04 (1.00)

Depress the "manual-control" pushbutton (1.0)

(***** CATEGORY D CONTINUED ON NEXT PAGE *****)

REFERENCE

Reactor Systems Manual-4.4

ANSWER D.05 (1.00)

A (1.0)

REFERENCE

Reactor Systems Manual-4.4

ANSWER D.06 (3.00)

Channel 1: B,C,D,E,G,H (.1 each)

Channel 3: B,C,E,F,X^H (.1 each, "F" is worth .2)

Channel 5: B,E,H (.2 each)

Channel 7: B,I (.3 each)

Channel 8: B,F,H (.2 each)

REFERENCE

Reactor Systems Manual 5.1-5.9

ANSWER D.07 (1.00)

D (1.0)

REFERENCE

Reactor Systems Manual 6.2.1

ANSWER D.08 (1.00)

The temperature indication would be high (1.0)

(***** CATEGORY D CONTINUED ON NEXT PAGE *****)

REFERENCE

Reactor Systems Manual-6.3

ANSWER D.09 (1.00)

B (1.0)

REFERENCE

Reactor Systems Manual 6.5

(***** END OF CATEGORY D *****)

ANSWER E.01 (1.00)

Off-gas is isolated (1.0) (blower stops and two isolation valves close) Actuates on alarm.

REFERENCE

Reactor Systems Manual-3.4

ANSWER E.02 (1.00)

To protect the primary coolant system (.75) against overpressurization (.25). (protection against tank overpressure not acceptable).

REFERENCE

Reactor Systems Manual-3.4

ANSWER E.03 (1.00)

Anti-siphon valves (.5) located above the core inlet piping penetrations (.5).

REFERENCE

Procedures Manual 4.4.4.4 page 1

ANSWER E.04 (1.00)

When the primary coolant level drops (.333) 4.0" (.333) below the overflow point (.333). and the primary storage tank low level (-2")

REFERENCE

Procedures Manual 4.4.4.4 page 1

ANSWER E.05 (1.00)

At the reactor inlet penetration (1.0) (-52" on level gauge)

(***** CATEGORY E CONTINUED ON NEXT PAGE *****)

REFERENCE

Procedures Manual 4.4.4.4 page 2

ANSWER E.06 (1.00)

A high efficiency particulate filter (.5) and an activated charcoal filter (.5) (would remove particulate matter and radioactive iodine from the effluent).

REFERENCE

Reactor Systems Manual-8.23

ANSWER E.07 (1.00)

a) an emergency compressed air cylinder (.5)

b) air locks (.5)

REFERENCE

Reactor Systems Manual-8.28

ANSWER E.08 (1.00)

four hours (1.0) (Six-Eight hours w/ load shedding)

REFERENCE

Reactor Systems Manual-8.37

ANSWER E.09 (1.00)

Reset its circuit breaker (1.0)

REFERENCE

Reactor Systems Manual-8.37

(***** CATEGORY E CONTINUED ON NEXT PAGE *****)

ANSWER E.10 (1.00) Deleted
(C or D are correct)

D (1.0)

REFERENCE

Reactor Systems Manual-8.34

ANSWER E.11 (1.00)

Normal power is restored (1.0)

REFERENCE

Reactor Systems Manual-8.38

ANSWER E.12 (1.00)

In the control room (1.0)

REFERENCE

Reactor Systems Manual-8.42

ANSWER E.13 (1.00)

City water solenoid valve closes (.5)
Sump Pump(s) stop (.5)
+ Alarm

REFERENCE

Reactor Systems Manual-9.11

(***** END OF CATEGORY E *****)

ANSWER F.01 (1.50)

a) Core tank level drops below the reactor inlet penetration (1.0) (-52" on the level gauge)

b) To ensure full city water pressure to the spray nozzles (.5) (ECCS)

REFERENCE

Procedures Manual 4.4.4.4 page 2

ANSWER F.02 (2.00)

a) open WV-23 (.5) (valve # not required)
hold open MV-101 using the push button located by the primary storage tank (.5).

b) Connect fire hose (.5) from make-up storage tank (.25) to primary storage tank (.25) and allow gravity feed (WV-11 to WV-20)

ANSWER F.03 (1.00)

Two licensed operators (.5), at least one of which is an SRO (.5).

ANSWER F.04 (1.25)

Unusual Event (.25) (.25 for correct order)
Alert (.25)
Site Area Emergency (.25)
General Emergency (.25)

REFERENCE

Procedures Manual 4.4 page 2

ANSWER F.05 (1.00)

(Because the source of the -p is unknown) the reactivity may suddenly reappear (.5), possibly initiating an excursion (.5).

(***** CATEGORY F CONTINUED ON NEXT PAGE *****)

REFERENCE

Procedures Manual 4.4.4.8 page 1

ANSWER F.06 (1.50)

a) minor scram (.5)

b) to prevent sending a cold slug of water through the core (1.0)

REFERENCE

Procedures Manual 5.2.4

ANSWER F.07 (1.00)

Because the reactor shields may require a long time (8 hours) to cool (.5). In the meantime, high temperatures could melt the lead shielding (.5).

REFERENCE

Procedures Manual 5.4.7

ANSWER F.08 (1.00)

To establish limits within which the integrity of the fuel clad is maintained (to protect fuel clad integrity). (1.0)

REFERENCE

Technical Specifications 2.1

ANSWER F.09 (1.00)

Completed Irradiation Information Form presented to duty operator (.5)

Duty operator gives permission (.5)

REFERENCE

Procedures Manual 1.10 page 5

(***** CATEGORY F CONTINUED ON NEXT PAGE *****)

ANSWER F.10 (1.00)

Holders of yellow film badges (1.0)

REFERENCE

Procedures Manual 1.12 page 1

ANSWER F.11 (1.00)

B (1.0)

REFERENCE

Procedures Manual 1.5 page 1

ANSWER F.12 (1.00)

on-duty console operator (1.0)

REFERENCE

Procedures Manual 1.14

(***** END OF CATEGORY F *****)

ANSWER G.01 (1.00)

Film badge (beta gamma) (.5)
Pocket dosimeter (gamma) (.5)

REFERENCE

Procedures Manual 1.14 page 3

ANSWER G.02 (1.00)

B
X (1.0)

REFERENCE

Reactor Systems Manual 1.14

ANSWER G.03 (2.50)

Intake (.5) and Exhaust (.5) butterfly dampers close
Intake (.5) and Exhaust (.5) fans stop
Auxiliary Fan stops (.5)
Alarm

REFERENCE

Reactor Systems Manual 8.15

ANSWER G.04 (1.50)

a) Gamma Scintillation (.75)
b) Sewer Pump Trips (.75)

REFERENCE

Reactor Systems Manual 7.4.2

ANSWER G.05 (1.50)

Tritium
~~Alpha Contamination~~ (.5)
Avoid skin contact (.5) and breathing D20 vapor (.5)

(***** CATEGORY G CONTINUED ON NEXT PAGE *****)

REFERENCE

Procedures Manual 5.3.4

ANSWER G.06 (1.50)

Count the activity of the Indium Foil (.5) atop the individual's film badge (.5). Activity of this Indium indicates neutron irradiation (.5).

REFERENCE

Procedures Manual 4.4.4.10

ANSWER G.07 (1.00)

Wash the affected area with soap (.5) and lukewarm (.25) water (.25).

REFERENCE

Procedures Manual 4.4.4.10 page 4

ANSWER G.08 (1.50)

Whole Body 1.25 Rem/Qtr (.5)
Skin 7.5 Rem/Qtr (.5)
Extremities 18.75 Rem/Qtr (.5)

REFERENCE

RPD, Appendix 2

ANSWER G.09 (1.00)

10 CFR 20 Appendix B (1.0)

REFERENCE

10 CFR

(***** CATEGORY G CONTINUED ON NEXT PAGE *****)

ANSWER G.10 (1.50)

Minimize time near the source (.5)
Maximize distance between the worker and the source (.5)
Utilize shielding to reduce radiation levels (.5)

REFERENCE

Standard radiation worker knowledge

ANSWER G.11 (1.00)

I= (1 R/hr)e^-.52*2 (1.0) from I=Io*e^-ux
= .36 R/hr

REFERENCE

CAF

(***** END OF CATEGORY G *****)
(********** END OF EXAMINATION **********)

QUESTION	VALUE	REFERENCE
A.01	1.00	9000223
A.02	1.00	9000224
A.03	1.00	9000225
A.04	1.00	9000226
A.05	1.00	9000227
A.06	1.00	9000228
A.07	1.00	9000229
A.08	1.00	9000230
A.09	2.00	9000231
A.10	1.75	9000232
A.11	1.00	9000233
A.12	2.00	9000234
	14.75	
B.01	1.00	9000235
B.02	1.00	9000236
B.03	1.00	9000237
B.04	1.00	9000238
B.05	1.50	9000239
B.06	1.00	9000240
B.07	1.00	9000241
B.08	1.00	9000242
B.09	1.00	9000243
B.10	1.00	9000244
B.11	2.50	9000245
B.12	1.50	9000246
B.13	1.00	9000247
	15.50	
C.01	3.00	9000248
C.02	3.00	9000249
C.03	1.50	9000250
C.04	2.25	9000251
C.05	1.00	9000252
C.06	1.25	9000253
C.07	1.50	9000254
C.08	1.00	9000255
	14.50	
D.01	3.00	9000256
D.02	1.00	9000257
D.03	1.00	9000258
D.04	1.00	9000259
D.05	1.00	9000260
D.06	3.00	9000261
D.07	1.00	9000262
D.08	1.00	9000263
D.09	1.00	9000264
	13.00	
E.01	1.00	9000265

QUESTION	VALUE	REFERENCE
E.02	1.00	9000266
E.03	1.00	9000267
E.04	1.00	9000268
E.05	1.00	9000269
E.06	1.00	9000270
E.07	1.00	9000271
E.08	1.00	9000272
E.09	1.00	9000273
E.10	1.00	9000274
E.11	1.00	9000275
E.12	1.00	9000276
E.13	1.00	9000277
	13.00	
F.01	1.50	9000278
F.02	2.00	9000279
F.03	1.00	9000280
F.04	1.25	9000281
F.05	1.00	9000282
F.06	1.50	9000283
F.07	1.00	9000284
F.08	1.00	9000285
F.09	1.00	9000286
F.10	1.00	9000287
F.11	1.00	9000288
F.12	1.00	9000289
	14.25	
G.01	1.00	9000290
G.02	1.00	9000291
G.03	2.50	9000292
G.04	1.50	9000293
G.05	1.50	9000294
G.06	1.50	9000295
G.07	1.00	9000296
G.08	1.50	9000297
G.09	1.00	9000298
G.10	1.50	9000299
G.11	1.00	9000300
	15.00	
	100.00	

Master Exam (SRO)

MIT 9/14/89

Attachment

#2

Nuclear Regulatory Commission
Operator Licensing
Examination

This document is removed from
Official Use Only category on
date of examination.

U. S. NUCLEAR REGULATORY COMMISSION
SENIOR REACTOR OPERATOR LICENSE EXAMINATION
REGION 1

FACILITY: Mass. Inst. of Tech.

REACTOR TYPE: MITR-II

DATE ADMINSTERED: 89/09/11

CANDIDATE: _____

INSTRUCTIONS TO CANDIDATE:

Use separate paper for the answers. Write answers on one side only. Staple question sheet on top of the answer sheets. Points for each question are indicated in parentheses after the question. The passing grade requires at least 70% in each category. Examination papers will be picked up six (6) hours after the examination starts.

CATEGORY VALUE	% OF TOTAL	CANDIDATE'S SCORE	% OF CAT. VALUE	CATEGORY
~~18.75~~ 17.25	~~18.75~~			H. REACTOR THEORY
~~20.00~~ 19.5	~~20.00~~			I. RADIOACTIVE MATERIALS HANDLING DISPOSAL AND HAZARDS
22.50	~~22.50~~			J. SPECIFIC OPERATING CHARACTERISTICS
18.00	~~18.00~~			K. FUEL HANDLING AND CORE PARAMETERS
~~20.00~~ 18.75	~~20.00~~			L. ADMINISTRATIVE PROCEDURES, CONDITIONS AND LIMITATIONS
~~97.50~~ 96.0			%	TOTALS
		FINAL GRADE		

All work done on this examination is my own. I have neither given nor received aid.

_____
Candidate's Signature

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. You may write your answers on the examination question page or on a separate sheet of paper. USE ONLY THE PAPER PROVIDED AND DO NOT WRITE ON THE BACK SIDE OF THE PAGE.

8. If you write your answers on the examination question page and you need more space to answer a specific question, use a separate sheet of the paper provided and insert it directly after the specific question. DO NOT WRITE ON THE BACK SIDE OF THE EXAMINATION QUESTION PAGE.

9. Print your name in the upper right-hand corner of the first page of each section of your answer sheets whether you use the examination question pages or separate sheets of paper. Initial each page.

10. 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.

11. If you are using separate sheets, number each answer as to category and number (i.e. 1.04, 6.10) and skip at least 3 lines between answers to allow space for grading.

12. Write "End of Category " at the end of your answers to a category.

13. Start each category on a new page.

14. Write "Last Page on the last answer sheet.

15. Use abbreviations only if they are commonly used in facility literature. Avoid using symbols such as < or > signs to avoid a simple transposition error resulting in an incorrect answer. Write it out.

16. The point value for each question is indicated in parentheses after the question. The amount of blank space on an examination question page is NOT an indication of the depth of answer required.

17. Show all calculations, methods, or assumptions used to obtain an answer.

18. Partial credit may be given. Therefore, ANSWER ALL PARTS OF THE QUESTION AND DO NOT LEAVE ANY ANSWER BLANK. NOTE: partial credit will NOT be given on multiple choice questions.

19. Proportional grading will be applied. Any additional wrong information that is provided may count against you. For example, if a question is worth one point and asks for four responses, each of which is worth 0.25 points, and you give five responses, each of your responses will be worth 0.20 points. If one of your five responses is incorrect, 0.20 will be deducted and your total credit for that question will be 0.80 instead of 1.00 even though you got the four correct answers.

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

21. When turning in your examination, assemble the completed examination with examination questions, examination aids and answer sheets. In addition, turn in all scrap paper.

22. To pass the examination, you must achieve an overall grade of 80% or greater and at least 70% in each category.

23. There is a time limit of (6) hours for completion of the examination. (or some other time if less that the full examination is taken.)

24. 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.

QUESTION H.01 (1.00)

WHICH one of the following are true concerning Delayed and/or Prompt Neutrons?

A) Delayed Neutrons are born at higher energies than Prompt Neutrons.

B) The average energy of a Delayed Neutron is 2 MeV.

C) Delayed Neutrons are more likely to be lost by leakage and parasitic absorption than Prompt Neutrons.

D) In the process of slowing down, the fraction of Prompt Neutrons that are lost is larger than the fraction of ~~Thermal~~ Delayed Neutrons that are lost.

(***** CATEGORY H CONTINUED ON NEXT PAGE *****)

QUESTION H.02 (1.00)

WHICH one of the following accurately describe the effect that Moderator Temperature has on core physics?

A) As moderator temperature increases, the mean free path between scattering collisions decreases.

B) Less neutrons will exit the core as moderator temperature increases.

C) As moderator temperature increases, neutrons are more likely to be absorbed by Uranium 238 and Plutonium-240.

D) Rod Worth will increase as moderator temperature decreases.

(***** CATEGORY H CONTINUED ON NEXT PAGE *****)

QUESTION H.03 (1.00)

WHICH one of the following accurately describe the effect that Fuel Temperature has on core physics?

A) A fuel temperature decrease results in Doppler Broadening of U-238 and Pu-240 resonance peaks and the decrease of resonance escape probability.

B) A decrease in fuel temperature will decrease neutron absorption by U-238 and Pu-240.

C) A fuel temperature increase results in Doppler Broadening of U-238 and Pu-240 resonance peaks and the decrease of neutron absorption during moderation.

D) A fuel temperature decrease will decrease the resonance escape probability.

(***** CATEGORY H CONTINUED ON NEXT PAGE *****)

QUESTION H.04 (1.00) Question Deleted

With the reactor critical, a Source is introduced to the core. WHICH one of the following is an accurate statement 50 generations AFTER the source is inserted?

A) The new countrate will be the original countrate PLUS 50 times the sources' contribution per generation.

B) The reactor will be supercritical, and the countrate will be increasing in an exponential fashion.

C) The countrate will be identical to the countrate before the source was added.

D) The board operator would notice a positive period.

(***** CATEGORY H CONTINUED ON NEXT PAGE *****)

QUESTION H.05 (1.00)

With the reactor at 25% power the control board operator scrams the reactor. WHICH one of the following most closely represents the resulting reactor behavior? Assume "zero power" is equal to or less than .001%.

A) A prompt drop followed by a -80 second period decay to zero power.

B) A prompt drop followed by a -26 second period decay to zero power

C) A prompt drop followed by a -26 second period decay, followed by a -80 second period decay to zero power.

D) A prompt drop to essentially zero power.

(***** CATEGORY H CONTINUED ON NEXT PAGE *****)

QUESTION H.06 (1.00)

Over a period of time while the reactor is operating in the automatic mode at 800 KW, the fuel temperature increased from 400 degrees to 405 degrees C. Assuming the temperature coefficient for the reactor is -1.4 x 10**-4 delta k/k/degree C, the regulating rod is worth 0.1% delta k/k/inch, and none of the other control elements move.

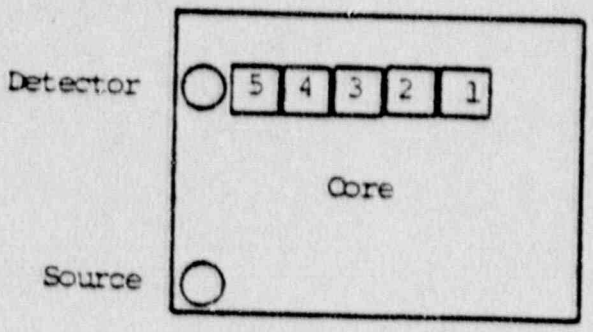
a) HOW FAR would the regulating rod move to compensate for the temperature change? (.75)

b) In What direction would the regulating rod move? (.25)

(***** CATEGORY H CONTINUED ON NEXT PAGE *****)

QUESTION H.07 (1.00)

What would be the expected consequence of loading fuel in the manner depicted in the figure below. (Fuel element 1 is loaded first, fuel element 2 loaded second, etc).



A) The 1/M plot would be concave, and would predict critical mass in an unconservative manner.

B) The 1/M plot would be convex, and would predict critical mass in a conservative manner.

C) The 1/M plot would be concave, and would predict critical mass in a conservative manner.

D) The 1/M plot would be convex, and would predict critical mass in an unconservative manner.

(***** CATEGORY H CONTINUED ON NEXT PAGE *****)

QUESTION H.08 (1.00)

WHICH one of the following accurately detail a factor contributing to Xenon balance within the reactor.

A) Most Xe-135 is formed by fission.

B) Tellurium-135 is a fission product which quickly decays to I-135.

C) Within approximately 8 hours after startup to full power, Xe-135 has reached its equilibrium value.

D) Several minutes following a reactor shutdown, Xe level is increasing because I-135 is not being produced.

(***** CATEGORY H CONTINUED ON NEXT PAGE *****)

QUESTION H.09 (2.00)

Given the following information:

Time	Power	Rod Position
0	50 W	50%
25 sec	100 W	55%

Determine the DIFFERENTIAL ROD WORTH between rod positions of 50% and 55%.
(L=.1 sec-1, Beff=.00786)

(λ)

(***** CATEGORY H CONTINUED ON NEXT PAGE *****)

QUESTION H.10 (1.75)

The reactor is subcritical by -.6667 delta k/k with an inserted source contributing 1000 neutrons per generation.

A) What is the reactor countrate? (1.0)

B) Some time later, control rods insert reactivity worth +.50 delta k/k. WHAT will be the resulting Countrate (.75)

(***** CATEGORY H CONTINUED ON NEXT PAGE *****)

QUESTION H.11 (1.00)

WHICH one of the following statements accurately describe the effect that different operations will have on Shutdown Margin (SDM)?

A) As primary light water temperature increases, SDM will INCREASE.

B) Following a shutdown, as fuel temperature cools, SDM will DECREASE.

C) Replacing an old fuel element with a fresh element will INCREASE SDM.

D) Reducing the temperature of the D2O Tank would INCREASE SDM.

E) A facility modification, which increased rod travel speed, would also INCREASE SDM.

(***** CATEGORY H CONTINUED ON NEXT PAGE *****)

QUESTION H.12 (2.50)

The following concern Safety Limits:

a) WHY is water height above the core included as a Safety Limit variable?

b) WHAT other plant parameters are needed to verify that Safety Limits are being adhered to? Assume core parameters have not been changed.

(***** CATEGORY H CONTINUED ON NEXT PAGE *****)

QUESTION H.13 (2.00)

After a refueling or change in core loading, the accuracy of the Safety Limit graph must be reverified. DESCRIBE the variables that are involved in reverifying the Safety Limit graph?

(***** CATEGORY H CONTINUED ON NEXT PAGE *****)

QUESTION H.14 (1.00)

WHICH one of the following ~~are~~ is accurate?

A) It is more likely for Heavy water to leak into the light water primary system than for the Light water to leak into the Heavy water system.

B) The neutron migration length in Heavy water is greater than the neutron migration length in Light water.

C) If Light water were to enter the Heavy water reflector, a positive reactivity effect would result.

D) If Heavy water were to enter the walls and bottom of the core tank, a negative reactivity effect would result first.

E) Heavy water has a larger absorption cross section than Light water.

(***** END OF CATEGORY H *****)

QUESTION I.01 (1.00) Question Deleted

WHICH one of the following most closely represents the exposure rate on top of the reactor (above the shielding) when the reactor is operating at 4.9 MW?

A) 1 mrem/hr

B) 10 mrem/hr

C) 20 mrem/hr

D) 50 mrem/hr

(***** CATEGORY I CONTINUED ON NEXT PAGE *****)

QUESTION 1.02 (2.50)

WHAT Five (5) things will occur if the Exhaust Air Effluent Monitoring System picks up radiation levels in excess of operating limits?

(***** CATEGORY I CONTINUED ON NEXT PAGE *****)

QUESTION I.03 (1.50)

a) WHAT type of detector(s) monitor liquid waste effluent from the waste storage tanks to the sanitary sewer?

b) WHAT will occur if the liquid waste effluent monitor(s) alarm on high radiation?

(***** CATEGORY I CONTINUED ON NEXT PAGE *****)

QUESTION 1.04 (1.50)

WHAT type of contamination is associated with D2O AND WHAT should be avoided when working with D2O in order to minimize any exposure hazard?

(***** CATEGORY I CONTINUED ON NEXT PAGE *****)

QUESTION I.05 (1.50)

HOW can it be confirmed if an individual has been exposed to neutron radiation?

(***** CATEGORY I CONTINUED ON NEXT PAGE *****)

QUESTION I.06 (1.00)

You have discovered some contamination on your hand during a frisk. HOW would you FIRST attempt to remove this contamination?

(***** CATEGORY I CONTINUED ON NEXT PAGE *****)

QUESTION I.07 (1.50)

WHAT are the NRC quarterly limits for radiation exposure of individuals in restricted areas?

(***** CATEGORY I CONTINUED ON NEXT PAGE *****)

QUESTION I.08 (1.50)

WHAT Three (3) precautions can be taken by a radiation worker to minimize their exposure from a radiation source?

(***** CATEGORY I CONTINUED ON NEXT PAGE *****)

QUESTION 1.09 (1.00)

A sample reading 1 Rem/hour is placed behind a 2 centimeter lead shield. WHAT will be the resulting exposure rate? Assume no buildup and a linear attenuation coefficiente equal to .52 cm-1.

(***** CATEGORY I CONTINUED ON NEXT PAGE *****)

QUESTION 1.10 (1.50)

You wish to store a small radioactive source temporarily in the reactor building. The source strength is estimated to be 500 millicuries and it emits gamma rays of an average energy of 1.3 Mev. CALCULATE how far from the source you would have to erect a "CAUTION - HIGH RADIATION AREA" barrier. Show all work.

(***** CATEGORY I CONTINUED ON NEXT PAGE *****)

QUESTION I.11 (2.00)

The following measurements are made from a beta-gamma point source:

2 Rem/hr at six inches
0.5 mrem/hr at ten feet

What are the relative fractions of betas and gammas emitted? State all assumptions and show calculations.

(***** CATEGORY I CONTINUED ON NEXT PAGE *****)

QUESTION 1.12 (1.00)

WHAT must be assumed if the High Radiation Set-Up Area Vault Alarm has actuated?

(***** CATEGORY I CONTINUED ON NEXT PAGE *****)

QUESTION I.13 (1.00)

WHICH one of the following correctly describe when Action 1X would be implemented?

A) There is danger that people in the path of the effluent might receive an integrated dose of more than 1 Rem whole body or 5 Rem thyroid as a result of exposure to the effluent for 1 hour.

B) There is danger that people in the path of the effluent have received an integrated dose of more 10 Rem whole body or 50 Rem thyroid as a result of exposure to the effluent for 1 hour.

C) The release is such that the probable internal dose to people in the path of the effluent is less than 1 Rem whole body or 5 Rem thyroid over a period of 1 hour.

D) The dose rate at any point outside of the site boundary is greater than 0.5 Rem/hour.

E) The dose rate everywhere outside of the exclusion area are less than 0.5 Rem/hour but greater than 0.6 mrem/hour.

(***** CATEGORY I CONTINUED ON NEXT PAGE *****)

QUESTION I.14 (1.00)

Following an inventory of source material, it is determined that a loss of material has occured and that a substantial hazard may result to persons in unrestricted areas. WHEN should the loss be reported to the NRC?

(***** CATEGORY I CONTINUED ON NEXT PAGE *****)

QUESTION I.15 (1.00)

WHO is responsible for decisions and coordination of all immediate actions during a radiological emergency?

(***** END OF CATEGORY I *****)

QUESTION J.01 (3.00)

The questions below concern operating characteristics following a reactor startup to 4.9 MW without any subsequent changes in experiment loadings or experimental facilities. Assume the reactor had been shutdown for 3 months.

a) As normal operation continues, WHAT Two (2) effects must be compensated for by Shim Bank movement? (1.5)

b) As normal operation continues, HOW will the flux profile of the core be affected? (.5)

c) As normal operation continues, and if no adjustment of Nuclear Instrumentation is made, WILL the Nuclear Instrumentation yield a conservative or non-conservative reading? Explain your answer.

(***** CATEGORY J CONTINUED ON NEXT PAGE *****)

QUESTION J.02 (3.00)

Assume a reactor startup to 4.9 MW is performed Ten (10) hours after a reactor scram from 4.9 MW. Rod control is in automatic and no manual operator actions are performed.

a) As operation at 4.9 MW continues, Initially HOW will Regulating Rod Position be affected? Explain your answer.

b) WHAT will be the final position of the Regulating Rod?

c) WHAT final position(s) will the Shim Blades attain? Explain your answer.

(***** CATEGORY J CONTINUED ON NEXT PAGE *****)

QUESTION J.03 (2.25)

WHAT Variable Parameters are needed to calculate the Thermal Power of the Reactor?

(***** CATEGORY J CONTINUED ON NEXT PAGE *****)

QUESTION J.04 (1.00)

Approximately HOW LONG does it take for the reactor to reach thermal equilibrium after being started up to full power? Explain your answer.

(***** CATEGORY J CONTINUED ON NEXT PAGE *****)

QUESTION J.05 (1.25)

WHAT facility feature(s) allow Natural Circulation Cooling to occur? HOW do these feature(s) contribute to sustaining natural circulation?

(***** CATEGORY J CONTINUED ON NEXT PAGE *****)

QUESTION J.06 (1.50)

HOW are fast neutrons generated in the Fast Neutron Spectrum Facility? HOW is the reactor involved?

(***** CATEGORY J CONTINUED ON NEXT PAGE *****)

QUESTION J.07 (1.00)

The Medical Therapy Facility utilizes Four (4) shutters to block and/or attenuate neutron flux. WHAT are these Four (4) shutters?

(***** CATEGORY J CONTINUED ON NEXT PAGE *****)

QUESTION J.08 (1.50)

MATCH the descriptions from Column II with the Technical Specification definition from Column I for which it is associated. Each item from Column II may be used more than once~~x~~ or not at all.

Column I	Column II
1. Reactor Secured	A. Regulating Rod Inserted
2. Reactor Shutdown	B. All Control Blades Inserted
	C. Core Defueled
	D. Console Key Removed
	E. No work in progress
	F. Secordary Cooling Secured
	G. Containment Ventilation Secured

(***** CATEGORY J CONTINUED ON NEXT PAGE *****)

QUESTION J.09 (1.00)

WHEN is the Reactor Floor Ar-41 Monitor most likely to alarm? Assume all cover gas systems are operating normally

(***** CATEGORY J CONTINUED ON NEXT PAGE *****)

QUESTION J.10 (1.50)

WHEN can the radial heavy water reflector be filled? Explain your answer.

(***** CATEGORY J CONTINUED ON NEXT PAGE *****)

QUESTION J.11 (1.50)

WHAT reactivity effect is caused by the heavy water reflector during HEATING of the primary light water as a result of a reactor startup? Explain your answer.

(***** CATEGORY J CONTINUED ON NEXT PAGE *****)

QUESTION J.12 (1.00)

WHEN is Containment Integrity required to be maintained?

(***** CATEGORY J CONTINUED ON NEXT PAGE *****)

QUESTION J.13 (1.50)

a) WHEN (under what condition) would City Water be utilized for emergency core cooling?

b) WHY is Cooling Tower Makeup secured when City Water is being used for Emergency Core Cooling?

(***** CATEGORY J CONTINUED ON NEXT PAGE *****)

QUESTION J.14 (1.50)

A "Low Flow Primary Coolant" alarm has actuated:

a) WHAT protective action should automatically initiate in response to the above alarm?

b) WHY is the operator cautioned not to restart either or both primary coolant pumps or restore secondary flow to any heat exchanger that was secured unless all blades and the regulating rod are fully inserted?

QUESTION K.01 (1.00)

WHAT are Two (2) reasons that the reactor is normally shutdown for 48 hours prior to refueling?

(***** CATEGORY K CONTINUED ON NEXT PAGE *****)

QUESTION K.02 (1.00)

WHAT interlock is associated with the reactor hold-down grid latch?

(***** CATEGORY K CONTINUED ON NEXT PAGE *****)

QUESTION K.03 (1.00)

WHAT Technical Specification criteria must be considered when determining what position the heavy water reflector will be in during refueling?

(***** CATEGORY K CONTINUED ON NEXT PAGE *****)

QUESTION K.04 (1.00)

WHAT reactivity effect must be considered when a fuel element is removed from the core?

(***** CATEGORY K CONTINUED ON NEXT PAGE *****)

QUESTION K.05 (1.00)

HOW is streaming of gamma radiation reduced when irradiated fuel is being moved in the air space beneath the top shield?

(***** CATEGORY K CONTINUED ON NEXT PAGE *****)

QUESTION K.06 (3.50)

The following data was taken during a core loading:

Fuel Elements	Detector A	Detector B	Detector C
		CR with all rods out	
0	270	303	350
2	290	400	499
4	323	526	666
6	385	800	1075
8	472	1429	2326

a) Estimate the number of fuel elements needed to go critical. Use graph paper provided. (2.0)

b) Was the source detector geometry satisfactory for each detector? Briefly explain. (1.0)

c) What additional information could have been obtained so that the total worth of the control rods could have been estimated? (.5)

(***** CATEGORY K CONTINUED ON NEXT PAGE *****)

QUESTION K.07 (1.0C)

After loading new fuel into the core, in WHICH ring will the highest mbeta/gm of U-235 be found? Explain your answer.

(***** CATEGORY K CONTINUED ON NEXT PAGE *****)

QUESTION K.08 (1.50)

STATE Two (2) parameters that must be observed during movement of fuel in the core which would require notification of personnel on the reactor top?

(***** CATEGORY K CONTINUED ON NEXT PAGE *****)

QUESTION K.09 (1.00)

Of what material are the fuel dummies constructed?

(***** CATEGORY K CONTINUED ON NEXT PAGE *****)

QUESTION K.10 (1.00)

HOW MANY core positions may be empty at one time during a refueling?

(***** CATEGORY K CONTINUED ON NEXT PAGE *****)

QUESTION K.11 (1.00)

From HOW MANY positions within the core, can fuel elements/dummies be transferred to the transfer cask?

(***** CATEGORY K CONTINUED ON NEXT PAGE *****)

QUESTION K.12 (1.00)

WHY are the shim blades required to be within 20 inches of the average shim blade height?

(***** CATEGORY K CONTINUED ON NEXT PAGE *****)

QUESTION K.13 (1.00)

According to the Technical Specifications, WHAT is the maximum power level where a Pu-Be source may be used in the core?

(***** CATEGORY K CONTINUED ON NEXT PAGE *****)

QUESTION K.14 (2.00)

STATE Four (4) locations where irradiated fuel may be stored at the MITR facility.

(***** END OF CATEGORY K *****)

QUESTION L.01 (1.00)

WHO is responsible for administration of the radiation protection program at the reactor facility?

(***** CATEGORY L CONTINUED ON NEXT PAGE *****)

QUESTION L.02 (1.00)

WHO (one title) has the overall responsibility on a shift for reactor operation, personnel safety, maintenance activities, and physical security of the plant?

(***** CATEGORY L CONTINUED ON NEXT PAGE *****)

QUESTION L.03 (1.75)

MATCH each procedure from Column II with its "classification" from Column I.

Column I	Column II
1. CLASS "A"	A. Scram Tests
	B. Abnormal Operating Procedure
2. CLASS "B"	C. Administrative Procedures
	D. Requalification Program
3. CLASS "C"	E. Interlock Tests
	F. Standard Operating Plans
	G. Nuclear Related Maintenance Procedure

(***** CATEGORY L CONTINUED ON NEXT PAGE *****)

QUESTION L.04 (2.00)

The following concern "Unreviewed Safety Questions":

a) WHERE can the definition of an "Unreviewed Safety Question" be found?

b) WHAT is one (1) of the three (3) criteria for determining whether an Unreviewed Safety Question exists?

(***** CATEGORY L CONTINUED ON NEXT PAGE *****)

QUESTION L.05 (1.00)

WHAT "Equipment Change Classification" pertains to changes or modifications of reactor systems that do not involve an Unreviewed Safety Question?

(***** CATEGORY L CONTINUED ON NEXT PAGE *****)

QUESTION L.06 (1.00)

WHICH one of the following accurately describe requirements pertaining to the use of procedures by an operator?

A) Verbatim adherence to approved procedures is strictly enforced.

B) Every attempt should be made to follow approved procedures as written.

C) If an MIT procedure is less conservative than the Technical Specifications, the adequacy of the procedure can be approved by MIT reactor management.

D) Approved procedures are guides, and do not require compliance.

(***** CATEGORY L CONTINUED ON NEXT PAGE *****)

QUESTION L.07 (1.00)

WHAT Two (2) major subjects must be discussed by the supervisory senior reactor operators during shift turnover?

(***** CATEGORY L CONTINUED ON NEXT PAGE *****)

QUESTION L.08 (1.00)

WHEN is it permissible to bypass safety functions required by Technical Specifications?

(***** CATEGORY L CONTINUED ON NEXT PAGE *****)

QUESTION L.09 (1.50)

WHAT personnel/groups must approve proposed irradiations?

(***** CATEGORY L CONTINUED ON NEXT PAGE *****)

QUESTION L.10 (1.00)

WHAT are the two (2) requirements that must be met before an approved routine sample can be inserted into the reactor?

(***** CATEGORY L CONTINUED ON NEXT PAGE *****)

QUESTION L.11 (1.00)

WHO is authorized to escort membe-s of the general public through the reactor building?

(***** CATEGORY L CONTINUED ON NEXT PAGE *****)

QUESTION L.12 (1.50)

WHO (more than one) must approve a Class B plan, procedure or equipment change? Assume radiation protection considerations are involved.

(***** CATEGORY L CONTINUED ON NEXT PAGE *****)

QUESTION L.13 (1.50)

a) WHAT action must be taken by an operator if a Safety Limit is exceeded?

b) If a Safety Limit is exceeded, WHEN can the reactor be restarted?

(***** CATEGORY L CONTINUED ON NEXT PAGE *****)

QUESTION L.14 (1.0)

WHICH one of the following is Reportable to the NRC?

A) The Primary Coolant Scram flowrate is found to be 900 gallons per minute while the reactor is operating with one primary pump in use.

B) Fuel being stored outside the core is determined to have a Keff=.85.

C) The Main Tank - Low Coolant Level Scram is found to be 3 inches below the overflow pipe.

D) A reactor shutdown is initiated due to a requirement in the Technical Specification.

(***** CATEGORY L CONTINUED ON NEXT PAGE *****)

QUESTION L.15 (1.50)

While conducting a normal reactor startup the 5th shim blade is raised to the subcritical position. If the period meter now indicates a steady value less than infinity, WHAT should be done?

(***** END OF CATEGORY L *****)
(********** END OF EXAMINATION **********)

MIT 9/14/89
Master Answer Key (SRO)

ANSWER H.01 (1.00)

D (1.0)

REFERENCE

MITR-II, Rx Physics Notes, Reactor Kinetics

ANSWER H.02 (1.00)

C (1.0)

REFERENCE

MITR-II, Rx Physics Notes, Reactivity Feedback

ANSWER H.03 (1.00)

B (1.0)

REFERENCE

MITR-II, Rx Physics Notes, Reactivity Feedback

ANSWER H.04 (1.00) Question Deleted

A (1.0)

REFERENCE

MITR-II, Rx Physics Notes, Reactor Startup

ANSWER H.05 (1.00)

X A (1.0

REFERENCE

Robert Reed Burn, Intro. To Nuc. Reactor Operations, pgs 4-14 to 4-24

(***** CATEGORY H CONTINUED ON NEXT PAGE *****)

ANSWER H.06 (1.00)

a) (-1.4E-4 * 5 degrees = -7E-4 delta k/k (.25)

(-7E-4 delta k/k) / (.001 delta k/k/inch) [.25] = .7 inches [.25]

b) The control rod moves out (.25)

REFERENCE

caf

ANSWER H.07 (1.00)

D (1.0)

REFERENCE

Robert Reed Burn, Intro. To Nuc. Reactor Operations, page 5-18

ANSWER H.08 (1.00)

B (1.0)

REFERENCE

MITR-II, Reactor Systems Manual, Chapter 10

ANSWER H.09 (2.00)

From inspection, Doubling Time = 25 seconds (.5)
T=DT/ln2 T=36.07 sec (.5)

Using Inhour Equation and neglecting the prompt contribution,
T= (Beff-p)/Lp reduces to p= Beff/(1+TL) (.25)

p = .00786/(1+36.07 *.1) = .0017 delta k/k (.5)

Therefore, differential Rod Worth is .0017 delta k/k between 50 and 55%.
(.25)

(***** CATEGORY H CONTINUED ON NEXT PAGE *****)

REFERENCE

MITR-II, Rx Physics Notes, Control Rod Calibration

ANSWER H.10 (1.75)

a)

Keff1 = 1/ 1-p (.25) Keff1 = 1/(1-(-.6667)) = .60 (.25)

CR= S/ 1-Keff (.25) CR = 1000/ 1-.60 = 2500 (.25)

b)

New core reactivity = -.6667 + .50 = -.1667 delta k/k (.25)
Keff = 1/ 1-p = 1/ (1-(-.1667)) = .8571 (.25)
CR= 1000/ 1-.8571 = 6998 (.25)

REFERENCE

MITR-II Rx Physics Notes, Subcritical Multiplication

ANSWER H.11 (1.00)

A (1.0)

REFERENCE

Technical Specifications

ANSWER H.12 (2.50)

a) Saturation temperature in the core (.5) is directly dependent on the static head (.5) of the water above the core.

b) Total Reactor Thermal Power (.5)
Reactor Coolant Total Flowrate (.5)
Reactor Coolant Outlet Temperature (.5)

REFERENCE

MITR, Technical Specifications, 2.1

(***** CATEGORY H CONTINUED ON NEXT PAGE *****)

ANSWER H.13 (2.00)

Fp : fraction of total power generated by the fuel (.5)

Fhc: hot channel factor, power in hotest coolant channel/ ave. channel pwr (.5)

df : flow disparity, min expected flow in the hot channel/ave coolant flow (.5)

Ff : fraction of primary flow cooling the fuel (.5)

REFERENCE

MITR, TS 2.1

ANSWER H.14 (1.00)

B (1.0)

REFERENCE

Reactor Systems Manual 10.9

(***** END OF CATEGORY H *****)

ANSWER I.01 (1.00) Neutron Detected

A (1.0)

REFERENCE

Reactor Systems Manual 1.14

ANSWER I.02 (2.50)

Intake (.5) and Exhaust (.5) butterfly dampers close
Intake (.5) and Exhaust (.5) fans stop
Auxiliary Fan stops (.5)

Alarm: Abnormal ΔP
High Radiation

Core Purge Blower Trips

REFERENCE

Reactor Systems Manual 8.15

ANSWER I.03 (1.50)

a) Gamma Scintillation (.75)
b) Sewer Pump Trips (.75)

+ Alarm

REFERENCE

Reactor Systems Manual 7.4.2

ANSWER I.04 (1.50)

~~Alpha Contamination~~ TRITIUM (.5)
Avoid skin contact (.5) and breathing D2O vapor (.5)

REFERENCE

Procedures Manual 5.3.4

ANSWER I.05 (1.50)

Count the activity of the Indium Foil (.5) atop the individual's film badge (.5). Activity of this Indium indicates neutron irradiation (.5).

(***** CATEGORY I CONTINUED ON NEXT PAGE *****)

REFERENCE

Procedures Manual 4.4.4.10

ANSWER I.06 (1.00)

Wash the affected area with soap (.5) and lukewarm (.25) water (.25).

REFERENCE

Procedures Manual 4.4.4.10 page 4

ANSWER I.07 (1.50)

Whole Body 1.25 Rem/Qtr (.5)
Skin 7.5 Rem/Qtr (.5)
Extremities 18.75 Rem/Qtr (.5)

REFERENCE

RPO, Appendix 2

ANSWER I.08 (1.50)

Minimize time near the source (.5)
Maximize distance between the worker and the source (.5)
Utilize shielding to reduce radiation levels (.5)

REFERENCE

Standard radiation worker knowledge

ANSWER I.09 (1.00)

I= (1 R/hr)e^-.52*2 (1.0) from I=Io*e^-ux
= .36 R/hr

REFERENCE

~~DAK~~ RPO

(***** CATEGORY I CONTINUED ON NEXT PAGE *****)

ANSWER I.10 (1.50)

R/hr = 6*E/d^2 d^2 = 6*.5*1.3 / .1 (1.0)
therefore d = 6.25 feet
where a high rad area = 100 mr/hr (.5)

REFERENCE

Gamma Energy

ANSWER I.11 (2.00)

assume beta will not travel 10 feet in air, therefore .5 mr is gamma (.5)

gamma dose at 1/2' = R1*D1^2/D2^2 = .5*10^2/.5^2 = 200 mr/hr (.5)

therefore beta contribution at 6 inches is 2000-200 = 1800 mr/hr (.5)

beta contribution / gamma contribution = 1800/200 = 9 (.5)

REFERENCE

beta gamma point sources

ANSWER I.12 (1.00)

An inadvertent criticality has occured (1.0)

REFERENCE

AOP 5.6.1

ANSWER I.13 (1.00)

A (1.0)

REFERENCE

Emergency Plan, PM 4.7.3 page 2

(***** CATEGORY I CONTINUED ON NEXT PAGE *****)

ANSWER I.14 (1.00)

Immediately (1.0)

REFERENCE

10 CFR 20.402(a)(1)

ANSWER I.15 (1.00)

Senior SRO licensed member on shift (1.0)

REFERENCE

Emergency Plan, PM 4.3

(***** END OF CATEGORY I *****)

ANSWER J.01 (3.00)

a) Short lived fission product poisons (.75)
Fuel burnup (.75)
OR, Temperature Effect

b) The axial flux profile moves upward in the core (max flux moves upward) (.5)

c) Non-Conservative (.25). Flux redistribution decreases the flux seen by the detectors (.40) even though total power is still the same (or greater) (.35)

REFERENCE

Procedures Manual-2.4 page 1

ANSWER J.02 (3.00)

a) The regulating rod will drive in to compensate for Xe burnup (.5)

b) Fully inserted (.5)

c) One Shim Blade (the one selected) will rundown (.5) (30 seconds) after the Regulating Rod reaches its near-in position (.5). The other Shim Blades will maintain their original position (.5), because they are not affected by the rundown (.5).

REFERENCE

Procedures Manual-2.4 page 3

ANSWER J.03 (2.25)

Primary Flow Rate (.5) and delta T across core (.25)
Reflector (D2O) Flow Rate (.5) and Reflector delta T (.25)
Shield Flow Rate (.5) and Shield delta T (.25)

REFERENCE

Procedures Manual-2.4

(***** CATEGORY J CONTINUED ON NEXT PAGE *****)

ANSWER J.04 (1.00)

24 hours (.5), the graphite reflector takes a long time to reach thermal equilibrium (.5).

REFERENCE

Reactor Systems Manual-6.4

ANSWER J.05 (1.25)

Four convection valves on the lower part of the core shroud (.5) will open when pressure above the core exceeds the pressure below the core (.75) allowing natural circulation cooling to occur.

REFERENCE

Reactor Systems Manual-3.15

ANSWER J.06 (1.50)

Neutrons produced by the reactor (~~.25~~) enter the 6CHI facility ~~are thermalized in the thermal column (.25) and enter the Wahlraum Area (.25). The Converter Cart (.25),~~ which contains a ~~lattice~~ bundle of slightly enriched U-235 (~~.25~~), is irradiated and produces fast neutrons from fission (~~.25~~).

REFERENCE

Reactor Systems Manual-2.3

ANSWER J.07 (1.00)

D2O Blister Tank (.25)
H2O Shutter Tank (.25)
Boral Shutter (.25)
Lead Shutter (.25)

REFERENCE

Reactor Systems Manual-2.11

(***** CATEGORY J CONTINUED ON NEXT PAGE *****)

ANSWER J.08 (1.50)

1. B,C,D,E (.25 each) Inclusion of "A" acceptable

2. B,C (.25) Exclusion of "A" acceptable

REFERENCE

MITR, TS page 1-1

ANSWER J.09 (1.00)

Under a condition of inadequate ventilation following a period when the reactor was operating (1.0).

REFERENCE

AOP PM 5.5.8

ANSWER J.10 (1.50)

Can be filled when the shim bank is fully inserted (.5). This ensures that the reactivity insertion (.5) associated with the filling process will not cause an inadvertent criticality (.5).

REFERENCE

RSM-10.6

ANSWER J.11 (1.50)

Heating of the heavy water (.5) causes the negative temperature coefficient to add negative reactivity (.5) by allowing more neutrons to leak out of the system (.5).

REFERENCE

Reactor Systems Manual 10.7

(***** CATEGORY J CONTINUED ON NEXT PAGE *****)

ANSWER J.12 (1.00)

Whenever the reactor is not secured (.5) or
movement of irradiated (unsealed, casked) fuel is being performed (.5)

REFERENCE

Technical Specification 3.5

ANSWER J.13 (1.50)

a) Core tank level drops below the reactor inlet penetration (1.0) (-52" on the level gauge)

b) To ensure full city water pressure to the spray nozzles (.5) (ECCS)

REFERENCE

Procedures Manual 4.4.4.4 page 2

ANSWER J.14 (1.50)

a) minor scram (.5)

b) to prevent sending a cold slug of water through the core (1.0)

REFERENCE

Procedures Manual 5.2.4

(***** END OF CATEGORY J *****)

ANSWER K.01 (1.00)

Permit decay of Na-24 (.5) Or, Lower fluid Levels About Core Tank
Permit dissipation of decay heat (.5)

REFERENCE

PM 2.7 and MIT examination comments for 9/5/84 SRO examination

ANSWER K.02 (1.00)

An interlock which will stop the primary coolant pumps (1.0)

REFERENCE

PM 2.7 page 3

ANSWER K.03 (1.00)

Adequate shutdown margin must be maintained (1.0)

REFERENCE

PM 2.7 page 3

ANSWER K.04 (1.00)

Reactivity addition due to the addition of water to the core (1.0)

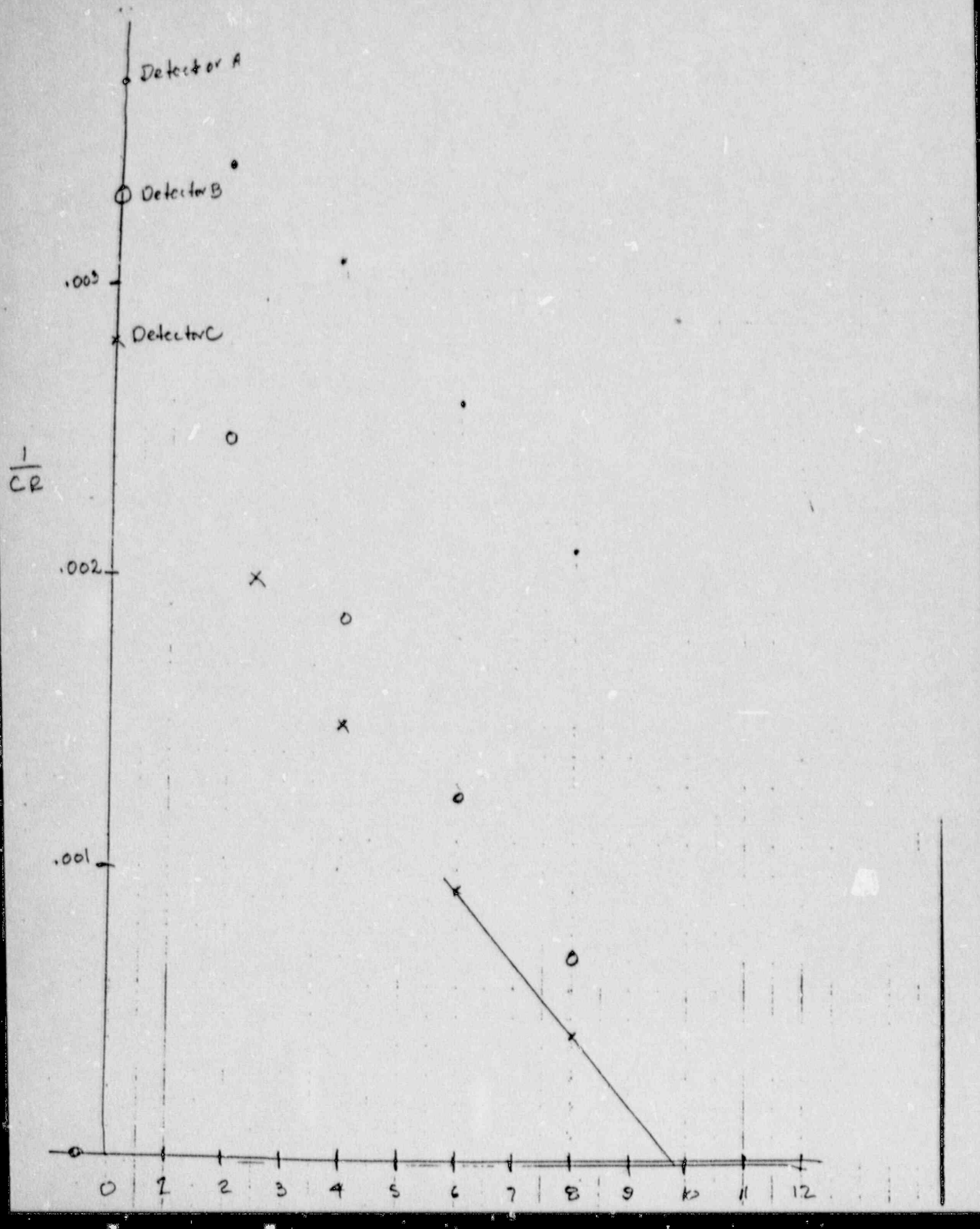
REFERENCE

PM 2.7 page 3

ANSWER K.05 (1.00)

A lead filled sleeve encircles the fuel (1.0)

(***** CATEGORY K CONTINUED ON NEXT PAGE *****)


Detector A
Detector B
Detector C
.003
.002
.001
1/CR
0
1
2
3
4
5
6
7
8
9
10
11
12

REFERENCE

PM 2.7 page 5

ANSWER K.06 (3.50)

a) See attached sketch - 10 fuel elements (2.0)

b) good geometry for B (.25) and C (.25) but not A (.25) - probably A is too close to the source (.25).

c) count rate for all rods in the core. (.5)

REFERENCE

RSM 10.9

ANSWER K.07 (1.00)

"A" ring (.5) because the flux is higher in this ring (.5)

REFERENCE

RSM 10.8

ANSWER K.08 (1.50)

2 of the following: (.75 each)
-subcritical multiplication increases by 2 or more
-steady positive period when no equipment is being moved in the core
-sustained increases in radiation level

REFERENCE

PM 3.3.1 page 2

ANSWER K.09 (1.00)

Aluminum (1.0)

(***** CATEGORY K CONTINUED ON NEXT PAGE *****)

REFERENCE

PM 3.3.1 page 3

ANSWER K.10 (1.00)

one (1.0)

REFERENCE

PM 3.3.1.1 page 1

ANSWER K.11 (1.00)

5 (1.0)

REFERENCE

PM 3.3.2 page 3

ANSWER K.12 (1.00)

- To avoid a higher power output per element due to the potential for adverse power peaking (1.0).
- To promote uniform burnup. - To maintain blade wear (flux vs work others)

REFERENCE

Technical Specification page 3-41

ANSWER K.13 (1.00)

500 KW (1.0)

REFERENCE

Technical Specifications page 3-40a

(***** CATEGORY K CONTINUED ON NEXT PAGE *****)

ANSWER K.14 (2.00)

4 of the following at .5 each:

-reactor core
-storage ring on the flow shroud
-dry storage holes on the reactor top
-spent fuel storage tank in reactor building basement
-fuel element transfer flask
-inside other proper shield within controlled area

REFERENCE

Technical Specifications page 3-37

(***** END OF CATEGORY K *****)

ANSWER L.01 (1.00)

MITR radiation protection officer (1.0)

REFERENCE

PM 1.1.3 page 1

ANSWER L.02 (1.00)

Duty Shift Supervisor (1.0)

REFERENCE

PM 1.3 page 1

ANSWER L.03 (1.75)

1. D,F (.25 each)
2. B,C,G
3. A,E

REFERENCE

PM 1.4 page 1

ANSWER L.04 (2.00)

a) 10 CFR 50.59 OR PM 1.4 (1.0)

b) one of the three criteria from 10CFR50.59 or PM 1.4 page 2 (1.0)

REFERENCE

10 CFR 50.59 or PM 1.4

ANSWER L.05 (1.00)

Class B (1.0)

(***** CATEGORY L CONTINUED ON NEXT PAGE *****)

REFERENCE

PM 1.4 page 2

ANSWER L.06 (1.00)

B (1.0)

REFERENCE

Procedures Manual 1.5 page 1

ANSWER L.07 (1.00)

Reactor Status (.5)
Experiment Status (.5)

REFERENCE

PM 1.7 page 1

ANSWER L.08 (1.00)

When the reactor is shutdown (1.0)

REFERENCE

PM 1.9 page 1

ANSWER L.09 (1.50)

MIT Reactor Safeguards Committee (.5)
Reactor Operations (.5)
Radiation Protection Office (.5)

REFERENCE

PM 1.10 page 1

(***** CATEGORY L CONTINUED ON NEXT PAGE *****)

ANSWER L.10 (1.00)

Completed Irradiation Information Form presented to duty operator (.5)

Duty operator gives permission (.5)

REFERENCE

Procedures Manual 1.10 page 5

ANSWER L.11 (1.00)

Holders of yellow film badges (1.0)

REFERENCE

Procedures Manual 1.12 page 1

ANSWER L.12 (1.50)

Two SROs (.5)
Director of Reactor Operations (.5)
MITR Radiation Protection Officer (or alternate) (.5)

REFERENCE

PM 1.4 page 3

ANSWER L.13 (1.50)

a) Reactor must be shutdown (.75)

b) After being authorized by the NRC (.75)

REFERENCE

Technical Specifications 7.7.1

(***** CATEGORY L CONTINUED ON NEXT PAGE *****)

ANSWER L.14 (1.0) ~~(2.50)~~

D (1.0)

REFERENCE

MITR Technical Specification

ANSWER L.15 (1.50)

Shutdown the reactor (.75)
Notify the Superintendent (.75)

REFERENCE

PM 2.3 page 1

(***** END OF CATEGORY L *****)
(********** END OF EXAMINATION **********)

QUESTION	VALUE	REFERENCE
H.01	1.00	9000001
H.02	1.00	9000002
H.03	1.00	9000003
H.04	1.00	9000004
H.05	1.00	9000005
H.06	1.00	9000006
H.07	1.00	9000007
H.08	1.00	9000008
H.09	2.00	9000009
H.10	1.75	9000010
H.11	1.00	9000011
H.12	2.50	9000012
H.13	2.00	9000013
H.14	1.00	9000014
	18.25	
I.01	1.00	9000015
I.02	2.50	9000016
I.03	1.50	9000017
I.04	1.50	9000018
I.05	1.50	9000019
I.06	1.00	9000020
I.07	1.50	9000021
I.08	1.50	9000022
I.09	1.00	9000023
I.10	1.50	9000024
I.11	2.00	9000025
I.12	1.00	9000026
I.13	1.00	9000027
I.14	1.00	9000028
I.15	1.00	9000029
	20.50	
J.01	3.00	9000030
J.02	3.00	9000031
J.03	2.25	9000032
J.04	1.00	9000033
J.05	1.25	9000034
J.06	1.50	9000035
J.07	1.00	9000036
J.08	1.50	9000037
J.09	1.00	9000038
J.10	1.50	9000039
J.11	1.50	9000040
J.12	1.00	9000041
J.13	1.50	9000042
J.14	1.50	9000043
	22.50	
K.01	1.00	9000044
K.02	1.00	9000045
K.03	1.00	9000046

QUESTION	VALUE	REFERENCE
K.04	1.00	9000047
K.05	1.00	9000048
K.06	3.50	9000049
K.07	1.00	9000050
K.08	1.50	9000051
K.09	1.00	9000052
K.10	1.00	9000053
K.11	1.00	9000054
K.12	1.00	9000055
K.13	1.00	9000056
K.14	2.00	9000057
	18.00	
L.01	1.00	9000058
L.02	1.00	9000059
L.03	1.75	9000060
L.04	2.00	9000061
L.05	1.00	9000062
L.06	1.00	9000063
L.07	1.00	9000064
L.08	1.00	9000065
L.09	1.50	9000066
L.10	1.00	9000067
L.11	1.00	9000068
L.12	1.50	9000069
L.13	1.50	9000070
L.14	2.50	9000071
L.15	1.50	9000072
	20.25	
	99.50	