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

EXAMINATION REPORT NO. 50-020/88-01(OL)

FACILITY DOCKET NO. 50-020

FACILITY LICENSE NO. R-37

LICENSEE: Massachusetts Institute of Technology
138 Albany Street
Cambridge, Massachusetts 02139

FACILITY: MIT Research Reactor

EXAMINATION DATES: January 25 - 26, 1988

CHIEF EXAMINER: _____ 3 Mar 88
Barry S. Norris Date
Senior Operations Engineer

APPROVED BY: _____ 3-10-88
Peter W. Eselgroth, Chief Date
PWR Section, Division of Reactor Safety

SUMMARY: Written and operating examinations were administered to two Senior Reactor Operator (SRO) candidates and one Reactor Operator (RO) candidate. All candidates passed the examinations and received their licenses.

DETAILS

TYPE OF EXAMINATIONS: Replacement

EXAMINATION RESULTS:

	RO Pass/Fail	SRO Pass/Fail
Written	1 / 0	2 / 0
Operating	1 / 0	2 / 0
Overall	1 / 0	2 / 0

CHIEF EXAMINER AT SITE: B. S. Norris (USNRC)

OTHER EXAMINERS: M. O. Bishop (EG&G)
W. S. Rosener (EG&G)

1. The following is a generic deficiency noted during the operating examinations. This information is being provided to aid the licensee in upgrading license and requalification training programs. No licensee response is required.

   A lack of in-depth knowledge of the operation of the automatic containment isolation valve was noted. In general, candidates were not able to clearly describe the operation of the valve beyond the fact that a major scram would cause it to close.

2. Personnel Present at Exit Meeting:

   NRC Personnel
   B. S. Norris - Chief Examiner

   NRC Contractor Personnel
   M. O. Bishop - Examiner, EG&G
   W. S. Rosener - Examiner, EG&G

   Facility Personnel
   J. A. Bernard - Superintendent, MITR
   L. Clark - Director, Reactor Operations
   O. V. Harling - Director, NRL
   K. Kwok - Assistant Superintendent, MITR

3. Summary of Comments Made at Exit Meeting:

   a. It was noted by the NRC that the lead seal on the Emergency Decontamination locker in the control room was not properly attached.

      The facility stated that the contents would be reinventoried immediately and that the locker would be sealed.

   b. The NRC noted that there is no accountability system in place to control the issuance of keys from the key locker in the control room.

      The facility stated that they did not think that control of the keys was required for safe operation, but that they would reevaluate the situation.

4. The written examination questions and answers were reviewed by the facility after all candidates had completed the examination. The primary reviewer was K. Kwok.

Attachments:
1. RO Written Examination and Answer Key
2. SRO Written Examination and Answer Key
3. Facility Comments and NRC Resolution on RO Written Examination
4. Facility Comments and NRC Resolution on SRO Written Examination

Attachment 1

U. S. NUCLEAR REGULATORY COMMISSION
REACTOR OPERATOR LICENSE EXAMINATION

FACILITY: MIT

REACTOR TYPE: RESEARCH

DATE ADMINSTERED: 88/01/25

EXAMINER: BISHOP, M.

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
15.50	15.50	_____	_____	A.	PRINCIPLES OF REACTOR OPERATION
12.50	12.50	_____	_____	B.	FEATURES OF FACILITY DESIGN
14.50	14.50	_____	_____	C.	GENERAL OPERATING CHARACTERISTICS
15.00	15.00	_____	_____	D.	INSTRUMENTS AND CONTROLS
14.00	14.00	_____	_____	E.	SAFETY AND EMERGENCY SYSTEMS
14.50	14.50	_____	_____	F.	STANDARD AND EMERGENCY OPERATING PROCEDURES
14.00	14.00	_____	_____	G.	RADIATION CONTROL AND SAFETY
100.0		_____ Final Grade	_____%		Totals

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

_____
Candidate's Signature

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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. 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.

3. Use black ink or dark pencil only to facilitate legible reproductions.

4. Print your name in the blank provided on the cover sheet of the examination.

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

6. Use only the paper provided for answers.

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

8. Consecutively number each answer sheet, write "End of Category __" as appropriate, start each category on a new page, write only on one side of the paper, and write "Last Page" on the last answer sheet.

9. Number each answer as to category and number, for example, 1.4, 6.3.

10. Skip at least three lines between each answer.

11. Separate answer sheets from pad and place finished answer sheets face down on your desk or table.

12. Use abbreviations only if they are commonly used in facility literature.

13. The point value for each question is indicated in parentheses after the question and can be used as a guide for the depth of answer required.

14. Show all calculations, methods, or assumptions used to obtain an answer to mathematical problems whether indicated in the question or not.

15. Partial credit may be given. Therefore, ANSWER ALL PARTS OF THE QUESTION AND DO NOT LEAVE ANY ANSWER BLANK.

16. If parts of the examination are not clear as to intent, ask questions of the examiner only.

17. You must sign the statement on the cover sheet that indicates that the work is your own and you have not received or been given assistance in completing the examination. This must be done after the examination has been completed.

18. When you complete your examination, you shall:

a. Assemble your examination as follows:

(1) Exam questions on top.

(2) Exam aids - figures, tables, etc.

(3) Answer pages including figures which are part of the answer.

b. Turn in your copy of the examination and all pages used to answer the examination questions.

c. Turn in all scrap paper and the balance of the paper that you did not use for answering the questions.

d. Leave the examination area, as defined by the examiner. If after leaving, you are found in this area while the examination is still in progress, your license may be denied or revoked.

QUESTION A.01 (2.50)

If the reactor is on a stable 25-second period, HOW long will it take to change the power level by 2 decades? SHOW all work.

QUESTION A.02 (2.00)

Briefly describe the two phenomena that contribute to the moderator temperature coefficient of reactivity for MITR-II.

QUESTION A.03 (2.00)

The MITR-II reactor produces a relatively fast response for a given reactivity input. Explain this response in terms of neutron generation time and delayed neutron fraction (BETA) at MITR-II.

QUESTION A.04 (2.00)

INDICATE whether each of the following statements are TRUE or FALSE.

a. An increasing concentration of Xe-135 reduces the thermal utilization factor, f, and 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 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 the radioactive decay of Xe-135 atoms.

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

QUESTION A.05 (3.00)

HOW much reactivity has been added to a subcritical reactor if the count rate has increased from 100 cps to 150 cps and if the initial value of Keff was 0.95? SHOW ALL WORK and express your answer in percent delta K/K.

QUESTION A.06 (2.00)

When calculating an estimated critical position for reactor startup, the operator uses the previous week's position and corrects for five possible different delta K changes. LIST four of the possible delta K changes.

QUESTION A.07 (2.00)

Refer to Figure 1, Regulating Rod - Control Blade Assembly, in back of test. Identify the components labeled A though D on the figure.

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

QUESTION B.01 (3.00)

Refer to Figure 2, Reactor Core Tank Support, in back of test. Identify each component labeled A through F on the figure.

QUESTION B.02 (2.00)

Briefly explain HOW the valve design and location allows the anti-syphon valves to prevent syphoning water from the primary tank.

QUESTION B.03 (2.00)

What are four methods of increasing the cooling tower water outlet temperature during reactor operations ?

QUESTION B.04 (2.00)

Answer the following in regard to shield cooling:

a. What would be the physical consequence of overheating the shield?

b. How many shield cooling regions is the shield divided into for cooling purposes?

c. What two interlocks protect the shield by not allowing reactor operation with the shield cooling system shutdown? (Setpoints not required).

QUESTION B.05 (2.00)

What are the four design functions of the D2O Cleanup System while it is in its normal configuration?

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

QUESTION B.06 (1.50)

Briefly explain how you would determine which tape was causing the alarm in the event of an alarm on the Leak Alarm Console.

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

QUESTION C.01 (1.50)

If you increase reactor power from 100 KW to 4.9 MW, WHEN would you run a heat balance to confirm that the reactor was at 4.9 MW. Briefly explain your answer.

QUESTION C.02 (2.50)

a. Briefly explain WHAT would be the effect on the cooling tower water system if the reactor were operated for thirty days at 4.9 MW with no blowdown from the cooling tower? Include WHY this effect occurs (1.5)

b. What prevents the cooling tower basin from overflowing into the yard if the makeup valve sticks open? (0.5)

c. (TRUE or FALSE)

Low secondary flow will cause a reactor scram if the reactor is operating and the low flow setpoint is reached. (0.5)

QUESTION C.03 (3.00)

a. Briefly Explain WHY the reactivity effect of dumping the radial heavy water reflector varies with the position of the shim blades. (1.0)

b. How does dumping the heavy water reflector effect reactivity with the shim bank at Top of Active Core as compared to dumping it with the shim bank Full-Inserted?

c. What position must the shim bank be in prior to pumping up the radial heavy water reflector following a dump of the reflector? Briefly explain WHY this position is required prior to the pump up.

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

QUESTION C.04 (1.50)

Answer each of the following TRUE or FALSE.

a. It is possible and permissible to operate the reactor with no forced flow in the primary coolant system.

b. With the reactor at full power the pneumatic tube temperature will increase to 100 degrees C in approximately five minutes if cooling air is lost.

c. Total thermal power output of the reactor is the sum of Primary Power, Reflector Power, Shield Power, and Cooling Tower Loss.

QUESTION C.05 (2.00)

During reactor operation, primary system ph MUST be maintained between _____-a-_____ and _____-b-_____, however, the DESIRED ph is _____-c- to _____-d-_____.

QUESTION C.06 (2.00)

List the normal flow for the following system with the reactor at full power.

a. Heavy Water System
b. Primary Coolant
c. Secondary Coolant
d. Shield Coolant

QUESTION C.07 (2.00)

Answer the following in regard to performing a reactor startup.

a. As shim blades are raised, WHAT TWO indications will you observe to verify the reactor is approaching criticality and HOW will the parameters react?

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

QUESTION D.01 (2.00)

What are two reasons WHY Ion Chambers do not need to be compensated when used for Reactor Power Indication at full power?

QUESTION D.02 (2.00)

Refer to Figure 3,Period Channels, at back of test. Identify each of the components marked "A" through "H".

QUESTION D.03 (2.00)

During reactor operation at 100% power you attempt to initiate automatic control of the regulating rod and it will not initiate. WHAT four items would you check to assure the "Automatic-Control-Permit" circuit is not preventing initiation?

QUESTION D.04 (3.00)

During reactor operation at near full power the "Automatic Rundown Circuit" for the control rod drive system is activated.

a. What has caused this circuit to activate? (1.0)

b. What four automatic actions and/or indications are initiated by this circuit? (2.0)

QUESTION D.05 (2.00)

Identify each item marked "A through H" on Figure 4, Functional Block Diagram of Absorber Control System, at back of exam.

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

QUESTION D.06 (2.00)

What are the two reasons for performing the once-a-week comparison of the "Reactor Thermal Power Balance" and the "Output Signal of the Neutron Level Channels"?

QUESTION D.07 (2.00)

Briefly explain WHY the reactor must be in "Neutron Kenetic Equilibrium" prior to performing the weekly comparison between the "Reactor Power Thermal Balance" and the "Output Signal of the Neutron Level Channels?" Include the effect on the "Neutron Level Channel" indication and WHAT causes this effect if the reactor is not in the "Neutron Kenetic Equilibrium" condition.

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

QUESTION E.01 (3.00)

What are six loads automatically supplied EMERGENCY POWER through panel 1 if normal power fails?

QUESTION E.02 (2.00)

Answer each of the following TRUE or FALSE:

a. When normal electrical power is lost and then regained 1 hour later, the Emergency Power MG set must be manually shutdown.

b. When normal electrical power is lost, the emergency power MG set does not start for approximately 12 seconds.

c. Natural circulation can provide adequate core cooling if normal and emergency power is lost.

d. Primary coolant auxiliary pump, MM2 breaker cannot be shut unless normal power is available.

QUESTION E.03 (2.50)

Answer the following in regard to the Containment Pressure Relief System.

a. Describe the filters in the exhaust lines. Include the TYPES of the filters and their positions relative to the flow stream. (1.5)

b. What is the rated system flow?

c. If the system is lined up to relieve pressure, what determines the system flow rate?

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

QUESTION E.04 (3.00)

a. What four automatic actions are initiated when a major scram is initiated manually from the control console? (2.0)

b. When is the scram pushbutton on the medical therapy console operable? (0.5)

c. Is the medical therapy console scram a "minor" or "major" scram? (0.5)

QUESTION E.05 (2.00)

a. What is the purpose of having two vacuum breakers in each line of the reactor building negative pressure protection system?

b. What is the design internal pressure (positive and negative) of the reactor building?)

QUESTION E.06 (1.50)

Answer the following in regard to emergency cooling:

a. How many modes of emergency cooling are there?

b. What are the two basic criteria the system is designed to accomplish?

c. What criteria must be satisfied in order to determine the system operable per the T.S. LCO? SETPOINTS REQUIRED.

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

QUESTION F.01 (3.00)

With fuel in the reactor, WHAT are six conditions/requirements that must be met for the reactor to be in the "SECURED" conditon?

QUESTION F.02 (1.50)

Answer each of the following TRUE or FALSE:

a. When the reactor is in the "Non-Operating but Attended" condition the control room must be continuously manned.

b. The console operator and ~~duty~~ reactor supervisor on duty must be in the control room during a reactor startup. (This change will be made for future ?)

c. The regulating rod is pulled to the estimated critical position prior to pulling any shim blades during a reactor startup.

QUESTION F.03 (2.50)

Answer the following in regard to bypassing a safety function NOT required by Technical Specifications:

a. Can the reactor be operated with such a safety function bypassed? (0.5)

b. If not part of an approved procedure, WHO must authorize such a bypass? (Three required) (1.5)

c. What do you do with a BYPASS LOG SHEET that is completed (filled up) on your shift? (0.5)

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

QUESTION F.04 (2.00)

A Licensed Reactor Operator has the authority to take reasonable action that departs from a license condition or technical specifications.

What four conditions must be met prior to your taking such action?

QUESTION F.05 (1.50)

You are the operator at the control console with the reactor at full power. What are three immediate actions required if a "Withdraw Permit Circuit Open" alarm is received?

QUESTION F.06 (2.00)

a. During performance of AOP 5.2.4 "Low Flow Primary Coolant," if the cause of the low flow is a tripped primary pump, the pump discharge valve, the inlet to HE-1B, and the heat exchanger inlet valve that corresponds to the tripped pump are shut.
BRIEFLY explain WHY these actions are taken.(1.5)

b. TRUE OR FALSE

If a primary pump trips with the reactor at power, all shim blades and the regulating rod must be inserted prior to restarting the pump.(0.5)

QUESTION F.07 (2.00)

During performance of AOP 5.8.9, Malfunction of a Shim Blade/Regulating Rod, operators are instructed to secure electrical power to the drive motor of any stuck shim blade. Briefly explain WHY this action is taken.

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

QUESTION G.01 (3.00)

In regards to the Operational General Safety Rules, prior to entry, what are three joint responsibilities of the operator-in-charge and any personnel entering either the reactor top, the medical therapy room, or the equipment room when the reactor is operating?

QUESTION G.02 (1.00)

Under what conditions may some one be authorized to incur radiation exposures in excess of the 10 CFR 20 limits?

QUESTION G.03 (3.00)

a. If the Reactor Floor Ar-41 Monitor gives an "High Level Radiation Monitor" alarm, where are four likely places the AR-41 originated.(2.0)

b. Briefly discuss WHAT is done to help prevent the production of AR-41 at MITR-II. Include in your answer the preventive measures taken (2 required) AND HOW these measurers help prevent production of AR-41.(1.0)

QUESTION G.04 (1.00)

Briefly explain why heavy water is a radiological concern? Include the isotope of concern AND the type of radiation emitted.

QUESTION G.05 (2.00)

What two types of dosimetry are all personnel working at the MITR-II reactor required to wear? (2.0)

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

QUESTION G.06 (2.00)

Answer each of the following TRUE or FALSE:

a. Personnel with BLUE film badge holders must be escorted at ALL times while in the Reactor Building to assure no radiation exposure.

b. Personnel with RED film badge holders must be under the direct supervision of a licensed SRO/RO while conducting experiments involving radiation.

c. Personnel with YELLOW film badge holders are all membrs of Operations or RPO staff with current quarter exposure less than 3 Rem.

d. Only personnel with YELLOW film badge holders may guide members of general public through the reactor building.

QUESTION G.07 (2.00)

a. What radiation detection device results become the official record of your exposure? (0.5)

b. You are assisting in a maintenance job and notice you have accumulated 60 mrem on your dosimeter. What two actions are you required to perform as a result of this exposure? (1.0)

c. (TRUE or FALSE)

Protective clothing used within the Restricted Area can NEVER be worn outside the Restricted Area. (0.5)

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

EQUATION SHEET

$f = ma$

$w = mg$

$E = mC^2$

$KE = \frac{1}{2}mv^2$

$PE = mgh$

$W = v\Delta P$

$\Delta E = 931\Delta m$

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

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

$Pwr = W_f \dot{m}$

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

$P = P_o\ e^{t/T}$

$SUR = 26.06/T$

$T = 1.44\ DT$

$SUR = 26\left(\frac{\lambda_{eff}\rho}{\bar{\beta} - \rho}\right)$

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

$T = l^*/(\rho - \bar{\beta})$

$T = (\bar{\beta} - \rho)/\lambda_{eff}\rho$

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

$\rho = [l^*/TK_{eff}] + [\bar{\beta}/(1 + \lambda_{eff}T)]$

$P = I\phi V/(3 \times 10^{10})$

$I = N\sigma$

$v = s/t$

$s = v_o t + \frac{1}{2}at^2$

$a = (v_f - v_o)/t$

$v_f = v_o + at$

$\omega = \theta/t$

Cycle efficiency = $\frac{\text{Net Work (out)}}{\text{Energy (in)}}$

$A = \lambda N \qquad A = A_o e^{-\lambda t}$

$\lambda = \ln 2/t_{\frac{1}{2}} = 0.693/t_{\frac{1}{2}}$

$t_{\frac{1}{2}}(eff) = \frac{(t_{\frac{1}{2}})(t_b)}{(t_{\frac{1}{2}} + t_b)}$

$I = I_o e^{-Ix}$

$I = I_o e^{-\mu x}$

$I = I_o\ 10^{-x/TVL}$

$TVL = 1.3/\mu$

$HVL = 0.693/\mu$

$SCR = S/(1 - K_{eff})$

$CR_x = S/(1 - K_{effx})$

$CR_1(1 - K_{eff})_1 = CR_2(1 - K_{eff})_2$

$M = 1/(1 - K_{eff}) = CR_1/CR_0$

$M = (1 - K_{eff})_0/(1 - K_{eff})_1$

$SDM = (1 - K_{eff})/K_{eff}$

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

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

$I_1 d_1 = I_2 d_2$

$I_1 d_1^2 = I_2 d_2^2$

$R/hr = (0.5\ CE)/d^2$(meters)

$R/hr = 6\ CE/d^2$(feet)

WATER PARAMETERS

1 gal. = 8.345 lbm

1 gal. = 3.78 liters

1 ft^3 = 7.48 gal.

Density = 62.4 lbm/ft^3

Density = 1 gm/cm^3

Heat of vaporization = 970 Btu/lbm

Heat of fusion = 144 Btu/lbm

1 Atm = 14.7 psi = 29.9 in. Hg

1 ft. H_2O = 0.433 lbf/in^2

MISCELLANEOUS CONVERSIONS

1 Curie = 3.7×10^{10} dps

1 kg = 2.21 lbm

1 hp = 2.54×10^3 BTU/hr

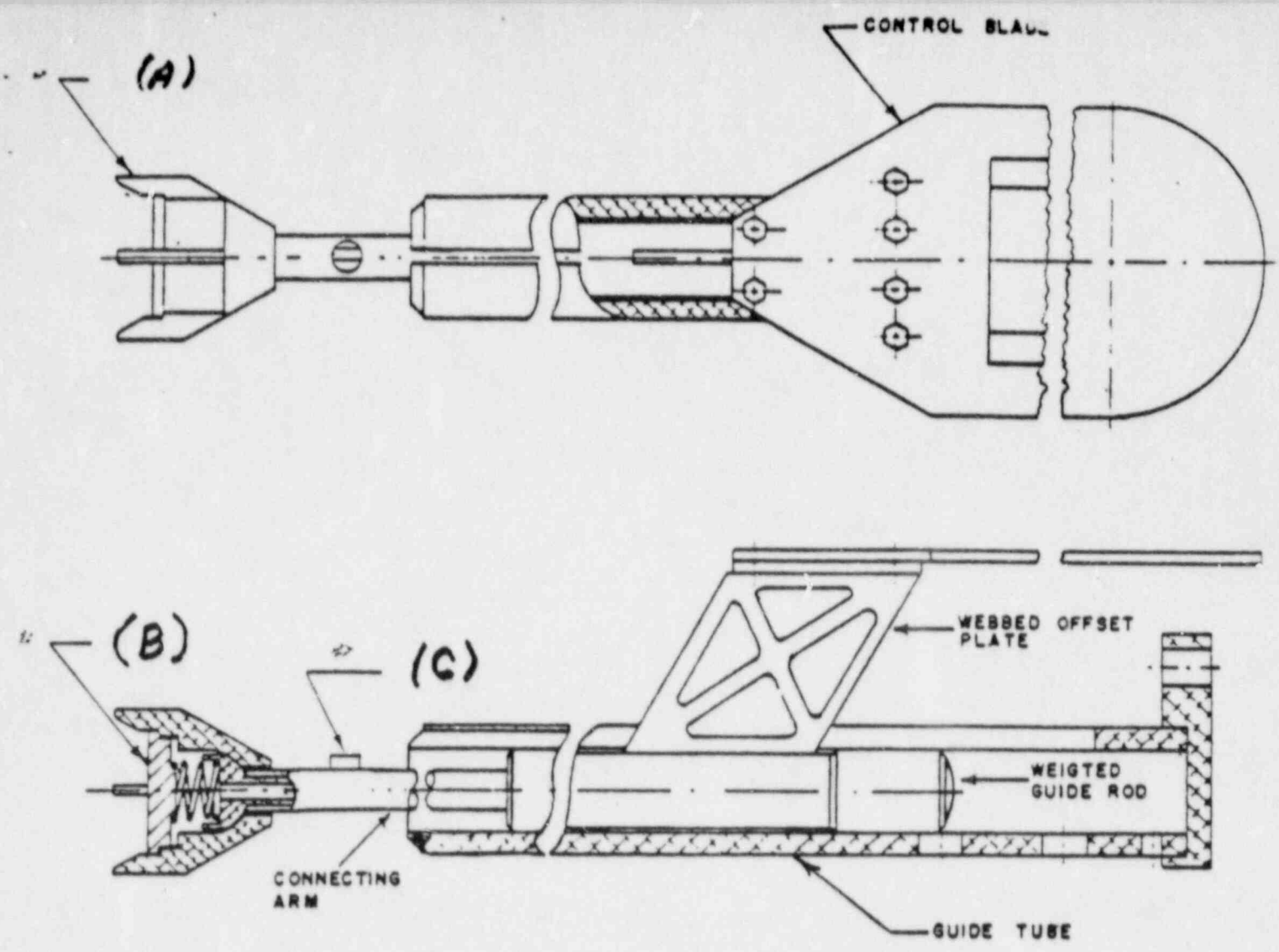
1 Mw = 3.41×10^6 Btu/hr

1 Btu = 778 ft-lbf

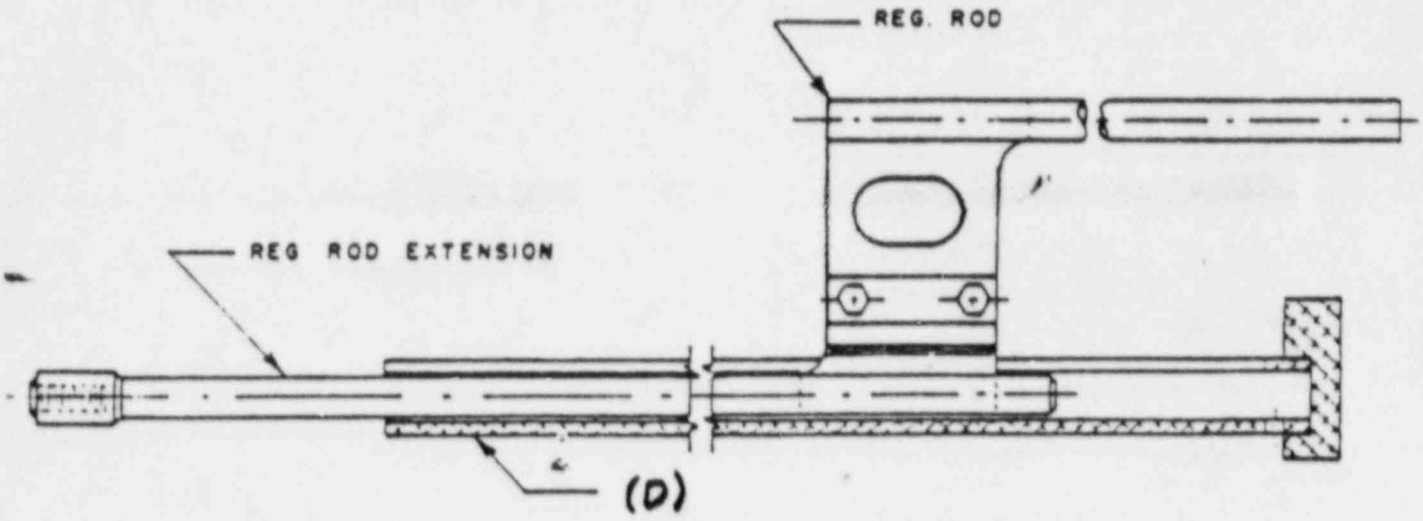
1 inch = 2.54 cm

$^oF = 9/5\ ^oC + 32$

$^oC = 5/9\ (^oF - 32)$

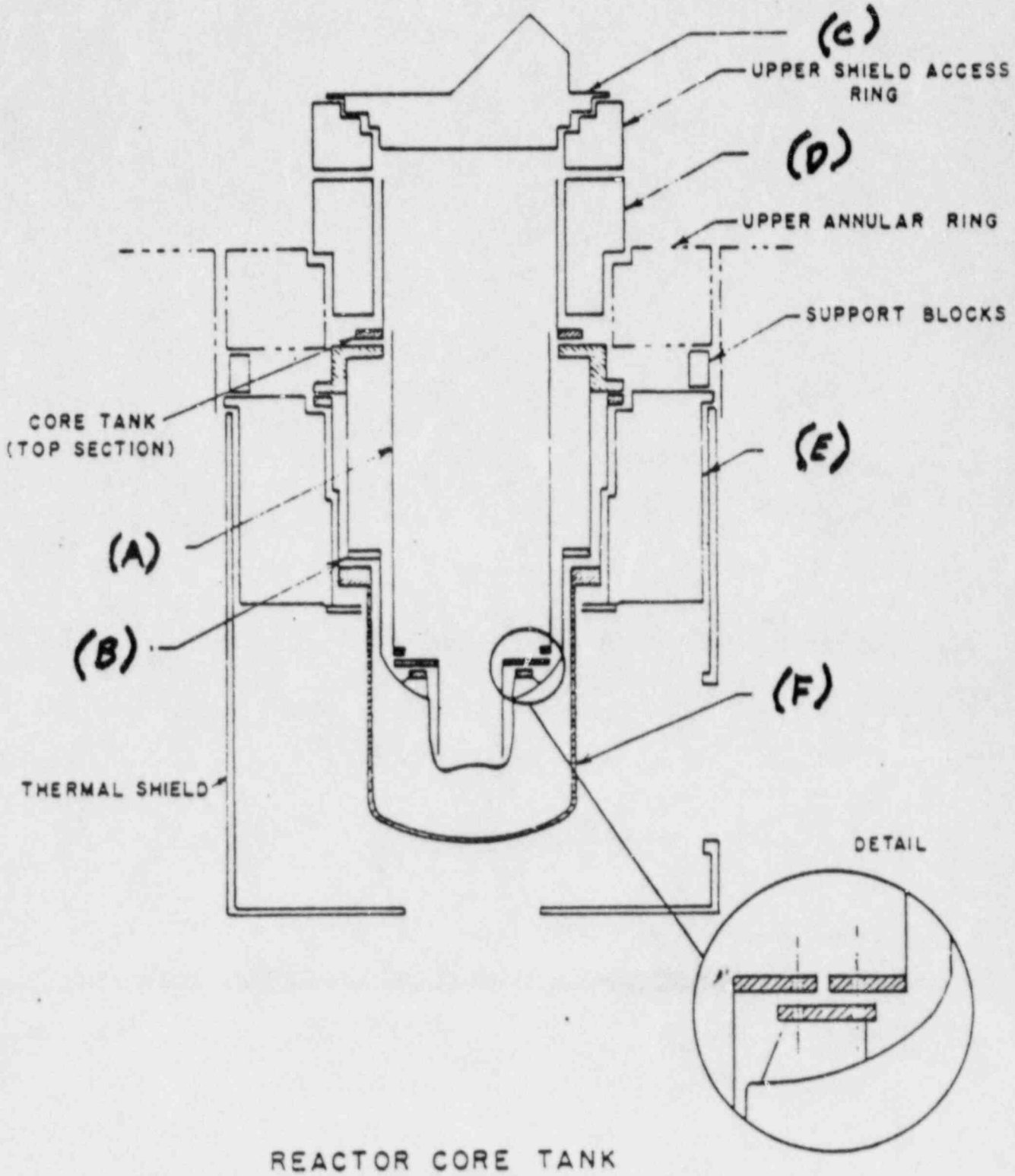


CONTROL BLADE ASSEMBLY



REGULATING ROD ASSEMBLY

FIG. 1



REACTOR CORE TANK SUPPORT

FIG. 2

PERIOD CHANNELS

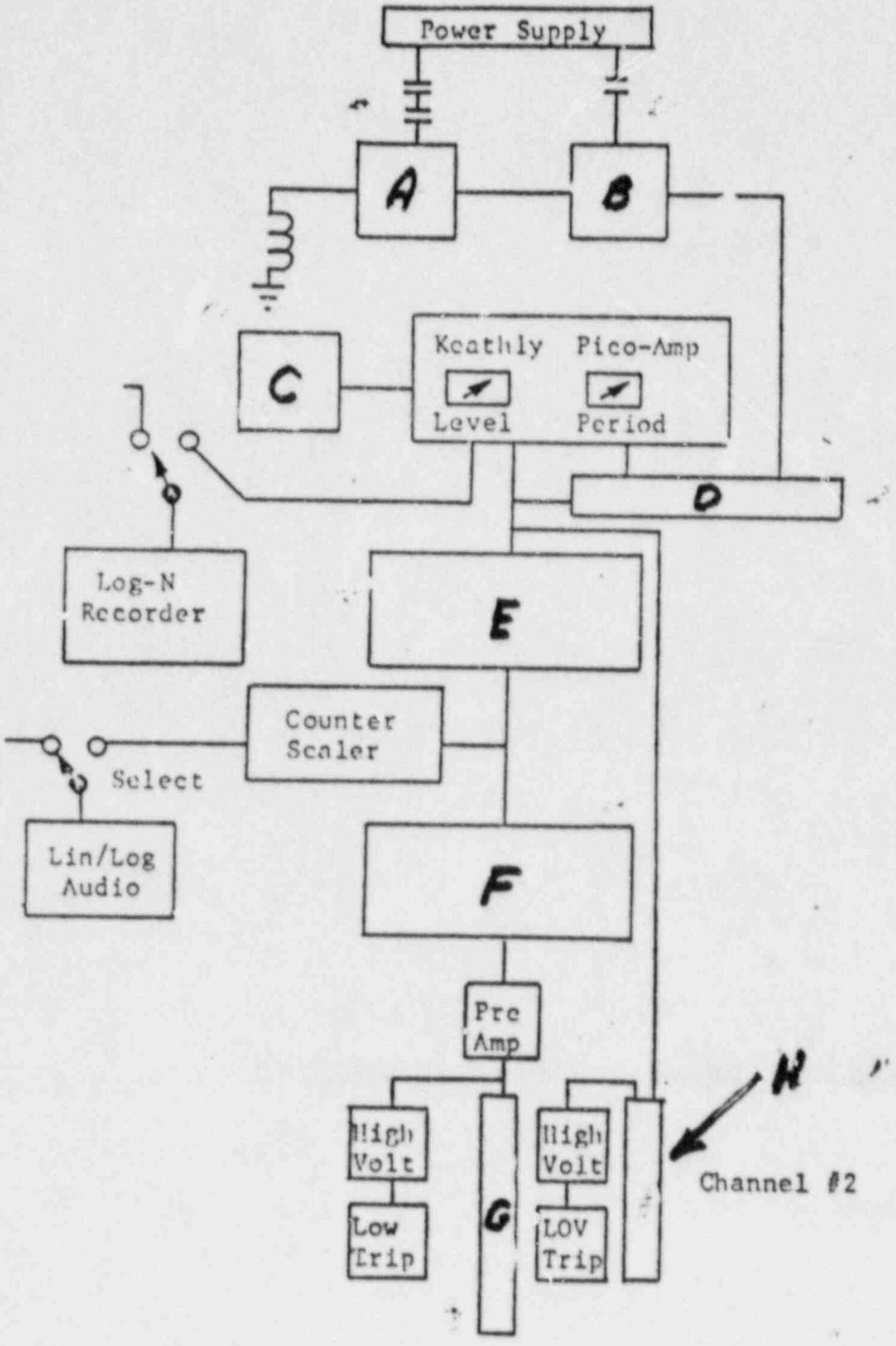
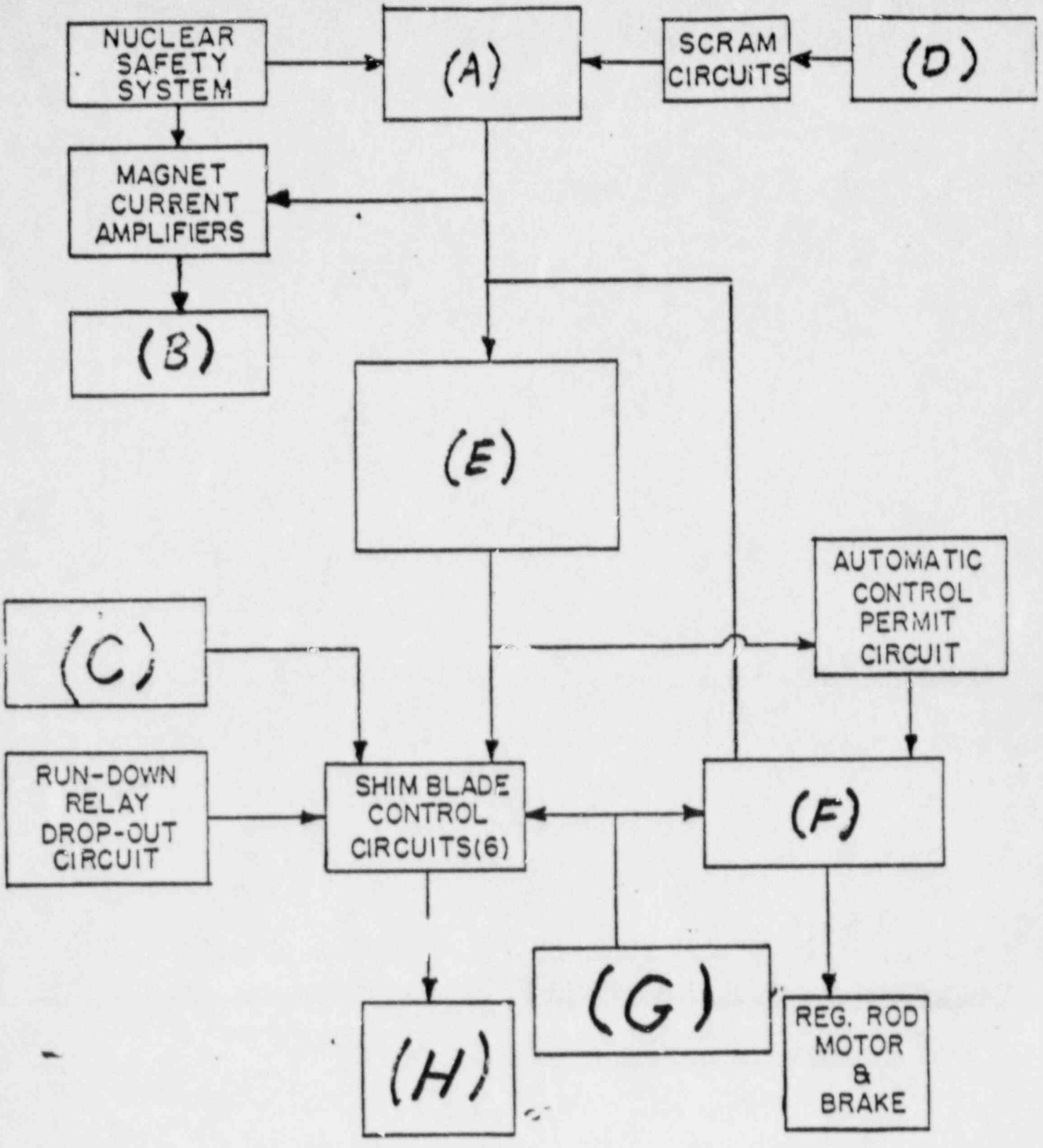


Figure 3



FUNCTIONAL PLOCK DIAGRAM OF ABSORBER CONTROL SYSTEM

FIGURE 4

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ANSWER A.01 (2.50)

From equation sheet:

$P = P_o e^{t/T}$ (0.5)

$P/P_o = 100 = e^{t/25\ sec}$ (0.5)

$\ln 100 = t/25\ sec$ (0.5)

$t = (25\ sec)(\ln 100)$ (0.5)

$= 115.13$ seconds $= 1.92$ minutes (0.5)

REFERENCE

1. MIT: Glasstone and Sesonske (MIT Training Program Reference), PM 1.16.2 pp. 1

ANSWER A.02 (2.00)

The first is the temperature rise of the light water in the reactor core. (0.5) Any such temperature rise will insert negative reactivity by causing a hardening in the neutron spectrum. (This means that the average neutron takes longer to thermalize so there are fewer fissions. (0.5) The second phenomenon is the radiation heating of the heavy water reflector. (0.5) Temperature rises here add negative reactivity by allowing more neutron leakage. (This second process lags the temperature rise of the light water in the core proper.) (0.5)

REFERENCE

MIT-RSM 10.8

ANSWER A.03 (2.00)

The sensitive response is due to the short neutron generation time for the MITR-II, even though its delayed neutron fraction is large (beta-bar = 0.00786). (1.0) The large Beta effective is predominately due to a large source of "slow born" photo neutrons developed in the reflector. (1.0)

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

REFERENCE

MIT-RSM 10.5

ANSWER A.04 (2.00)

a. True
b. True
c. False
d. True

[+0.5] each

REFERENCE

MIT-RSM 10.6

ANSWER A.05 (3.00)

cr1/cr2 = (1-Keff2) / (1-Keff1) (0.5)
100/150 = (1-Keff2) / (1-0.95) (0.5)
1-Keff2 = (10/15 x 0.05
Keff2 = 0.967 (0.5)

Change in reactivity = (Keff2-1) /Keff2 - (Keff1-1) /Keff1 (0.5)
= (Keff2 - Keff1) / (Keff1 x Keff2) (0.5)
= (0.967 - 0.95) / (0.95 x 0.967)
= 1.85% delta k/k (0.5)

REFERENCE

MIT: Reactor Physics Notes (Reactor Subcritical Multiplication).
Eight pages from the front of book.(No page numbers in book)

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

ANSWER A.06 (2.00)

1. Delta K due to temperature change
2. Delta K due to sample loading
3. Delta K due to xenon
4. Delta K due to fuel loading
5. Delta K due to burnup

(Any 4 at 0.5 each)

REFERENCE

MIT-PM 3.1.1.2 page 13

ANSWER A.07 (2.00)

A. Magnet Coupling
B. Armature
C. Blade Bottom Permanent Magnet
D. Guide Tube

REFERENCE

MIT-RSM Figure 1.12

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

ANSWER B.01 (3.00)

A. Core Shroud
B. Core Tank
C. Top Shield Lid
D. Upper Shield Ring
E. Lower Annular Ring
F. Reflector Tank

(0.5 each)

REFERENCE

MIT-RSM Figure 1.11

ANSWER B.02 (2.00)

or - 52 inches

The valve is installed at the top of the core shroud (0.5). Primary flow closes the ball valve during reactor operation (0.5). Loss of flow (0.5) allows the ball valve to open, breaking any syphon path (0.5).

REFERENCE

MIT-RSM 1.7

ANSWER B.03 (2.00)

1. Bypass booster pump
2. Bypass Tower
3. Operate C.T. fan at 1/2 speed.
4. Vary pitch of fan blades.
5. Restrict air admitted to tower (rearrange external boards and flaps).

(Any 4 at 0.5 each)

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

REFERENCE

MIT-RSM 3.10

ANSWER B.04 (2.00)

a. Melting the lead. (0.5)
b. Four (0.5)
c. 1. Low water flow from shield (PF-1) (0.5)
2. Low pump discharge pressure (PPS-1) (0.5)

REFERENCE

MIT-RSM 3.13 paragraph 3.5.1, Shield Coolant System

ANSWER B.05 (2.00)

1. Maintains the purity.
2. Maintains Reflector Tank Level.
3. Provides a surge volumn (to compensate for heatups - cooldown).
4. Provides dump volumn for emergency reactor shutdown.

(0.5 each)

REFERENCE

MIT-RSM Section 3.3.3, Cleanup System, page 3.7

ANSWER B.06 (1.50)

Depress the pushbuttons, directly above the light for the alarming channel. (0.5) one at a time until the alarm light goes out. (0.5) Determine the location by utilizing the Leak Tape Location List. (0.5)

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

REFERENCE

MIT-RSM paragraph 33.6, Leak Detection System, page 3.10

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

ANSWER C.01 (1.50)

Twenty four hours after reaching 4.9 MW(0.5). This wait is necessary because of the large heat capacity (0.5) of the graphite reflector. (0.5)

REFERENCE

MIT-RSM Section 6.3.4

ANSWER C.02 (2.50)

a. The dissolved solids in the makeup water (0.5) would be concentrated (0.5) due to evaporation out of the tower (0.5)

b. An overflow stand pipe drains to the sewer. (0.5)

c. True (0.5)

REFERENCE

MIT-RSM paragraph 3.4.2, Main Flow System, page 3-11

ANSWER C.03 (3.00)

a. The shim blades operate in the region between the core and the heavy water reflector (0.5) thereby exerting a shadowing influence on the reflector. (0.5)

b. A dump with the bank fully inserted is worth about two thirds the worth of a dump with the bank at Top of Active Core. (1.0)

c. The shim bank must be Fully Inserted (0.5). This position is required to ensure the reactivity inserted during the pump up does not occur when the reactor is or could go critical. (0.5)

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

REFERENCE

MIT-RSM-10.6

ANSWER C.04 (1.50)

a. True
b. True
c. False

REFERENCE

MIT-PM-2.2, PM-5.5.1, PM-2.4 page 5

ANSWER C.05 (2.00)

a. 5.5
b. 6.9
c. 5.5
d. 6.5

(0.5 each)

REFERENCE

MIT PM 3.1, Startup Checklist, Section 3.1.1.1, Two Loop Mechanical page 13 of 15

ANSWER C.06 (2.00)

a. 140 gpm (+ or - 10 gpm)
b. 2050 gpm (+ or - 50 gpm)
c. 900 gpm (+ or - 50 gpm) per pump or 1800 gpm total
d. 90 - 110 gpm

(0.5 each)

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

REFERENCE

MIT-PM-3.1.1.2 page 14 of 15

ANSWER C.07 (2.00)

a. 1. Neutron level (0.5) will be increasing (0.5).
2. Reactor period (0.5) will exhibit shorter transient periods. (0.5)

Will also accept correct discussion of steady state and dynamic periods for full credit.

REFERENCE

MIT-PM 2.3, Reactor Safety Procedures, page 2 of 7

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

ANSWER D.01 (2.00)

1. Neutron flux is several orders of magnitude greater than gamma flux.
2. Gamma flux is proportional to fission rate and reactor power.

REFERENCE

MTI RSM-5.4 Paragraph 5.2.3, Uncompensated Ion Chambers

ANSWER D.02 (2.00)

A. Mag. Amp.
B. Scram Amp.
C. Off Scale Trip
D. Period Network
E. Pulse to D.C. Converter
F. Descriminator Amplifier
G. Fission Chamber
H. Ion Chamber

REFERENCE

MIT RSM Figure 5.1, Period Channels

ANSWER D.03 (2.00)

1. ALL shim blades must be above subcritical interlock position.
2. The power-set/actual power deviation must not exceed 1.5%.
3. The regulating rod control switch must be in neutral position.
4. The regulating rod must be withdrawn beyond its near-in position (1.6 inches).

(0.5 each)

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

REFERENCE

MIT-RSM-4.4

ANSWER D.04 (3.00)

a. The regulating rod has been at its near-in position (0.5) (1.6 inches) for thirty seconds with the reactor in automatic control. (0.5)

b. 1. Red light comes on.
2. Buzzer sounds
3. Reactor control shifts to manual (after 30 seconds).
4. Selected shim blade drives in (prior to 1.5% deviation).
(0.5 each)

REFERENCE

MIT-RSM-4.5 (second paragraph)

ANSWER D.05 (2.00)

A. Withdraw Permit Circuit
B. Shim Blade Magnets
C. Automatic Run-Down Circuit
D. Start-Up Interlocks
E. Subcritical Interlock & Override Permit Circuit
F. Regulating Rod Control Circuit
G. All Absorbers in Circuit
H. Shim Blade Motors and Brakes

REFERENCE

MIT RSM Figure 4.1, Functional Block Diagram of Absorber Control System

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

ANSWER D.06 (2.00)

1. It is the basis for calibrating the neutron level channels.
2. It is the basis for setting the safety channel level trip points.

(1.0 each)

REFERENCE

MIT RSM - Item 6.3.4 page 6.5

ANSWER D.07 (2.00)

The axial neutron flux shape would vary if this condition was not present (1.0) Consequently the neutron detectors output would vary (1.0).

REFERENCE

MIT RSM Item 6.3.4 page 6.5, first paragraph

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

ANSWER E.01 (3.00)

Safety Amps	Recorders	T.V.
Rad Monitors	Clock	Intercom System
Servo Unit	Front Panel Outlets	
Ann. Panel	Indicators	
~~DM 2a~~ MM 2	Rod Control	
Med. Rm. Recpt.	Pneumatic Tube	
Magnet Power	Evac. Alarm	

(Any 6 @ 0.5 each)

REFERENCE

MIT RSM Table 8-8B page 8.34

ANSWER E.02 (2.00)

a. False
b. False
c. True
d. False

REFERENCE

MIT RSM paragraph 8.8.2 Emergency Room Dist. System page 8.37 & 8.38

ANSWER E.03 (2.50)

a. Three filters in series in each line, Absolute Filter - Charcoal Filter - Absolute Filter

(3 Filters @ 0.25 for type & 0.25 for location or ea).

b. 800 cfm (0.5)

c. Building/atmosphere delta pressure (0.5).

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

REFERENCE

MIT-RSM-paragraph 8.4, Containment Pressure Relief System page 8.23 and Figure 8.8.

ANSWER E.04 (3.00)

a. 1. Ventilation System Secured.
2. Containment Shell is Sealed.
3. D2O Reflector is Dumped.
4. Withdraw permit circuit deenergized (shim blades drop).

(0.5 each)

b. When the Medical Therapy's console key switch is ON.(0.5)

c. Minor (0.5)

REFERENCE

MIT RSM paragraph 9.3 page 9.8

ANSWER E.05 (2.00)

a. Prevent leakage out of the building in the event of internal overpressure. (1.0)
b. 2.0 psig greater than atmospheric - positive (0.5)
0.1 psig less than atmospheric - negative (0.5)

REFERENCE

MIT RSM paragraph 8.1 page 8.1

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

ANSWER E.06 (1.50)

a. 4 (0.5)

b. Keep core covered (0.25) and core temp < boiling (0.25).

c. 10 gpm (0.25) within 5 minutes of activation (0.25).

REFERENCE

MIT-RSM paragraph 3.2.7, Emergency Cooling page 3.4

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

ANSWER F.01 (3.00)

1. Reactor Shutdown
2. Console Key Switch "OFF".
3. Console Key Switch Removed and in Proper Custody.
4. No work in progress within main core tank involving fuel or experiments.
5. No maintenance of the core structure.
6. No maintenance of installed control blades.
7. No maintenance of control blade drives unless visibly decoupled from the control blade.

(Any 6 @ 0.5 each)

REFERENCE

MIT-PM 2.2 page 3 of 11

ANSWER F.02 (1.50)

a. False
b. ~~True~~ False (for this test only)
c. False

REFERENCE

MIT PM 2.2 pp. 3 of 11 Item 16, PM 2.3 page 1 of [illegible] tem 2.3.1.3

ANSWER F.03 (2.50)

a. Yes (0.5)
b. Reactor Superintendent, Duty Shift Supervisor, and Electronics Supervisor (0.5 each) (or electronics tech. (for this exam only))
c. File it in the front of the reactor console log. (0.5)

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

REFERENCE

MIT PM 1.9 Paragraph 1.9.2 page 1 of 2

ANSWER F.04 (2.00)

1. An emergency where such action is needed immediately to protect the public health and safety.
2. No action consistent with license conditions and technical specifications that can provide adequate or equivalent protection is immediately apparent.
3. Must be approved by licensed SRO prior to taking the action.
4. NRC notified if possible (prior to taking the action).

(0.5 ea)

REFERENCE

MIT-PM 1.3 page 1 of 2 and 2 of 2

ANSWER F.05 (1.50)

1. Acknowledge the alarm.
2. Scram the reactor (minor) if not already scrammed.
3. Verify reactor power decreasing.
4. Notify reactor shift supervisor.

(Any 3 @ 0.5 each)

REFERENCE

MIT AOP 5.1.2, Withdraw Permit Circuit Open

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

ANSWER F.06 (2.00)

a. This action prevents pumping vibration (0.5) which may occur if one pump is left running (0.5) with certain HX lineups.(0.5)

b. True (0.5)

REFERENCE

MIT AOP 5.2.4, Low Flow Primary Coolant, Immediate Action No. 4

ANSWER F.07 (2.00)

This action will prevent damage to the drive motor if a scram occurs (1.0) since the motor would attempt to drive in and being unable to move the motor would burn out.(1.0) or prevent sudden reactivity affect (1.0) should the blade move ~~suddenly~~ rapidly if suddenly freed. (1.0)

REFERENCE

MIT AOP 5.8.9, Malfunction of a Slim Blade/Regulating Rod, Followup Action No. 4

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

ANSWER G.01 (3.00)

1. To determine that normal radiation levels exist based on control room and/or local instrumentation.
2. To assess the need for a radiation survey with a portable detector.
3. To evaluate the potential for dose rate changes during occupancy.

(3 at 1.0 ea)

REFERENCE

MIT-PM 1.14, pg. 6 Item No. 9

ANSWER G.02 (1.00)

To save a human life (0.5) or to insure nuclear safety (0.5).

REFERENCE

MIT-PM 4.3, page 14

ANSWER G.03 (3.00)

a. High flux regions such as the thermal column, pipe tunnel, lid space, experimental port, instrument lead boxes, reactor floor hot cell, 36V's if not sealed, or a drop in building temperature

(any 4 at @ 0.5 each.)

b. The high flux regions are sealed and/or flooded with carbon dioxide (0.5) or helium in order to exclude as much air as possible since AR-40 is present in air. (0.5)

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

REFERENCE

RSM page 7.5 paragraph 7.3, Reactor Floor Argon-41 monitor

ANSWER G.04 (1.00)

Because of the Tritium (0.5) which is an ~~alpha~~ beta emitter (0.5).

REFERENCE

MIT-PM 4.5, page 4

ANSWER G.05 (2.00)

1. Beta-Gamma Monitoring Badge
2. Pocket Dosimeter (gamma)

(1.0 ea)

REFERENCE

MIT-PM 2.5, page 1

ANSWER G.06 (2.00)

a. False
b. False
c. False
d. True

(0.5 ea)

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

REFERENCE

MIT-PM 1.12, Film Badge Classification page 1 of 5

ANSWER G.07 (2.00)

a. Film Badge (0.5)
b. 1. Record the exposure on the posted dosimeter sheet. (0.5)
   2. Re-zero the dosimeter. (0.5)
c. False (0.5)

REFERENCE

MIT-PM 1.12 page 5 of 5 of June 8, 1983 (Memo Karaian to Rad Workers and Experimenters

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

ATTACHMENT 2

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

FACILITY: MASS. INSTITUTE OF TECH.

REACTOR TYPE: RESEARCH

DATE ADMINSTERED: 88/~~10~~11/25

EXAMINER: ROESENER, S.

CANDIDATE MASTER

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
20.00	20.00			H. REACTOR THEORY
~~20.00~~ 19.00	20.00			I. RADIOACTIVE MATERIALS HANDLING DISPOSAL AND HAZARDS
20.00	20.00			J. SPECIFIC OPERATING CHARACTERISTICS
20.00	20.00			K. FUEL HANDLING AND CORE PARAMETERS
~~20.00~~ 19.00	20.00			L. ADMINISTRATIVE PROCEDURES, CONDITIONS AND LIMITATIONS
~~100.0~~ 98.00			%	Totals
		Final Grade		

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

I.04 (1.00 point) and L.08.b (1.00 point) deleted

BF 11.7.88

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. 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.

3. Use black ink or dark pencil only to facilitate legible reproductions.

4. Print your name in the blank provided on the cover sheet of the examination.

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

6. Use only the paper provided for answers.

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

8. Consecutively number each answer sheet, write "End of Category __" as appropriate, start each category on a new page, write only on one side of the paper, and write "Last Page" on the last answer sheet.

9. Number each answer as to category and number, for example, 1.4, 6.3.

10. Skip at least three lines between each answer.

11. Separate answer sheets from pad and place finished answer sheets face down on your desk or table.

12. Use abbreviations only if they are commonly used in facility literature.

13. The point value for each question is indicated in parentheses after the question and can be used as a guide for the depth of answer required.

14. Show all calculations, methods, or assumptions used to obtain an answer to mathematical problems whether indicated in the question or not.

15. Partial credit may be given. Therefore, ANSWER ALL PARTS OF THE QUESTION AND DO NOT LEAVE ANY ANSWER BLANK.

16. If parts of the examination are not clear as to intent, ask questions of the examiner only.

17. You must sign the statement on the cover sheet that indicates that the work is your own and you have not received or been given assistance in completing the examination. This must be done after the examination has been completed.

18. When you complete your examination, you shall:

a. Assemble your examination as follows:

(1) Exam questions on top.

(2) Exam aids - figures, tables, etc.

(3) Answer pages including figures which are part of the answer.

b. Turn in your copy of the examination and all pages used to answer the examination questions.

c. Turn in all scrap paper and the balance of the paper that you did not use for answering the questions.

d. Leave the examination area, as defined by the examiner. If after leaving, you are found in this area while the examination is still in progress, your license may be denied or revoked.

QUESTION H.01 (2.00)

a. Define EFFECTIVE Delayed Neutron Fraction. (1.00)

b. How would the Effective Delayed Neutron Fraction of the MITR-II change (INCREASE, DECREASE, REMAIN THE SAME) if the deuterium reflector were replaced by a light water reflector? Briefly explain your answer. (1.00)

QUESTION H.02 (3.00)

a. What are the three parameters needed to calculate the power being transferred from the fuel to the primary coolant? (1.00)

b. To obtain the total power output of the reactor what two other coolant streams must be evaluated? (1.00)

c. Why does it take about 24 hours of constant power operation before thermal equilibrium operation is attained for the MITR-II reactor? (1.00)

QUESTION H.03 (2.00)

If the moderator and reflector temperature rises from 35 C to 40 C, how far would the regulating rod be moved in order to maintain criticality? See the attached curves for information needed to calculate the rod motion. Show all work. State all assumptions.

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

QUESTION H.04 (3.00)

The reactor operator is conducting a routine reactor startup after it has been shutdown for several days. Prior to withdrawing a shim blade he reads a stable count of 50 cps on the startup channel. Immediately after withdrawing this blade he reads a count of 80 cps.

a. If he performed no blade motion for five minutes, would the count rate INCREASE, DECREASE or REMAIN THE SAME? Explain, assuming the reactor is subcritical at 80 cps. (1.50)

b. After 5 minutes he withdraws another blade the same distance (assume the same amount of reactivity is added as in "a" above) but the reactor is still subcritical. Is the change in count rate for this second rod withdrawal GREATER THAN, LESS THAN or THE SAME AS the change in count rate observe in the first case? Explain your answer. (1.50)

QUESTION H.05 (2.00)

If the shim bank is at the height predicted by the estimated critical position (ECP), and the ECP was done correctly in accordance with MITR-II procedures, what will be the indications seen by the operator?

QUESTION H.06 (1.00)

What is the major source of neutrons used for routine startups of the MITR-II?

QUESTION H.07 (2.00)

State TWO reasons why the differential rod worth of the regulating rod peaks at only a few inches of withdrawal as compared to the near center of travel peak of the shim bank differential worth. (The differential worth curves are included as an attachment to aid in the visualization of this question.)

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

QUESTION H.08 (3.00)

a. How long after a reactor shutdown does the xenon concentration peak? Assume one week of full power operation prior to shutdown. (1.00)

b. Explain in terms of the two production and two removal processes why the xenon buildup occurs following the shutdown. (2.00)

QUESTION H.09 (2.00)

Assuming the reactor to be just critical at 100 kW:

a. Explain the initial (prompt) response of the reactor power to a ten inch insertion of the regulating rod. A general explanation is desired NOT a calculation. (1.00)

b. Describe the behavior of reactor power at two minutes following the ten inch insertion. (1.00)

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

QUESTION I.01 (2.00)

a. When the reactor is in normal operation, how often should the secondary water be sampled for Tritium? (0.50)

b. What three actions must be taken if secondary water tritium concentrations exceed one microcurie/liter? (1.50)

QUESTION I.02 (2.00)

a. In the event of an MITR-II radiological emergency, who is responsible for decisions and coordination of all immediate actions? (1.00)

b. What two actions should always be taken to maximize emergency plan effectiveness. (1.00)

QUESTION I.03 (3.00)

a. According to procedure PM-4.7.2 the EAL for a General Emergency can be determined by using the following formulae:

1. For stack release... (1.58E7)(Permissible Concentration)

2. For containment release...(5.26E7)(Permissible Concentration)

Why is the limit for stack releases more restrictivethan the limit for containment releases? (1.00)

b. The above formulae assume that the particular radioisotope being released is known. Explain how the EALs account for the fact that the limiting radioisotope being released may not be known? (1.00)

c. List FOUR of the radiation monitor levels that you would read to determine if a General Emergency should be inacted? (1.00)

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

QUESTION I.04 (1.00)

Multiple Choice:(Choose only one answer)

There must be no direct contact with fingers on the irradiated containers or samples because of the high probability of:

a. gamma radiation.

b. beta radiation.

c. surface contamination.

d. alpha contamination.

Ordered

QUESTION I.05 (1.50)

List THREE independent measurements or indications use to monitor or detect heavy water leakage into the secondary coolant.

QUESTION I.06 (1.00)

Why must the blowdown of the cooling tower basins be secured when the reactor is not operating?

QUESTION I.07 (1.00)

What TWO automatic responses of the sewer radiation monitor are verified prior to a discharge from the waste storage tanks?

QUESTION I.08 (1.50)

State the THREE automatic responses you would verify after receiving an "High Radiation Level Core Purge" alarm.

QUESTION I.09 (1.00)

State the purpose of the Core Purge (Off-Gas) System.

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

QUESTION I.10 (2.50)

a. Why must the, "DO NOT USE THIS EXIT," sign on the inner door of the main personnel airlock be backlit when the, "Trouble NW-12 Gamma Monitor," alarm actuates? (1.00)

b. State the TWO warning indications that will be automatically actuated outside of the control room when the "Trouble NW-12 Gamma Monitor," scam alarm actuates. Include in your answer the location of the warnings which occur outside the control room. (1.50)

QUESTION I.11 (1.50)

a. What TWO individuals should jointly authorize emergency exposures which may exceed 10CFR20 limits? (1.00)

b. If it is not possible to reach the above individuals in a timely manner, who is the next in line to make the emergency exposure authorizations? (0.50)

QUESTION I.12 (2.00)

a. What is the radiological concern associated with continued reactor power operations during a containment isolation? (1.00)

b. What must be done in order to continue operations if a single plenum radiation monitor becomes inoperative due to a plugged flow line and containment isolates? (1.00)

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

QUESTION J.01 (4.00)

Regarding the Convection and Anti-Syphon valves within the core tank:

a. Give the purpose of each of these valve types. (1.00)

b. Describe how each valve type functions to carry out its purpose. Include in your explanation a description of the valve's performance in BOTH the normal AND the accident positions. (3.00)
(A simplified sketch demonstrating these points is acceptable.)

QUESTION J.02 (1.50)

TRUE or FALSE?

a. The main core tank level indicator ML-3A is an electrically driven transmitter which is supplied by emergency power. (0.50)

b. ML-3B is a pneumatically powered system and indicates on linear scale meters that are mounted in the control room and the emergency instrumentation cabinet in the utility room. (0.50)

c. A reactor scram on low main tank water level will occur only if both ML-3 and ML-2 level probes are uncovered. (0.50)

QUESTION J.03 (2.00)

a. When would it be necessary to utilize the containment pressure relief system? (1.00)

b. What TWO functions does the containment pressure relief system blower perform? (1.00)

QUESTION J.04 (1.00)

In accordance with Standard Operating Plans , PM 2.3.1, Normal Reactor Startup," what should be your immediate response if the reactor goes critical at a position more than 0.5 inches below the ECP?

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

QUESTION J.05 (2.00)

Answer the following questions for a "Normal Reactor Startup":

a. Explain how the transfer from the fission chamber mode to the ion chamber mode is made. (1.00)

b. Explain the response of the channel to the actions in "a" above. (1.00)

QUESTION J.06 (1.00)

During a reactor startup, why is the reactor power held for five minutes after each MW of power increase?

QUESTION J.07 (2.50)

Following a three day shutdown, the reactor was started up and has been running at full power for 10 hours. Assuming that the regulating rod is in automatic control and that no changes in the sample or experiment configurations are to be made, how many times will it be necessary to manually cycle the regulating rod over the next 30 hours. All reactivity curves you will need for this question are attached to the test. Show all your work.

QUESTION J.08 (3.00)

During the first few hours of power operation following a short (4 hour) shutdown from an extended period of full power operation, the operator makes the mistake of allowing the Xe transient to drive the regulating rod to the near-in position. When the automatic rundown light energizes the operator notices it.

a. What should be his THREE immediate actions if he desires to continue power operations? (1.50)

b. How long after the light energizes will a rod start to move? (0.50)

c. In accordance with Standard Operating Plans, PM 2.4.1 "Full Power Operation," when can the operator no longer take the actions of step "a" to recover? (1.00)

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

QUESTION J.09 (3.00)

List FIVE of the immediate actions that are the responsibility of the Reactor Supervisor upon a loss of normal electrical power in accordance with the Abnormal Operating Procedure, PM 5.8.4, "Loss of Normal Electrical Power."

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

QUESTION K.01 (2.00)

List FOUR indications that would be indicative of a release of fission products from the fuel elements in the core tank?

QUESTION K.02 (2.00)

What FOUR abnormal conditions may cause a Spent Fuel Storage Pool alarm?

QUESTION K.03 (3.00)

After each refueling or change in core loading, the reactor shall not be operated above a power level of 1.0 KW unless an evaluation is made to ensure that two Technical Specifications are satisfied.

a. What are the two Technical Specifications? (2.00)

b. What persons shall complete and approve these evaluations? (1.00)

QUESTION K.04 (4.00)

During refueling, what are TWO designed safety features associated with the hold-down grid plate AND what is the design purpose of each? (4.00)

QUESTION K.05 (1.00)

What is the basis for the Technical Specification that, "Prior to transferring an irradiated element from the reactor vessel to the transfer flask, the element shall not have been operated in the core at a power level above 100 kW for at least four days?"

QUESTION K.06 (3.00)

a. What Xe condition and TWO adverse control rod positions are assumed when calculating shutdown margins? (1.50)

b. Explain what variable reactivity is AND TWO factors which cause it to occur. (1.50)

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

QUESTION K.07 (2.00)

According to your Technical Specifications, when is your reactor considered secured if fuel is present in the core?

QUESTION K.08 (1.00)

a. According to MITR Technical Specifications, approximately how many MITR fuel elements would be required for criticality assuming optimum conditions? (0.50)

b. What is the maximum number of fuel elements allowed by Technical Specifications to be outside designated storage areas at any one time? (0.50)

QUESTION K.09 (2.00)

a. When loading a new 445 gram U-235 fuel element during refueling, which ring (A,B or C) will give you the highest mβ/gram of U-235? (0.50)

b. If you load a 506 gram element instead of a 445 gram element in the same fuel location, will the mβ/gram of U-235 for the 506 gram element be GREATER THAN, LESS THAN or THE SAME AS that of the 445 gram element. Briefly explain your answer. (1.50)

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

QUESTION L.01 (1.50)

a. In accordance with MITR-II Technical Specifications, who must be present (minimum level of qualification) if the reactor is not secured but is shutdown? (1.00)

b. For the conditions mentioned above, what additional personnel must be available on site or on call? (0.50)

QUESTION L.02 (1.00)

TRUE or FALSE?

a. Work shall not be conducted in the reactor building unless a reactor supervisor or a reliable person appointed by a reactor supervisor is present. (0.50)

b. The shift supervisor may grant permission to an experimenter to irradiate acids or other corrosive liquids. (0.50)

QUESTION L.03 (2.00)

What TWO things must you do before making a tour outside the range of the intercom system if you are the on-duty senior reactor operator?

QUESTION L.04 (4.00)

a. Whose permission is required to post a warning tag on facility equipment and who may post a warning tag? (1.00)

b. List FIVE requirements which must be observed when "locking out" facility equipment. (3.00)

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

QUESTION L.05 (2.00)

a. In accordance with MITR-II Technical Specification 7.8.3 and Administrative Procedure, PM 1.5, "Procedures Adherence Temporary Change Method," in what case may a temporary change be made to a class B procedure without the pre-approval of the Director of Reactor Operations? (1.00)

b. Who must approve the temporary change discussed in "a" above? (Give level of qualification.) (1.00)

QUESTION L.06 (3.00)

a. What are the FOUR interrelated variables associated with the core thermal and hydraulic performance on which Safety Limits are based? (2.00)

b. What is the objective of the Safety Limits? (1.00)

QUESTION L.07 (1.50)

In the event of a required building evacuation following an emergency:

a. Who must normally authorize re-entry into any portion of the reactor facility? (0.50)

b. Under what circumstances can the on-duty shift supervisor authorize re-entry? (1.00)

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

QUESTION L.08 (3.00)

Utilize the attached EAL's to answer the following:

a. For each of the events below, state the minimum emergency classification which may be declared. (0.50 each)

1. A large crowd of protesters marching around the reactor building.

2. A fire damaging an experiment which causes the release of radioactive materials.

3. A tornado damaging the containment building.

4. A slow and uncontrollable decrease in core tank level such that level remains above the anti-syphon valves.

b. What criteria is used for classifying emergency conditions? (1.00)

Deleted

QUESTION L.09 (2.00)

10CFR55 defines an operator as any individual who manipulates a control of a facility:

a. Define the term "control" as it applies to MITR-II. (1.00)

b. Under what conditions is the person physically manipulating a control not required to hold a valid operator's license? (1.00)

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

ANSWER H.01 (2.00)

a. The fraction of the thermal neutron population that was born delayed. (1.00)

b. DECREASE [0.50]

Loss of the large source of slow born photoneutrons created in the deuterium [0.50] results in the decrease in the effective delayed neutron fraction if the heavy water reflector is replaced by light water. (1.00)

REFERENCE

Reactor Physics Notes, Reactor Kinetics and Control Rod Calibration by Reactor Period Measurement, p. 3.
Reactor Systems Manual, Ch. 10, Sec. 10.3.

ANSWER H.02 (3.00)

a. 1. Delta Temperature of the primary coolant.[0.33]

2. Heat Capacity of the primary coolant.[0.33]

3. Flow rate of the primary coolant.[0.34] (1.00)

b. 1. Deuterium Tank coolant system.[0.50]

2. Shield coolant system.[0.50] (1.00)

c. Because the graphite reflector has a large heat capacity. (1.00)

REFERENCE

Reactor Systems Manual, Ch. 6, Sec. 6.3.4.

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

ANSWER H.03 (2.00)

Reactivity worth at 35 C --> -75 mβ (+/- 5) [0.33]

Reactivity worth at 40 C --> ~~-188~~ 126 mβ (+/- 5) [0.33]

Change in reactivity --> ~~-188~~ 126 mβ - (-75 mβ) = ~~-113~~ 51 mβ (+/- 10) [0.33]

Assuming regulating rod initially at 6 inches out (any value will be accepted) its worth is 190 mβ [0.33]. 190 mβ + ~~113~~ 51 mβ = ~~303~~ 241 mβ which is equivalent to a rod height of ~~10.7~~ 9.5 in. [0.35]

Therefore the rod would move out ~~4.7~~ 3.5 in. [0.33]. (Must be consistent within .5 in. based on reactivity insertion calculated for temperature change.) (2.00)

REFERENCE

Reactor Systems Manual, Ch. 10, Sec. 10.7
Reactor Systems Manual, Ch. 10, Figure 10.18 "Reactivity Effects for Uniform Heating of Primary and Reflector".
PM 6.5.16.1 "MITR-II Integral Reg Rod Worth Curve".

ANSWER H.04 (3.00)

a. INCREASE [0.50]. Right after the rod motion ceases subcritical multiplication equilibrium level is not yet established [0.50]. The level will continue to increase until the new equilibrium is reached [0.50]. (1.50)

b. GREATER THAN [0.50]. As the multiplication factor approaches one (or as the reactor approaches criticality) [0.50], the number of generations required to reach equilibrium increases [0.50] and therefore the change in count rate increases. (1.50)

OR

The final equilibrium level is proportional to (1 -1/p).
As K approaches 1, p approaches zero from the negative side and each step change in reactivity causes (1 - 1/p)
to change (increase) by a larger amount resulting in a larger increase in the associated neutron level (or count rate).
(As p aprroaches 0 from the negative side (1 - 1/p) approaches infinity.) (Noté Bien: p = rho.)

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

REFERENCE

Reactor Physics Notes, Reactor Startup and Reactor Subcritical Multiplication, pp. 7 - 13.

ANSWER H.05 (2.00)

Slight positive period (about 50 seconds) [1.00] and a steadily increasing power level (count rate) (without blade motion) [1.00]. (2.00)

REFERENCE

Standard Operating Plan 2.3.1 "Normal Reactor Startup", step 12.

ANSWER H.06 (1.00)

Photoneutrons.

OR

Gamma + Deuterium --> Hydrogen + Neutron (1.00)

REFERENCE

Reactor Physics Notes, Reactor Startup and Reactor Subcritical Multiplication, p. 7.

ANSWER H.07 (2.00)

1. The full-in position of the reg rod is six inches above the bottom of the core. (1.00)

2. The reg rod is heavily shadowed by the shim bank in its upper region of withdrawal. (1.00)

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

REFERENCE

Reactor Systems Manual, Ch. 10, Sec. 10.4.

ANSWER H.08 (3.00)

a. 6 hours. (1.00)

b. Immediately following reactor shutdown, the production of xenon from fission and its removal by burnup are effectively stopped [0.50]. Since the production from fission is small compared to the production of xenon by iodine decay [0.50] and since the burnup is large compared to the loss from decay of xenon [0.50] the net effect is a large decrease in xenon loss and a small decrease in xenon production and thus a large increase in xenon concentration [0.50]. (2.00)

REFERENCE

Reactor Systems Manual, Ch. 10, Sec. 10.8.

ANSWER H.09 (2.00)

a. The reactor power will drop immediately [0.50] due to the quick response of the prompt neutrons to the change in reactivity [0.50]. (1.00)

b. At two minutes the reactor power will be decreasing [0.50] at a rate controlled by the decay of delayed neutron precursors [0.50]. (1.00)

REFERENCE

Reactor Physics Notes, Reactor Kinetics and Control Rod Calibration by Reactor Period Measurement, p. 11.

OR

For a normal insertion of ten inches, the power will begin to ramp down immediately [a50] due to the quick response of the prompt neutrons to the ramp change in reactivity [a50].

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

ANSWER I.01 (2.00)

a. At least once every 24 hours. (0.50)

b. 1. The cooling Tower Spray must be secured [0.50].

2. Any discharge to the sanitary sewer of secondary water must be stopped [0.50].

3. The heavy water reflector heat exchanger must be isolated [0.50] (1.50)

REFERENCE

Technical Specification 3.8.

ANSWER I.02 (2.00)

a. The senior NRC-licensed member on shift. (1.00)

b. 1. Shutdown the reactor.

2. Isolate the containment. (1.00)

REFERENCE

Emergency Plan and Procedures, Sec. 4.3.1.2.1.

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

ANSWER I.03 (3.00)

a. Because the dilution for stack releases is caluculated to be less than the dilution for containment releases. (1.00)

b. The EALs are based on the assumption that the most limiting MPC is being released. (1.00)

c. Any four of the following at 0.25 each:

1. Plenum gas monitor.

2. Plenum particulate monitor.

3. Stack gas monitor.

4. Stack particulate monitor.

5. Stack area monitor. (1.00)

6. Portable monitors at site boundary.

REFERENCE

Emergency Plan and Procedures, Sec. 4.7.2.2.1 & 2, and 4.7.2.2.1; 4.4 & 14, pg 1.

OR

Because the point of maximum concentration for a containment release is some distance away from the point of concern (where the public has access) [0.50] whereas the point of maximum concentration and point of concern are the same for stack releases [0.50].

ANSWER I.04 (1.00)

b. Delayed

REFERENCE

Administrative Procedures, Sec. 1 10.8.1.1-11.

ANSWER I.05 (1.50)

1. Secondary water radiation monitoring.

2. Daily sampling and analysis of the secondary water (for tritium).

3. Monitoring of level in deuterium dump tank (by a low level alarm or by site glass). (1.50)

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

REFERENCE

Technical Specification 3.8.

ANSWER I.06 (1.00)

Because the secondary radiation monitors are not capable of detecting any primary to secondary leakage when the reactor is shutdown.

REFERENCE

Reactor Systems Manual, Ch. 7, Sec. 7.4.1.

ANSWER I.07 (1.00)

1. The "High Level Radiation Monitor" alarm actuates. (Exact name of alarm is not required for full credit.) (0.50)

2. The sewer pump (RM-3) stops. (0.50)

REFERENCE

Operating Procedures Checklists, PM 3.6, "Waste Storage Tank Dump Procedure", p. 2.

Recent change to procedure has the operability of the sewer radiation monitor checked also. This will need to be included in this answer in the future.

ANSWER I.08 (1.50)

1. Closure of the intake valve (MV-83).

2. Closure of the core purge blower suction valve (the primary storage tank air discharge valve) (MV-64).

3. The core purge blower trips off. (1.50)

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

REFERENCE

Abnormal Operating Procedures, PM 5.6.5, "High Radiation Level Core Purge", p. 1.
Reactor Systems Manual, Ch. 7, Sec. 7.7.

ANSWER I.09 (1.00)

The purpose of the core purge system is to ~~prevent the accumulation of N-16 and Ar-41 in the void above the primary water pool.~~ (any one of the following for 1.00):

1. Prevent hydrogen buildup
2. Prevent accumulation of Ar^{41}
3. Prevent accumulation of N^{16}

REFERENCE

Reactor Systems Manual, Ch. 3, Sec. 3.2.5.
Technical Specification, 3.4

ANSWER I.10 (2.50)

a. To be conservative, it is assumed that the actual radiation level in the set-up area is high [0.50] and, until proven otherwise, personnel are not allowed to exit through the airlock [0.50].

OR

To protect personnel [0.50] from potential overexposure [0.50]. (1.00)

b. A blue light [0.50] and a warning bell [0.50] at the reception desk [0.50]. (1.50)

REFERENCE

Abnormal Operating Procedures, PM 5.6.1, "High Radiation Set-Up Vault", and PM 5.6.4, "Trouble NW-12 Gamma Monitor".
Reactor Systems Manual, Ch. 7, Sec. 7.6.

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

ANSWER I.11 (1.50)

a. The Director of Reactor Operations [0.50] and the MITR Radiation Protection Officer [0.50]. (1.00)

b. The Senior licensed member of the NRL Staff on-site. (0.50)

REFERENCE

Emergency Plan and Procedures, Sec. 4.3.3.2.

ANSWER I.12 (2.00)

a. Buildup of Ar-41 in the containment building. (1.00)

b. Bypass the affected channel using the key switch [0.50] and reopen dampers and restart ventilation fans (restore containment ventilation to service) [0.50]. (1.00)

REFERENCE

Abnormal Operating Procedures, PM 5.6.3, "Trouble Radiation Monitor".

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

ANSWER J.01 (4.00)

a. The anti-syphon valves prevent syphon draining of the core tank following a break of the reactor coolant inlet line [0.50].

The convection valves permit convection cooling during periods of no forced flow [0.50]. (1.00)

b. The anti-syphon valve's ball is forced upward to cover the syphon break during normal primary pump operation [0.75]. If the inlet line were to break the pressure holding the ball ball would be lost and gravity would cause the ball to drop which would uncover the syphon break [0.75].

The convection valve's ball is forced upward to cover what is effectively a core bypass hole during normal primary pump operation [0.75]. If primary coolant flow was lost, gravity would cause the ball to drop which would uncover the core bypass hole completing a path that would allow for natural circulation [0.75].

OR

Make sketches similar to those attached which demonstrate the above points. (3.00)

REFERENCE

Reactor Systems Manual, Ch. 1, Sec. 1.5.3; Ch. 3, Sec 3.2.7.
Reactor Systems Manual, Ch. 1, Figure 1.17 "Natural Convection Valves", and Figure 1.16 "Anti-syphon Valves".

ANSWER J.02 (1.50)

a. TRUE

b. FALSE

c. FALSE (1.50)

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

REFERENCE

MITR RSM 6.8
Reactor Systems Manual, Ch. 6, Sec. 6.5.1.

ANSWER J.03 (2.00)

a. If building pressure exceeds 2 psig, and if radiation levels and/or structural damage preclude opening the main or auxiliary dampers. (1.00)

b. ~~Draws air through the system prior to reactor startup to both clean and activate the charcoal filter.~~ (1.00)
"Any two of the following at 0.50 each:
1. Pressurizing the containment for the annual leak rest.
2. Cleaning the charcoal filter.
3. Activating the charcoal filter.

REFERENCE
Reactor Systems Manual, Ch. 8, Sec. 8.4.
Abnormal Operating Procedures, PM 5.5.7 "Building Overpressure.

ANSWER J.04 (1.00)

Lower the shim bank [0.50] by at least 1.0 inch [0.50]. (1.00)

REFERENCE

Standard Operating Plans, PM 2.3.1 "Normal Reactor Startup", Step 11.

ANSWER J.05 (2.00)

a. The transfer is made by adjusting (reducing) the gain. (1.00)
(*NOTE: Half credit is lost if the candidate includes adjusting the discriminator as this is no longer done.)

b. Adjusting the gain downward causes a large decrease in the input to the channel [0.50] which results in a short duration negative period indication [0.50]. (1.00)

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

REFERENCE

Standard Operating Plans, PM 2.3.1 "Normal Reactor Startup", Step 15.
Reactor Systems Manual, Ch. 5, Sec. 5.3.1.
*Facility Assistant Superintendent's Explanation during plant tour.

ANSWER J.06 (1.00)

To allow the reactor core and primary coolant to approach thermal equilibrium [0.50] thereby reducing stress on the fuel element cladding [0.50]. (1.00)

REFERENCE

Standard Operating Plans, PM 2.3.1 "Normal Reactor Startup", Step 21 & 2

ANSWER J.07 (2.50)

At 10 hours into an essentially Xe free startup the Xe reactivity is - 1675 mβ

At 40 hours the Xe reactivity is - 3900 mβ

Therefore the change in reactivity due to Xe is - 2225 mβ [1.00]

The regulating rods cycle between 2 and 10 inches, equivalent to 68 mβ to 248 mβ or a change of 180 mβ for each cycle. [1.00]

2225 mβ/ 180 mβ per cycle = 12.33 cycles (will accept 11 to 13 cycles) [0.50] (2.50)

REFERENCE

Standard Operating Plans, PM 2.4.1 "Full Power Operation", Step 3.
PM 6.5.16.1 "MITR-II Integral Reg Rod Worth Curve".
Reactor Systems Manual, Ch. 10, Figure 10.16 "MITR-II Xenon Startup Transient" & Figure 10.17 "MITR-II Xenon Shutdown Transient".

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

ANSWER J.08 (3.00)

a. 1. Depress the rundown reset button.

2. Place the control rods on manual.

3. Reshim. (1.50)

b. 30 seconds. (0.50)

c. When the rod being driven in is no longer within two inches of the the bank height. (1.00)

REFERENCE

Standard Operating Plans, PM 2.4.1 "Full Power Operation", Step 4.b.

ANSWER J.09 (3.00)

Any five of the following at 0.60 each:

1. Check that the MG set is running [0.30] and adjust its output voltage to 208 volts [0.30].

2. Notify the MIT Campus Police and Physical Plant of the extent of the power outage.

3. If possible, notify the occupants of NW-12 that the vault alarm was spurious.

4. Check the personnel accountability board and determine how many experimenters etc. are inside the containment building.

5. Bypass secondary coolant flow to the cooling tower basins.

6. If necessary, open CV-33 to supply pressurized air to the main personnel lock gaskets.

7. Enter the containment via either personnel lock, check the reactor floor and basement for personnel and escort all non-essential personnel from the building via the main lock. (3.00)

8. Verify the console operator has carried out his immediate actions.

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

REFERENCE

Abnormal Operating Procedures, PM 5.8.1, "Loss of Normal Electrical Power", pp. 1 & 2.

Abnormal Operation Procedures, PM 5.0.

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

ANSWER K.01 (2.00)

Any FOUR of the following at 0.50 each:

Increasing readings on core purge monitor (or alarm).
Increasing readings on plenum air monitor (or alarm).
Increasing readings on N-16 monitor (or alarm).
Increasing activity in pool samples.
Increasing primary conductivity (or alarm).
Increasing equipment room monitors.
Increasing containment building area monitors. (2.00)

REFERENCE

Abnormal Operating Procedures, PM 5.8.2 "Fission Product Detection in the Primary Coolant", p. 1.

ANSWER K.02 (2.00)

1. Loss of power to the SFSP control and alarm panel.
2. Leak
3. Low SFSP level.
4. Low flow through the SFSP ion exchanger. (2.00)

REFERENCE

Abnormal Operating Procedures, PM 5.7.12 "Spent Fuel Storage Pool", p. 1.

ANSWER K.03 (3.00)

a. 1. The ratio $F_{HC} F_p / d F_f f$ is predicted to be less than 2.9 [1.00].

2. The core is predicted to operate below incipient boiling at every point in the core [1.00]. (2.00)

b. Two Senior Reactor Operators. (1.00)
(The Superintendent and/or the Assistant Superintendent may be named directly since they are the most senior licensed SRO's)

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

REFERENCE

Technical Specification, 3.1.3, and 7.2.

ANSWER K.04 (4.00)

Any two of the following at 2.00 points each:

1. Feature - The grid is designed so that there is normally access to only one core position at a time [1.00].

   Purpose - This limits the amount of water that can be in the core at any one time [0.50] by making it difficult, (though not impossible, for more than one core position to be defueled at time [0.50]. (2.00)

2. Feature - The grid's latch is interlocked with the primary coolant pumps so that if the latch is released, the coolant pumps stop and remain off until the grid is latched again [1.00].

   Purpose - This protects the fuel elements from damage and the reactor as a whole from inadvertent criticality.

   OR

   This prevents core components from being expelled by hydraulic force [1.00]. (2.00)

REFERENCE

Standard Operating Plans, PM 2.7 "Fuel Handling", p. 3.

ANSWER K.05 (1.00)

This prevents melting of the fuel element by afterheat. (1.00)

REFERENCE

Technical Specification, 3.10.

3. Feature - The grid cannot be rotated unless the shim blades are fully inserted [1.00].

   Purpose - This prevents fuel movement without maximum shutdown reactivity from the shim blades [1.00] (2.00)

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

ANSWER K.06 (3.00)

a. It is assumed that the core is Xe free [0.50] and that the regulating rod [0.50] and the most reactive shim blade are fully withdrawn [0.50]. (1.50)

b. Variable reactivity refers to reactivity changes that may occur dur.ng core life [0.50].

Factors which cause variable reactivity include:
(any two of the following at ~~0.00~~ 0.50 each) [1.00]
fuel burnup
xenon (and samarium) changes
sample changes
experiment changes (1.50)

REFERENCE

Technical Specification, 3.9.

ANSWER K.07 (2.00)

1. The reactor is shutdown. (0.50)

2. Console key switch off and key is in proper custody. (0.50)

3. No work in progress within the main core tank [0.50] involving fuel or experiments [0.20], or maintenance of the core structure [0.10], installed control blades [0.10] or installed control blade drives when not visibly decoupled from the control blade [0.10]. (1.00)

REFERENCE

Technical Specifications, 1.1.

ANSWER K.08 (1.00)

~~a. 8 1/3 (+0/-1)~~ ~~(0.50)~~

a. 8 1/3 (+0/-1) (0.50)

b. 4 (0.50)

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

REFERENCE

Technical Specifications, 3.10.

ANSWER K.09 (2.00)

a. A-ring because the flux is highest due to less leakage. (0.50)

b. LESS THAN [0.50]

Due to the self shielding of the more heavily loaded elements [1.00] (1.50)

REFERENCE

Reactor Systems Manual, Ch. 10, Sec. 10.8.1.

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

ANSWER L.01 (1.50)

a. 1. A licensed SRO [0.50].

2. Another person (qualification not specified) [0.50]. (1.00)

b. MITR Radiation Protection Officer (or his designated alternate). (0.50)

REFERENCE

Technical Specifications 7.2.1

ANSWER L.02 (1.00)

a. TRUE (0.50)

b. FALSE (0.50)

REFERENCE

Administrative Procedures, PM 1.14.2.3, Paragraph 6, and PM 1.14.2.1, Paragraph 5.

ANSWER L.03 (2.00)

1. Obtain some method by which the Operator-in-Charge may page you. (1.00)

2. Inform the Operator-in-Charge. (1.00)

REFERENCE

Administrative Procedures, PM 1.14.1, Paragraph 2.

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

ANSWER L.04 (4.00)

a. 1. On duty console operator [0.50].

2. Any member of the NRL/RPO staff [0.50]. (1.00)

b. Any five of the following at 0.60 each:

1. SRO will witness lockout [0.30] AND verify the system is in a safe condition [0.30].

2. Person performing work will perform lockout.

3. Person performing work will retain the key on his person.

4. A notation as to the system being locked out shall be made on the status board.

5. The system must be tagged out.

6. Lockouts shall be removed under the direction of an SRO [0.30] by the the person who performed the work [0.30]. (3.00)

7. Must obtain permission from the on-duty console operator.

REFERENCE

Administrative Procedures, PM 1.14.3.

ANSWER L.05 (2.00)

a. If the change does not change the intent of the original procedure. (1.00)

b. 1. An SRO [0.50].

2. Any other member of the reactor staff [0.50] (1.00)

REFERENCE

Technical Specifications 7.8.3.

Administrative Procedure, PM 1.5, "Procedures Adherence Temporary Change Method."

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

ANSWER L.06 (3.00)

a. 1. Total reactor thermal power [0.50].

2. Reactor coolant total flow rate [0.50].

3. Reactor coolant outlet temperature [0.50].

4. Height of water above the outlet end of the heated section of the hottest fuel channel [0.50]. (2.00)

b. To establish limits within which the integrity of the fuel clad is maintained. (1.00)

OR (will accept)

To prevent flow instabilities.

REFERENCE

Technical Specifications 2.1.

ANSWER L.07 (1.50)

a. The Emergency Director. (0.50)

~~b. Building evacuation necessitated by the buildup of Argon-41 [0.50] following loss of ventilation for routine reasons (i.e., loss of off-site electrical power or steam) [0.50]. (1.00)~~

REFERENCE

Emergency Plan and Procedures, PM 4.3.3.3.

b.

1. Whenever the on-duty Shift Supervisor is the acting Emergency Director. [0.50]

2. Whenever the building evacuation was necessitated by the build up of Argon-41 [0.25] following a loss of ventilation for routine reasons [~~or~~ 0.25] (such as loss of offsite electrical power or steam). (1.00)

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

ANSWER L.08 (3.00)

a. 1. Notification of Unusual Event

2. Alert

3. Site Area Emergency

4. Alert (2.00)

b. Potential radiological consequences. (1.00)

Deleted

REFERENCE

Emergency Plan and Procedures, PM 4.5, Tables 4.5.3-1,2,3 & 4 "EALs for Notification of Unusual Events, Alerts, Site Area Emergencies & General Emergencies", Pm 4.4, Sec 4.4.1.

ANSWER L.09 (2.00)

a. Apparatus and mechanisms of a nuclear reactor, the manipulation of which directly affect the reactivity or power of the reactor. (1.00)

b. The individual manipulating the control must be under the direction of and in the presence of a licensed reactor operator [0.50] and the manipulation must be part of the individuals training as a student [0.50]. (1.00)

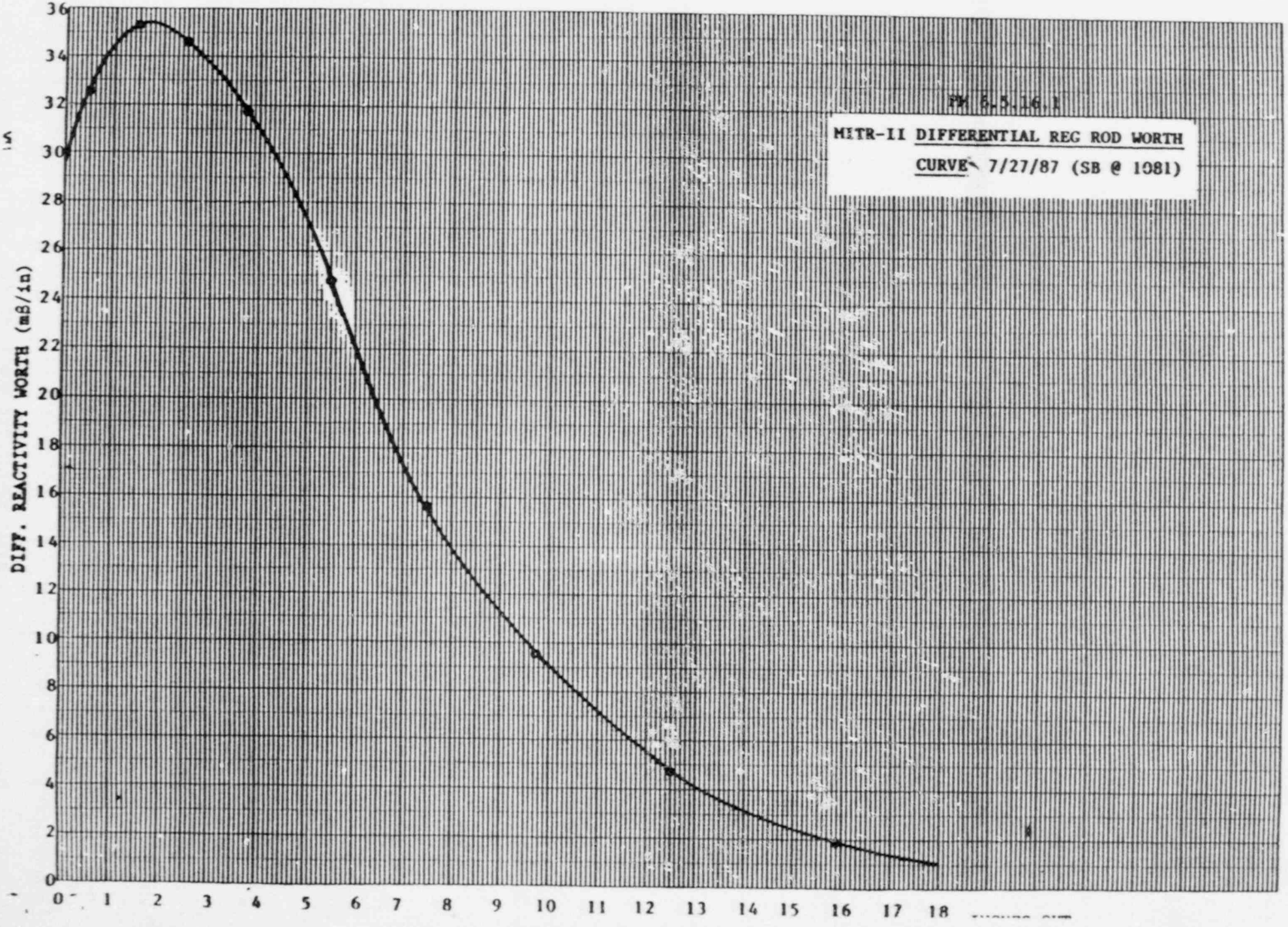
REFERENCE

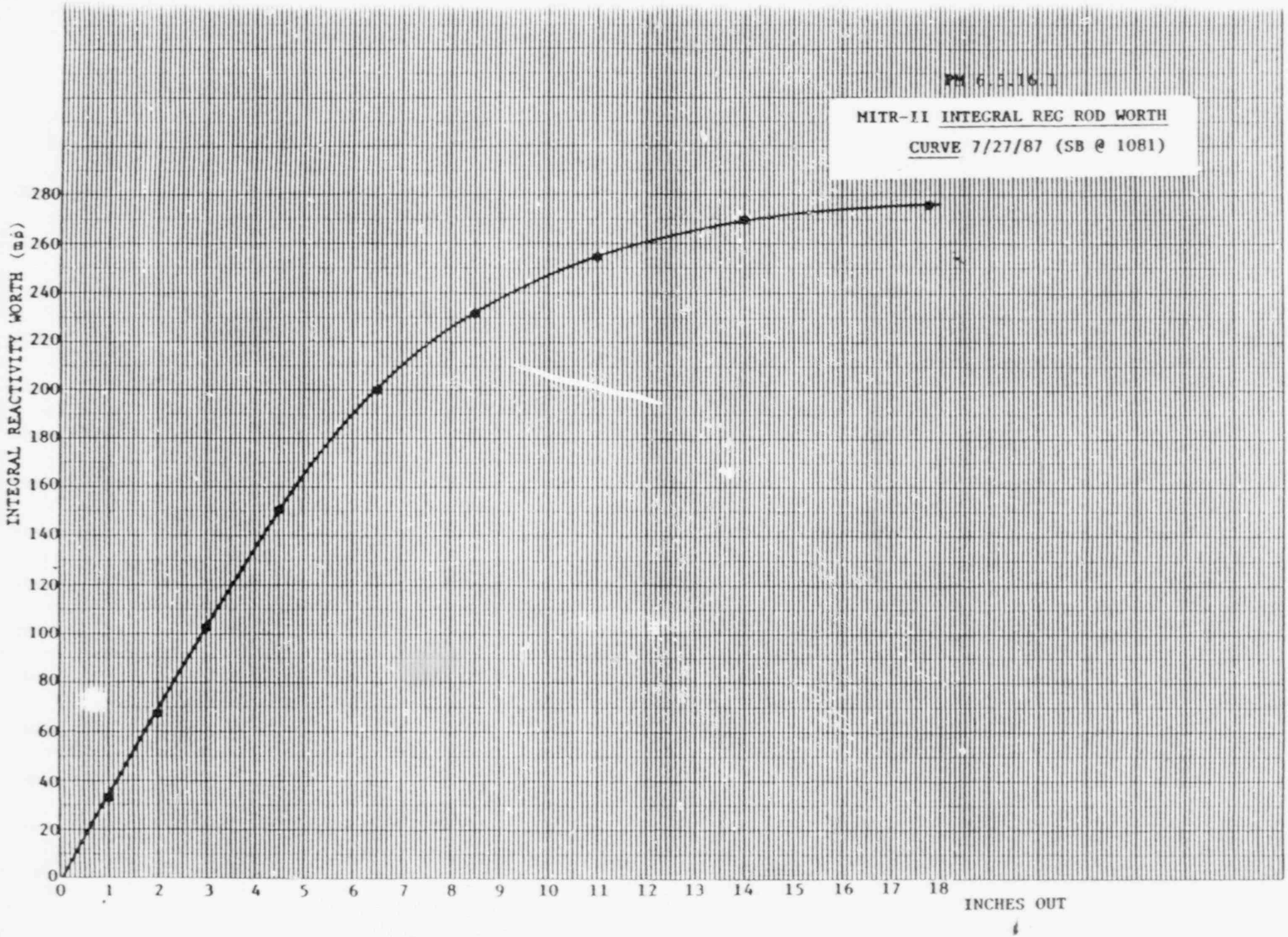
10CFR55, Part 55.4 , 55.9 and 55.13.

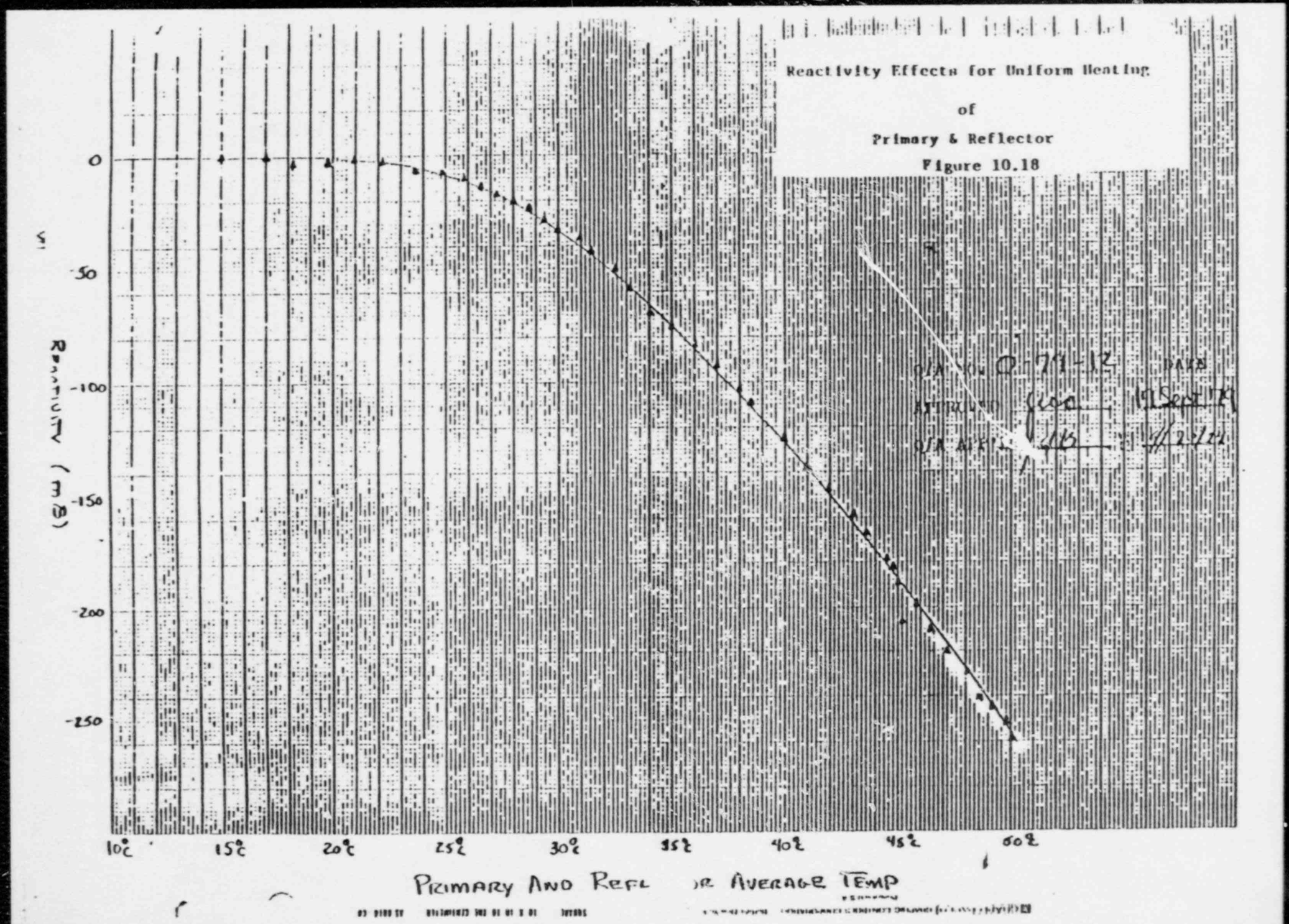
(***** END OF CATEGORY L *****)
(********** END OF EXAMINATION **********)

QUESTION	VALUE	REFERENCE
H.01	2.00	ZZZ0000001
H.02	3.00	ZZZ0000002
H.03	2.00	ZZZ0000003
H.04	3.00	ZZZ0000004
H.05	2.00	ZZZ0000005
H.06	1.00	ZZZ0000006
H.07	2.00	ZZZ0000007
H.08	3.00	ZZZ0000008
H.09	2.00	ZZZ0000009
	20.00	
I.01	2.00	ZZZ0000010
I.02	2.00	ZZZ0000011
I.03	3.00	ZZZ0000012
I.04	1.00	ZZZ0000013
I.05	1.50	ZZZ0000014
I.06	1.00	ZZZ0000015
I.07	1.00	ZZZ0000016
I.08	1.50	ZZZ0000017
I.09	1.00	ZZZ0000018
I.10	2.50	ZZZ0000019
I.11	1.50	ZZZ0000020
I.12	2.00	ZZZ0000021
	20.00	
J.01	4.00	ZZZ0000022
J.02	1.50	ZZZ0000023
J.03	2.00	ZZZ0000024
J.04	1.00	ZZZ0000025
J.05	2.00	ZZZ0000026
J.06	1.00	ZZZ0000027
J.07	2.50	ZZZ0000028
J.08	3.00	ZZZ0000029
J.09	3.00	ZZZ0000030
	20.00	
K.01	2.00	ZZZ0000031
K.02	2.00	ZZZ0000032
K.03	3.00	ZZZ0000033
K.04	4.00	ZZZ0000034
K.05	1.00	ZZZ0000035
K.06	3.00	ZZZ0000036
K.07	2.00	ZZZ0000037
K.08	1.00	ZZZ0000038
K.09	2.00	ZZZ0000039
	20.00	
L.01	1.50	ZZZ0000040
L.02	1.00	ZZZ0000041
L.03	2.00	ZZZ0000042
L.04	4.00	ZZZ0000043

QUESTION	VALUE	REFERENCE
L.05	2.00	ZZZ0000044
L.06	3.00	ZZZ0000045
L.07	1.50	ZZZ0000046
L.08	3.00	ZZZ0000047
L.09	2.00	ZZZ0000048
	20.00	
	100.0	


FM 6.5.16.1
MITR-II DIFFERENTIAL REG ROD WORTH
CURVE 7/27/87 (SB @ 1081)
DIFF. REACTIVITY WORTH (mδ/in)
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
34
36
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18


FM 6.5.16.1
MITR-II INTEGRAL REG ROD WORTH
CURVE 7/27/87 (SB @ 1081)
INTEGRAL REACTIVITY WORTH (mδ)
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18
INCHES OUT


Reactivity Effects for Uniform Heating
of
Primary & Reflector
Figure 10.18
0
-50
-100
-150
-200
-250
Reactivity (mk)
10°C
15°C
20°C
25°C
30°C
35°C
40°C
45°C
50°C
Primary And Reflector Average Temp

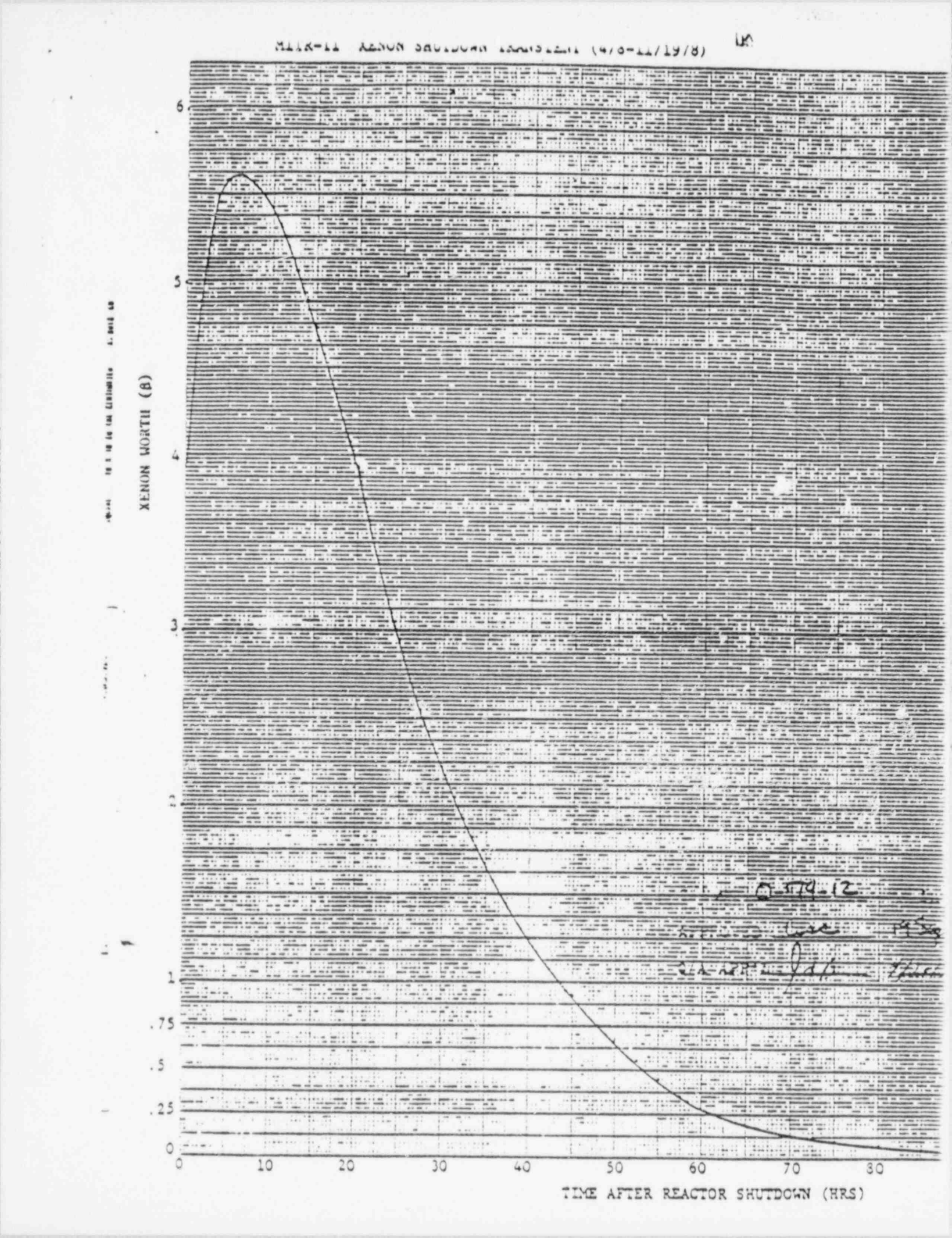

XENON WORTH (β)
6
5
4
3
2
1.75
1.5
1.25
0
0
10
20
30
40
50
60
70
80
TIME AFTER REACTOR SHUTDOWN (HRS)

Figure 10.16

MITR-II XENON STARTUP TRANSIENT (4/11-14/1978)

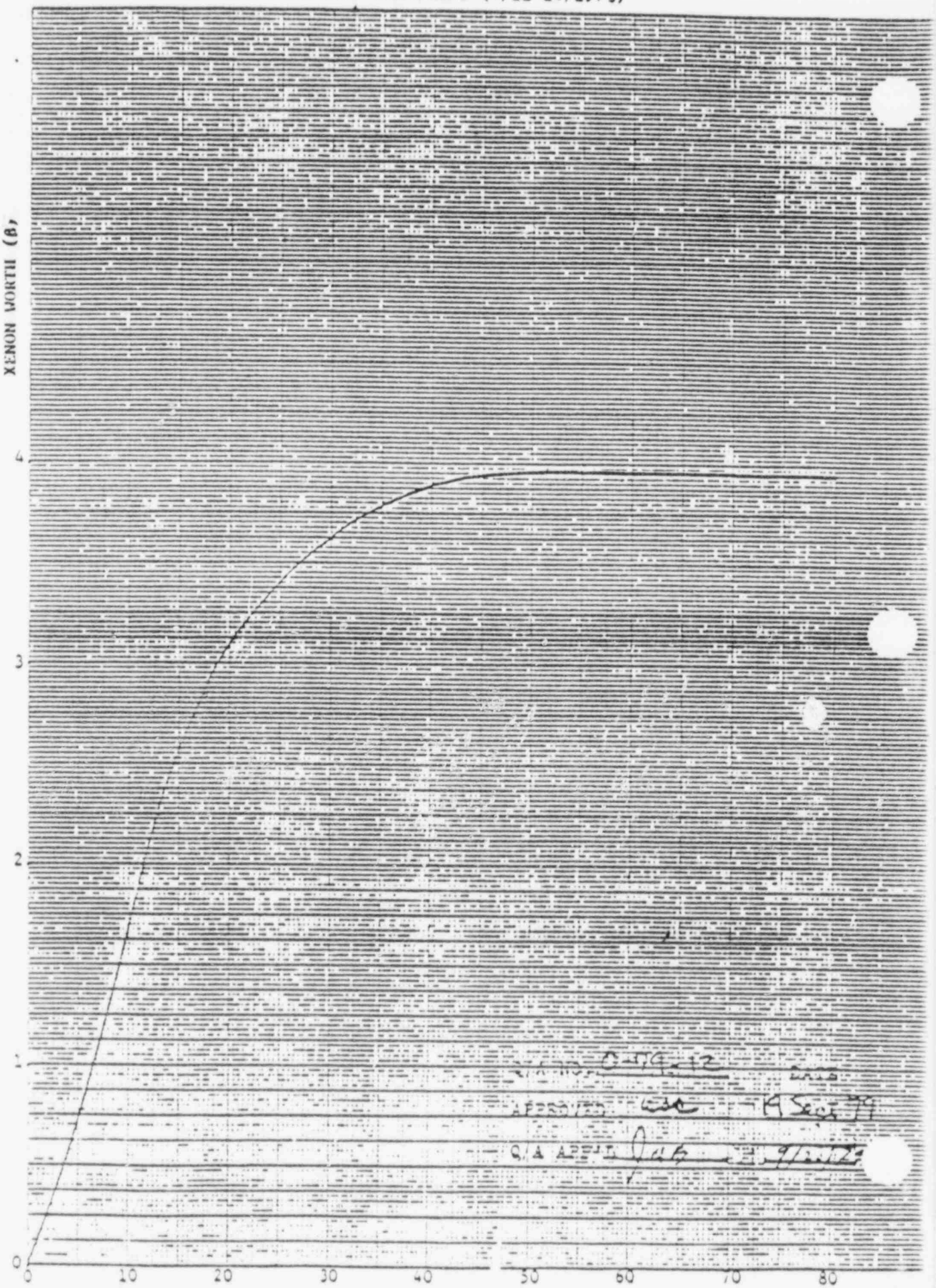


Table 4.5.3-4: EALs for a General Emergency

1. Actual or projected doses at the site boundary in the exposure pathway of 1 rem whole body or 5 rem thyroid for unrestricted areas when averaged over one hour. Note: Figure 4.7.2.2-1 lists the conditions and instrument readings corresponding to a projected off-site dose of 1 rem/hour. (PM 4.4.4.15a)
2. Sustained actual or projected radiation levels at the site boundary of 500 mrem/hour whole body. (PM 4.4.4.14a/4.4.4.11/4.4.4.12)
3. Blockage of fuel element channels thereby causing a loss of coolant to the affected channels and a fuel melt. This is the design basis accident. (PM 4.4.4.15a)
4. Loss of physical control of either the containment building which includes the control room or of auxiliary areas that house vital equipment. (PM 4.4.4.5/4.4.4.6).
5. Events that have caused or will cause massive facility and/or reactor system damage that could lead to the melting of fuel. (PM 4.4.4.15a)

Table 4.5.1-1: EALs for a Site Area Emergency

1. Confirmed abnormal radiation levels leading to actual or projected radiological effluents at the site boundary exceeding 250 MPC for unrestricted areas when averaged over 24 hours. This level corresponds to an exposure of 375 mrem whole body accumulated over 24 hours. (PM 4.4.4.15b)
2. Same as #1 except the effluents could cause an integrated exposure of 500 mrem thyroid. (PM 4.4.4.15b)
3. Radiation levels at the site boundary of 100 mrem/hour sustained for one hour. (PM 4.4.4.14b/4.4.4.11)
4. Abnormal loss of primary coolant such that the core tank level drops below the anti-syphon valves. (Note: This accident is not considered credible, but procedures exist for coping with it.) (PM 4.4.4.4)
5. Imminent loss of physical control of the reactor. (PM 4.4.4.6)
6. Severe natural events being experienced. These include:
   (a) An earthquake that is causing observable damage to the reactor safety equipment within the containment building.
   (b) A flood that is affecting the operability of any reactor safety system.
   (c) Tornado or hurricane force winds that are damaging the containment building. (PM 4.4.4.2)

Table 4.5.1-2: EALs for an Alert

1. Confirmed abnormal radiation levels leading to actual or projected radiological effluents at the site boundary exceeding 50 MPC for unrestricted areas when averaged over 24 hours. This level corresponds to an exposure of 75 mrem whole body accumulated over 24 hours. (PM 4.4.4.15b)
2. Same as #1 except the effluents could cause an integrated exposure of 100 mrem thyroid. (PM 4.4.4.15b)
3. Radiation levels at the site boundary of 20 mrem/hour sustained for one hour. (PM 4.4.4.14b/4.4.4.11)
4. Abnormal loss of primary coolant such that the core tank level remains at or above the anti-syphon valves. (PM 4.4.4.4)
5. Loss of radioactive material control that causes radiation dose rates or airborne radionuclides to increase above permissible exposure levels by a factor of 1000 throughout the containment building. (PM 4.4.4.12)
6. Radiation dose rates throughout the containment building in excess of 100 mrem/hour sustained for one hour. These levels would necessitate evacuation of all personnel. (PM 4.4.4.12)
7. A fire leading to loss of radioactive material control within the containment building. (PM 4.4.4.3)
8. An imminent or existing hazard such as:
   (a) Missile(s) impacting on the containment building.
   (b) An explosion that affects facility operation.
   (c) An uncontrolled release of toxic or flammable gases into the containment building. (PM 4.4.4.9)

Table 4.5.3-1: EALs for Notification of Unusual Events

1. Confirmed abnormal radiation levels leading to actual or projected radiological effluents at the site boundary exceeding 10 MPC for unrestricted areas when averaged over 24 hours. This level corresponds to an exposure of 15 mrem whole body accumulated over 24 hours. (PM 4.4.4.15b)
2. Report or observation that severe natural phenomena are either imminent or existing. These include storms with tornado or hurricane force winds that could strike the facility, earthquakes that could adversely affect the reactor's safety systems, and floods that could adversely affect the reactor's safety systems. (PM 4.4.4.2)
3. Threats to or breaches of security. (PM 4.4.4.5/4.4.4.6)
4. A reactor safety limit's being exceeded such that a fuel damage accident that could release radionuclides to the containment building is possible. (PM 4.4.4.1)
5. A fire within the containment building that lasts beyond the incipient stage or for more than ten minutes. (PM 4.4.4.3)
6. Receipt of a bomb threat. (PM 4.4.4.7)

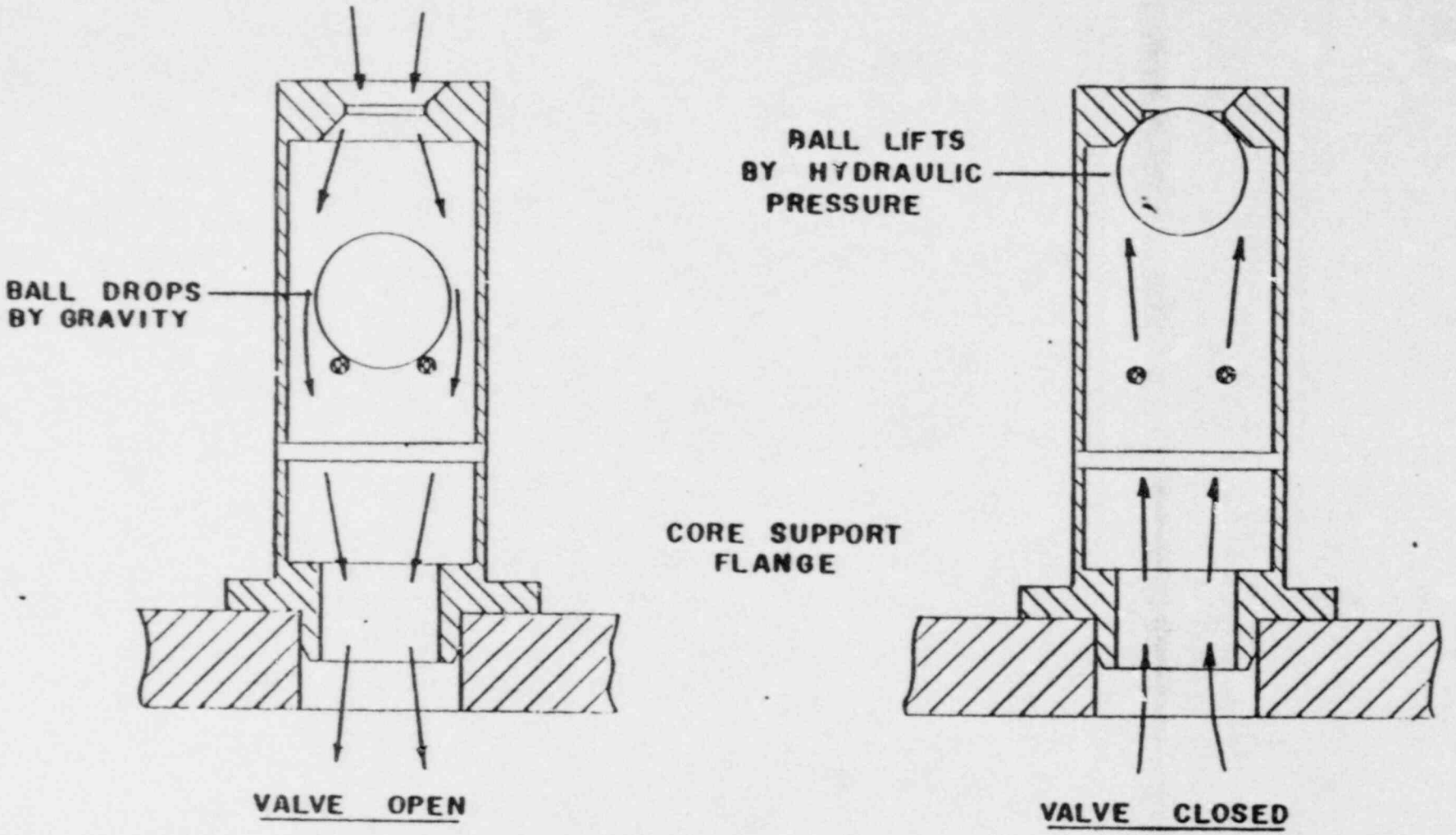
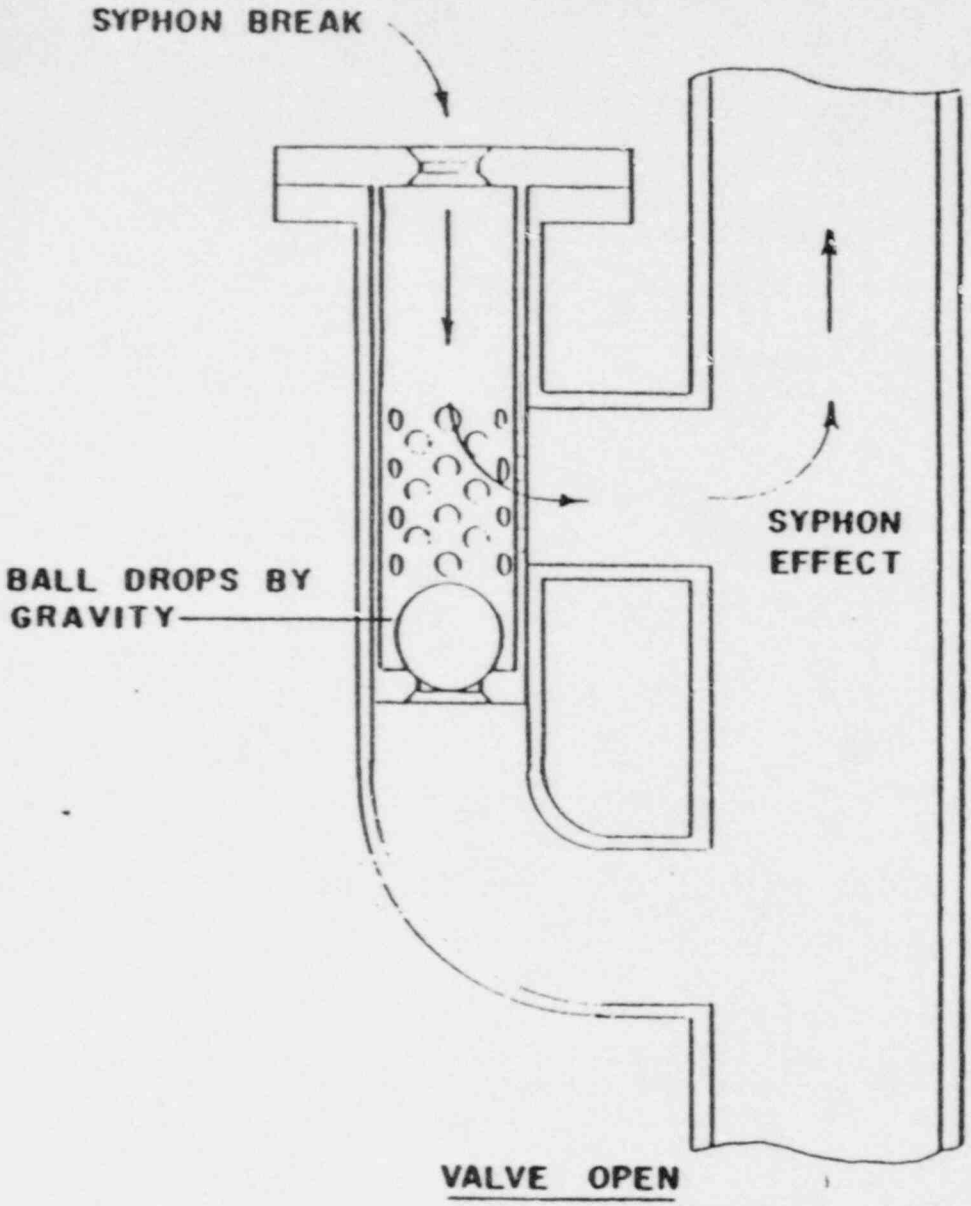


FIGURE 1.17
NATURAL CONVECTION VALVES

Q/A NO. 0-79-3 DATE
APPROVED cwa 31 Aug 79
Q/A APP'L [signature] 31 Aug 79



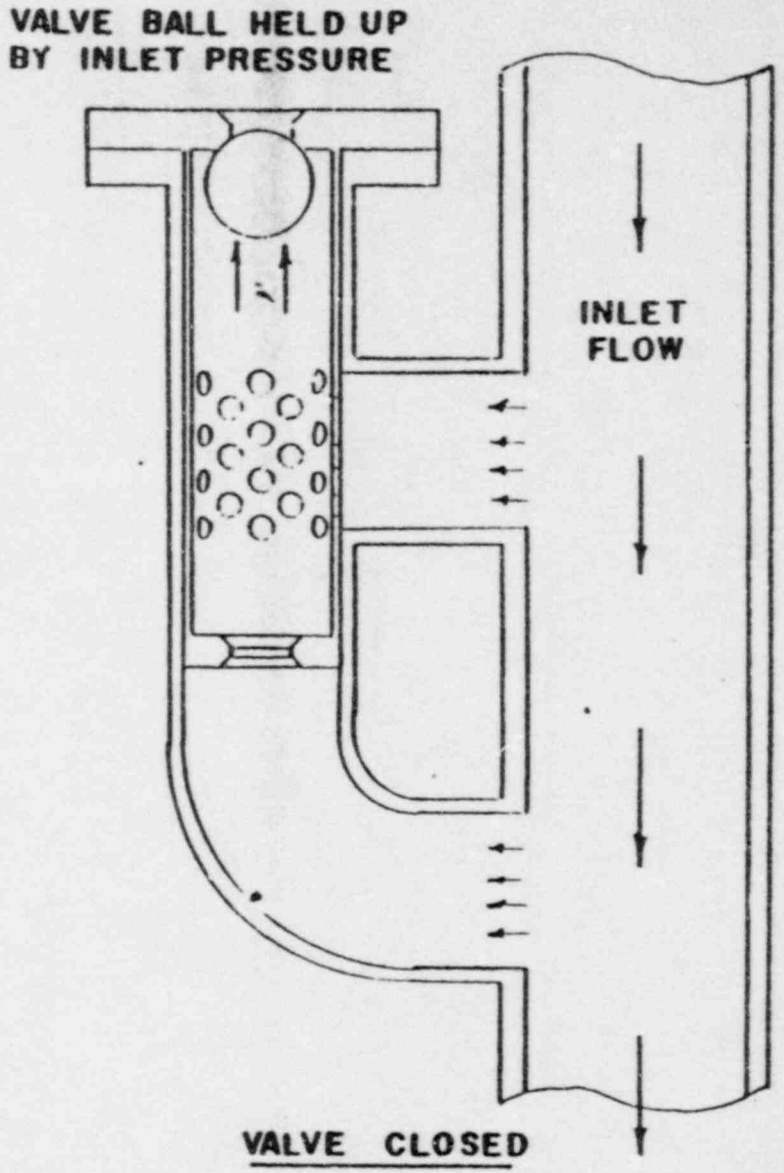


FIGURE 1.16
ANTI-SYPHON VALVES

Q/A NO.	O-79-3	DATE
APPROVED	Case	31 Aug 79
Q/A APP'L	[illegible]	31 Aug 79

Attachment 2

FACILITY COMMENTS AND NRC RESOLUTIONS FOR MASSACHUSETTS INSTITUTE OF TECHNOLOGY REACTOR OPERATOR EXAM ADMINISTERED ON JANUARY 25,1988.

QUESTION B.02

Facility Comment:

Top of core shroud is -52 inches which is the inlet penetration for the primary piping. The anti-syphon valves are located at the inlet penetration. RSM 3.2.7, Mode 2 of ECS cooling

NRC Resolution:

Comment is valid. Credit will be given if this value is utilized in reference to the anti-syphon valve location. "or -52 inches" will be added to first sentence of answer immediately after "core shroud"

QUESTION C.02.b

Facility Comment:

The plugs in the cooling tower standpipe overflow must first be removed.

NRC Resolution:

Comment is valid. No credit will be deducted if this step is included in the discussion.

QUESTION C.07

Facility Comment:

Operators are taught to distinguish between steady (asympotic) and dynamic periods. See MITR Physics Notes.

NRC Resolution:

Comment is valid. Full credit will be given if a discussion of prompt and long term effects on reactor period is included in the answer. The answer sheet will be modified to reflect this by adding "Will also accept correct discussion of steady state and dynamic periods for full credit".

QUESTION E.01

Facility Comment:

Believe there is a typo in the answer. Should be MM2 not DM2.

NRC Resolution:

Comment is valid. Answer will be changed to correct this

QUESTION E.06.b

Facility Comment:

Also, provide core cooling in event of loss of off-site power (Mode I).

NRC Resolution:

Comment is not valid. Although this function is provided by keeping the coolant temp. less than boiling it could not be considered acceptable for full credit. Partial credit will be given this response for one of the two required answers.

QUESTION F.02(b)

Facility Comment:

Answer as given is correct, but sometimes we have both a duty shift supervisor (examples, MIT Physical Plant, customer relations) and a shift supervisor (reactor operation only). So, question could be confusing.

NRC Resolution:

Comment is valid. For this test the answer will be changed to False and for future tests the question will be changed to read "Reactor Supervisor on Duty" instead of "Duty Reactor Supervisor".

QUESTION F.03(b)

Facility Comment:

The Electronics Technician is currently also the Electronics Supervisor, a licensed SRO.

NRC Resolution:

Comment is valid. For this exam the Electronics Technician will be accepted as an acceptable substitute for Electronics Supervisor.

QUESTION F.04

Facility Comment:

Question inappropriate for and RO exam. Decisions of this type would be made by the shift supervisor.

NRC Resolution:

Comment is not valid. The question directly addresses authority limitations placed on the RO by 10CFR, it does not ask him to make the decision. However, since it would be reasonable to expect the RO to immediately bring such an action to the SRO for approval this will be taken into account during grading.

QUESTION F.07

Facility Comment:

Also, prevent sudden reactivity effect should blade move rapidly if suddenly freed.

NRC Resolution:

Comment is valid. This could be a possible consequence of not opening the breaker and will be added to the answer as an alternate acceptable answer.

QUESTION G.04

Facility Comment:

Appears to be a typo. Should be "Beta" not "Alpha".

NRC Resolution:

Comment is valid. Answer will be changed to read "Beta" instead of "Alpha".

CHANGES MADE BY EXAMINER DURING THE EXAM GRADING

1. QUESTIONS C.06(c) - Added " per pump or 1800 gpm total" immediately after "900 gpm" in the answer. This will account for total secondary flow.

2. QUESTION D.04(a) - Added "with the reactor in automatic control" to end of the answer. This will make the answer exact.

ATTACHMENT 4

MASSACHUSETTS INSTITUTE OF TECHNOLOGY REACTOR
MITR-II
SENIOR REACTOR OPERATOR EXAMINATION
JANUARY 25, 1988

Specific facility comments concerning the SRO examination, followed by the NRC resolutions, are listed in the following paragraphs.

QUESTION H.09(a)

FACILITY COMMENT:

Question implies a step insertion of the regulating rod whereas in practice the regulating rod cannot be decoupled from its drive and its maximum speed of insertion would be a ramp rate at 4.25 inches per minute. Both ramp and step insertions of the regulating rod should be accepted. RSM 1.6.2.

NRC RESOLUTION:

It is agreed that answers assuming ramp insertion should be accepted in addition to those assuming step insertions. The answer key is changed as follows:

"OR

For a normal insertion of ten inches, the power will begin to ramp down immediately [0.50] due to the quick response of the prompt neutrons to the ramp change in reactivity [0.50]."

QUESTION I.02(a)

FACILITY COMMENT:

Answer should also be the emergency director who may be the most senior NRC-licensed member on shift if the director for operations is not present.

NRC RESOLUTION:

In accordance with the "MITR-II Procedure Manual Chapter #4, Emergency Plans and Procedures," paragraph 4.3.1.2.1,

> "The senior NRC-Licensed staff member on shift...is responsible for decisions and coordination of all immediate actions in an emergency..."

In light of the above procedural direction, the answer "Emergency Director" is not accepted.

QUESTION I.03(a)

FACILITY COMMENT:

The answer is not consistent with the answers from previous NRC exams. The correct answer should be that the point at which maximum reconcentration occurs for a stack release is far away from the reactor where the population is concentrated, whereas the maximum concentration for a containment building release is at the containment wall where a 60 foot distance is available before normal occupancy by the general public.

NRC RESOLUTION:

The question is not the same as on previous NRC exams. It is much more general and, therefore, a much more general answer was expected. However, a correct detailed answer explaining why the dilution factor is more for containment than for stack releases is acceptable. The following is added as an additional correct answer:

"Because the point of maximum concentration for a containment release is some distance away from the point of concern (where the public has access) [0.50] whereas the point of maximum permissible concentration and point of concern are the same for stack releases [0.50].

ADD REFERENCE:

"Emergency Plan and Procedures, PM 4.7.2.2.1."

QUESTION I.03(c)

FACILITY COMMENT:

Answer should be:

1. Stack gas monitor
2. Stack particulate monitor
3. Stack area monitor
4. Portable monitoring

REFERENCE:

PM 4.4.4.14 page 1 and PM 4.4.4.15 page 2 which give the EALS for general emergencies.

NRC RESOLUTION:

Agreed, additional answer will be added as follows:
"6. Portable monitors at site boundary."

ADD REFERENCE:

"Emergency Plan and Procedures, Section 4.4.4.14, page 1."

QUESTION I.04

FACILITY COMMENT:

Both b and c are correct. MIT has pointed out the ambiguity of this question from previous NRC examinations. Either b or c was previously accepted as the correct answer.

NRC RESOLUTION:

It is agreed that there are two good answers to the question and, therefore, it is deleted from the test. The note, "Deleted due to ambiguity," will be added to the question in the exam bank.

QUESTION I.07

FACILITY COMMENT:

Change made to PM 3.6 after material was sent to NRC ADDED requirement to check for operability of the sewer radiation monitor prior to discharge. So, there are three automatic responses.

NRC RESOLUTION:

Noted. Added note to exam to go into exam bank as follows:

"Recent change to procedure has the operability of the sewer radiation monitor checked also. This will need to be included in this answer in the future."

QUESTION I.09

FACILITY COMMENT:

Purposes of core purge system:

(a) Detect fission product gas release. (PM 5.6.5)
(b) Prevent hydrogen buildup from radiolysis. (Tech Spec 3.4, Basis)
(c) Limit Ar-41 buildup.

NRC RESOLUTION:

It is agreed that the core blower is integral in the removal of H2 from the air space at the top of the core tank. It is not agreed that the system is installed for the detection of fission product gas release. The answer is changed to read:

"The purpose of the core purge system is to (any one of the following for 1.00):

1. Prevent hydrogen buildup.
2. Prevent the accumulation of Ar^{41}.
3. Prevent the accumulation of N^{16}.

ADD REFERENCE:

"Technical Specification, 3.4".

QUESTION J.03(b)

FACILITY COMMENT:

Pressure relief blower is also used to pressurize the containment building for the annual building pressure and leakage test. (PM 6.1.2.1)

NRC RESOLUTION:

Agreed, the answer will be changed to read as follows:

"Any two of the following at 0.50 each:

1. Pressurizing the containment for the annual leak test.
2. Cleaning the charcoal filter.
3. Activating the charcoal filter."

QUESTION J.08(a)

FACILITY COMMENT:

Placing reactor on manual control has the net effect of depressing the rundown reset button.

NRC RESOLUTION:

The procedure clearly states that the rundown reset button is to be pressed. The answer is not changed.

QUESTION J.09

FACILITY COMMENT:

Also, supervisor should verify that:

(a) Core is being adequately cooled. (PM 5.8.4)
(b) Operator is following proper procedures. (PM 5.0)

NRC RESOLUTION:

(a) Is not listed in 5.8.4 and is not accepted.
(b) Is a generic response for all casualties and is accepted. The answer is changed as follows:

"8. Verify the console operator has carried out his immediate actions."

ADD REFERENCE:

"Abnormal Operating Procedures, PM 5.0."

QUESTION K.03

FACILITY COMMENT:

The technical specifications state two senior operators. But, it has always been the Assistance Superintendent and the Superintendent.

NRC RESOLUTION:

Since the normal method of operation is more restrictive than the Technical Specification, Assistance Superintendent and Superintendent will be accepted. The answer is changed as follows:

"(The Superintendent and/or the Assistant Superintendent may be named directly. Since they are the most senior licensed SRO's)."

ADD REFERENCE:

"Technical Specifications, 7.2."

QUESTION K.04

FACILITY COMMENT:

There are three safety features. The third is that the blades must be fully inserted in order to rotate the grid. Insures reactor shutdown prior to refueling. (RSM 1.4)

NRC RESOLUTION:

Agreed, the answer is changed as follows:

"Any two of the following at 2.00 points each:

1. .....(As already written in answer)
2. .....(As already written in answer)
3. Feature - The grid cannot be rotated unless the shim blades are fully inserted [1.00].

Purpose - This prevents fuel movement without maximum shutdown reactivity from the shim blades [1.00]. (2.00)

ADD REFERENCE:

"Reactor Systems Manual, Chapter 1, Section 1.4."

QUESTION K.08

FACILITY COMMENT:

Believe answer is correct (8 1/3 and 4) but it is not legible due to over printing by typewriter.

NRC RESOLUTION:

Agreed, answer separated will read as follows:

"a. 8 1/3 (+ 0/-1)
b. 4"

QUESTION L.07(b)

FACILITY COMMENT:

On-Duty Shift Supervisor may also authorize reentry to save a life. (PM 4.4.4.13)

NRC RESOLUTION:

The facility comment and the examination answer are both too limiting. Reactor reentry for any valid purpose is authorized by, "The Emergency Director who is the Director of Reactor Operations or, in his absence, the Senior NRC-licensed staff member on site." Therefore, the on-Duty Shift Supervisor could authorize reentry any time he was the Senior NRC-licensed staff member on-site (Reference - PM 4.4.4.13, "Reactor Reentry") or whenever," the building evacuation was necessitated by the buildup of Argon-41 following a loss of ventilation for routine reasons such as loss of off-site electrical power or steam," (Reference PM 4.3.3.3, "Authorization for Reentry.")

Also note that the Emergency Director is the Director of Reactor Operations but his function is carried out by the on-duty Shift Supervisor and then the on-site senior licensed member of the Reactor Operations Staff (who may be the on-duty SS) until properly relieved of this responsibility by the Director of Reactor Operations, (Reference PM 4.3.2.1, "Emergency Director.")

The answer, in light of the above and in light of the way in which the question was asked is changed to read as follows:

1. "Whenever the on-duty Shift Supervisor is the acting Emergency Director [0.50].

2. Whenever the building evacuation was necessitated by the buildup of Argon-41 [0.25] following a loss of ventilation for routine reasons [0.25] (such as loss of off-site electrical power or steam). (1.00)

REFERENCE:

"Emergency Plan and Procedures, PM 4.4.4.13 and 4.3.2.1".

The following changes were made to the examination as a result of final review.

QUESTION H.03

Change "-138" to "-126"
Change "-63" to "-51"
Change "253" to "241"
Change "10.7" to "9.5"
Change "4.7" to "3.5"

Explanation: Error made in reading temperature versus reactivity curve.

QUESTION K.06

Change "0.05 each" to "0.50 each"

Explanation: Editorial error.

QUESTION L.04

Add the following:

7. Must obtain permission from the on-duty console operator.

Explanation: Requirements for hanging the tag are also requirements for conducting the lockout.

QUESTION L.05

Add Reference:

"Administrative Procedure, PM 1.5, "Procedures Adherence Temporary Change Method".

Explanation: Additional reference as noted in question.

QUESTION L.08b

Deleted

Explanation: Question was too vague and criteria was used instead of the intended criterion.