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

EXAMINATION REPORT NO. 50-54/86-03

FACILITY DOCKET NO. 50-54

FACILITY LICENSE NO. R-81

LICENSEE: Cintichem, Inc.
P.O. Box 324
Tuxedo, New York 10987

FACILITY: Cintichem Reactor

EXAMINATION DATES: September 17-18, 1986

CHIEF EXAMINER: D A Coe — 10/27/86
D. Coe, Lead Reactor Engineer Examiner — date

Reviewed By: Noel F Dudley FOR RMK — 10/27/86
R. Keller, Chief, Projects Section 1C — date

APPROVED BY: H B Kister — 10/28/86
H. Kister, Chief, Projects Branch No.1 — date

SUMMARY: Written and operating examinations were administered to one Reactor Operator (RO) candidate and one Senior Reactor Operator (SRO) candidate. Both candidates passed the written and operating examinations and were issued licenses.

REPORT DETAILS

TYPE OF EXAMS: Replacement

EXAM RESULTS:

	RO Pass/Fail	SRO Pass/Fail
Written Exam	1/0	1/0
Oral Exam	1/0	1/0
Overall	1/0	1/0

1. Examiners

   W. J. Apley, PNL (Chief Examiner)

2. Examination Review Meeting

   At the conclusion of the written examination, the examiner met with Robert Strack, Bill Ruzicka, and Stan Lupinski. The facility reviewers were requested to provide comments with references to the NRC Regional Office within 5 days. They were also told that formal feedback on the examination would be accepted at the scheduled exit meeting.

3. Exit Meeting

   The Chief Examiner held an exit meeting on September 18, 1986 following the last oral examination. The licensee was represented by S. Lupinski and W. Ruzicka. Procedures changes not included in the examination material provided by the facility were furnished. The facility raised several concerns about the answer keys (RO and SRO); no concerns about the questions themselves. These concerns have been provided in written form (see Attachment 3). No generic weaknesses were identified. The facility was again told that they had 5 days to get their comments in to the regional office regarding the written examinations.

Responses to the facility comments are provided in Attachment 4. The facility did not know if or when they would have future examination candidates (RO or SRO).

Attachments:
1. Written Examination and Answer Key (RO)
2. Written Examination and Answer Key (SRO)
3. Facility Comments on Written Examinations
4. Resolution of Facility Comments

Attachment 1

U. S. NUCLEAR REGULATORY COMMISSION
REACTOR OPERATOR LICENSE EXAMINATION

FACILITY: UNION CARBIDE CORP.

REACTOR TYPE: TEST

DATE ADMINISTERED: 86/09/17

EXAMINER: APLEY, W.

CANDIDATE: ANSWER KEY - 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
14.00	14.00	_____	_____	A.	PRINCIPLES OF REACTOR OPERATION
15.00	15.00	_____	_____	B.	FEATURES OF FACILITY DESIGN
14.00	14.00	_____	_____	C.	GENERAL OPERATING CHARACTERISTICS
14.00	14.00	_____	_____	D.	INSTRUMENTS AND CONTROLS
14.00	14.00	_____	_____	E.	SAFETY AND EMERGENCY SYSTEMS
15.00	15.00	_____	_____	F.	STANDARD AND EMERGENCY OPERATING PROCEDURES
14.00	14.00	_____	_____	G.	RADIATION CONTROL AND SAFETY
100.00		_____ Final Grade			Totals

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

Reviewed: Walter A. Apley

_____
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 A.01 (2.00)

The reactor is shut down with all control rods fully inserted. Keff is 0.950 and the count rate is 20 cps. A sample is then inserted into the core and the count rate is seen to increase to 36 cps. WHAT is the reactivity value of the sample? (2.0)

QUESTION A.02 (1.00)

DEFINE "excess reactivity." (1.0)

QUESTION A.03 (1.50)

Besides moderation, LIST three (3) other functions that water serves in the UCNR? (1.5)

QUESTION A.04 (2.00)

Is the worth of a control rod MORE or LESS if the temperature of the moderator decreases? EXPLAIN WHY. (2.0)

QUESTION A.05 (1.00)

HOW long will it take the reactor to reach 2 kW while ascending on a period of 60 seconds from 100 watts? (1.0)

QUESTION A.06 (1.50)

EXPLAIN how the operator is able to remove a large portion of the total core xenon by changing only a few elements? (1.5)

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

QUESTION A.07 (2.00)

The following count rates were obtained during the loading of fuel into a reactor. The counts were taken with all control rods fully withdrawn.

Core Condition	CPS
source only	15
5 fuel elements	17
10 fuel elements	25
15 fuel elements	47
18 fuel elements	75
20 fuel elements	120

To the nearest fuel assembly, HOW many would be required for a critical loading? SHOW your determination using a 1/M plot. (2.0)

QUESTION A.08 (.50)

ANSWER TRUE or FALSE.

After a reactor shutdown, decay heat rate and count rate will exactly track down with each other. (0.5)

QUESTION A.09 (1.00)

WHY is the worth of two (2) rods together not necessarily the same as the sum of their individual worths? (1.0)

QUESTION A.10 (1.00)

ANSWER TRUE or FALSE.

a. A week after a reactor shutdown, a Xe-135-free core is also an I-135-free core. (0.5)

b. The equilibrium Xe-135 reactivity at 70% power is less than twice the equilibrium Xe-135 reactivity at 35% power. (0.5)

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

QUESTION A.11 (.50)

WHICH of the following statements is NOT correct? (0.5)

(a.) Less dense moderator allows more neutrons to escape (-).

(b.) Less dense moderator results in less thermalization of neutrons and, therefore, less thermal neutrons available for U-235 fission (-).

(c.) Less thermalization results in less fast fission effect (-).

(d.) Less dense moderator results in less neutron capture in the moderator (+).

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

QUESTION B.01 (1.50)

WHAT is the neutron source for the UCNR and HOW does it produce neutrons? (1.5)

QUESTION B.02 (2.50)

The UCNR is controlled by Shim-safety rods and a regulating rod.

a. WHAT are the differences between the two (2) types of control rods (composition/linkage/drive speed)? (1.8)

b. HOW are these rods prevented from "bouncing" following a SCRAM? (0.7)

QUESTION B.03 (1.50)

DESCRIBE the difference between the appearance of standard and control fuel elements, as seen from the top of the pool. (1.5)

QUESTION B.04 (1.00)

WHAT prevents the accidental gravity draining of the pool to the 100,000 gallon storage tank? (1.0)

QUESTION B.05 (.50)

ANSWER TRUE or FALSE.

The secondary (rabbit container) irradiation containers are designed to be leak-tight for gases. (0.5)

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

QUESTION B.06 (1.50)

Regarding the pneumatic rabbit system:

a. WHERE are the sample containers (or "rabbits") from the two (2) pneumatic tubes placed in the high flux region (i.e., relative to the core and beam tubes). (1.0)

b. WHERE does the constant exhaust system that inserts and removes the rabbits vent to? (0.5)

QUESTION B.07 (3.00)

DRAW the reactor cooling system, showing the following components. (3.0)

1. pool
2. holdup tank
3. primary pump
4. level control valve
5. heat exchanger
6. secondary pump
7. temperature control valve

QUESTION B.08 (1.00)

WHY is the water tight gasket seal on the outside of the shield for the beam tube rather than on the inside? (1.0)

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

QUESTION B.09 (1.00)

DESCRIBE WHAT will happen to the following components of the ventilation system in the event of an excursion. (1.0)

a. supply air duct damper
b. hold-up tank vent solenoid
c. beam tube exhaust fan
d. emergency ventilation fan

b. The building air undergoes _____ complete changes per hour. (0.5)

1. 1
2. 4
3. 8
4. 16

QUESTION B.10 (1.50)

DESCRIBE briefly the path radioactive waste takes from the hot lab to the point where it is being stored as non-radioactive waste in the Mall Tank(s). (1.5)

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

QUESTION C.01 (1.50)

EXPLAIN how boiling in the core would affect reactivity. (1.5)

QUESTION C.02 (1.50)

WHY must the primary pump not be operated if the secondary pump is off? (1.5)

QUESTION C.03 (3.00)

a. EXPLAIN how reactor heat is removed by Natural Circulation. (1.0)

b. WHAT two (2) indications are used to ensure that adequate natural circulation is occurring? (2.0)

QUESTION C.04 (1.00)

WHAT two (2) primary coolant conditions would indicate that the demineralizer system is not performing its function? (1.0)

QUESTION C.05 (.50)

ANSWER TRUE or FALSE.

One gallon of pH 4.0 water when added to one gallon of pH 6.0 water will result in a two gallon mixture of pH 5.0. (0.5)

QUESTION C.06 (.50)

ANSWER TRUE or FALSE.

If a rabbit sample when inserted had no noticeable reactivity effect, then that ensures that the sample when returned to the terminal area will have no unreasonable amount of reactivity. (0.5)

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

QUESTION C.07 (1.50)

WHAT indications should the operator expect to observe as criticality is achieved regarding count rate change and period? (1.5)

QUESTION C.08 (2.50)

Reactor power has been constant at 2.5 MW for three days. Power is increased to 5 MW for two days, then returned to 2.5 MW for three more days. PLOT the expected xenon reactivity and SHOW where different periods of rod motion (either out or in) would be required. (2.5)

QUESTION C.09 (1.00)

WHAT two (2) methods or operations may be used to determine control rod worth? (1.0)

QUESTION C.10 (1.00)

WHY would maximum allowable core power have to be reduced for pool temperatures greater than 120 deg F? (1.0)

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

QUESTION D.01 (1.50)

Neutron flux is measured outside the reactor core at the UCNR and read out as a signal which is proportional to reactor power. GIVE two (2) reasons why this measurement is not good enough for a determination of the heat power of the core. (1.5)

QUESTION D.02 (1.50)

LIST three (3) events or actions which would cause a transfer from Auto to Manual rod control operation. (1.5)

QUESTION D.03 (1.50)

MATCH each of the following detectors with the ranges listed. (1.5)

a.	compensated ion chamber	1.	startup range
b.	uncompensated ion chamber	2.	intermediate range
c.	fission chamber	3.	power range

QUESTION D.04 (2.00)

LIST the indicating lights associated with the rod drive system and state HOW each indication is derived. (2.0)

QUESTION D.05 (1.50)

a. HOW can a fire alarm be differentiated from a site evacuation alarm, since both alarms use the same system? (0.7)

b. PROVIDE two (2) means by which the fire/site evacuation alarm might be actuated. (0.8)

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

QUESTION D.06 (1.00)

The reactor is shut down and the trace on the Log N period recorder is a straight thin line. IS the CIC OVERCOMPENSATED, PERFECTLY COMPENSATED, or UNDERCOMPENSATED? (1.0)

QUESTION D.07 (1.00)

To change over automatically to natural convection cooling at low flow rates, a weighted flapper valve seals the core exit plenum. HOW would the operator know if the flapper valve seals were leaking? (1.0)

QUESTION D.08 (1.50)

MATCH the following instrumentation definitions. (1.5)

a. channel check

b. channel calibration

c. channel test

---

1. the introduction of a signal into the channel to verify that it is operable

2. an adjustment of the channel so that its output responds, within acceptable range and accuracy, to known values of the parameter that the channel measures

3. a qualitative verification of acceptable performance by observation of channel behavior

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

QUESTION D.09 (1.50)

Two (2) curves are plotted and compared when determining the correct PHS and GAIN control settings on the linear amplifier.

a. WHAT is the fission chamber position for these two (2) curves? (1.0)

b. The PHS setting is chosen at the greatest difference between the curves sufficient to allow WHAT minimum value of count rate? (0.5)

QUESTION D.10 (1.00)

WHERE and HOW does the operator determine which specific area an intrusion alarm indicates? (1.0)

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

QUESTION E.01 (2.00)

EXPLAIN the differences between a "fast" and a "slow" SCRAM. (2.0)

QUESTION E.02 (2.80)

LIST the interlocks that inhibit rod withdrawal. (2.8)

QUESTION E.03 (2.20)

WHAT scrams protect the reactor above 2nL? (2.2)

QUESTION E.04 (2.00)

WHICH emergency generator (50 kW or 45 kW) provides power to each of the items listed below if outside power fails? (2.0)

a. reactor console
b. reactor building exhaust fan (EF13)
c. reactor building motor operated doors
d. beam tube flushing and circulating pump

QUESTION E.05 (2.00)

EXPLAIN how the core would be cooled in the event of a loss of pool water. INCLUDE the source of water and HOW it would be initiated. (2.0)

QUESTION E.06 (.50)

At WHAT value of charcoal filter efficiency is a reactor shutdown required? (0.5)

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

QUESTION E.07 (.50)

ANSWER TRUE or FALSE.

The emergency generator consumes about 3 gallons an hour (75 gallons per day) when operating. (0.5)

QUESTION E.08 (2.00)

LIST four (4) ~~of the five (5)~~ conditions that will cause a reverse in the rod control system. (2.0)

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

QUESTION F.01 (3.00)

Suppose the supply of HP air is lost. WHAT indications would the operator have of this? WHAT action should the operator take? HOW would the building ventilation system be affected? (3.0)

QUESTION F.02 (2.50)

EXPLAIN WHAT the operator should do and WHY if the yellow bulb at the entrance to the transformer room lights and starts flashing while the reactor is at power. (2.5)

QUESTION F.03 (1.00)

When inserting an experiment into the core, EXP 'IN how the operator would verify its reactivity worth. (1.0)

QUESTION F.04 (.50)

ANSWER TRUE or FALSE.

Permission must be obtained from an SRO prior to shifting the reactor from automatic to manual. (0.5)

QUESTION F.05 (1.00)

WHAT document and signature constitutes approval for an operator to insert a sample into the core? (1.0)

QUESTION F.06 (1.00)

WHEN is a heat balance required to be performed during a reactor startup? (1.0)

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

QUESTION F.07 (2.00)

WHAT personnel are required to be present and WHERE are they to be stationed for fuel manipulation within the core and core region? (2.0)

QUESTION F.08 (2.00)

According to procedures, WHAT are the minimum staffing requirements for startup of the reactor? (2.0)

QUESTION F.09 (1.50)

a. WHAT is the minimum frequency with which log book entries must be made? (0.75)

b. WHICH of the following entries is NOT required to be entered in the logbook? (0.75)

1. changes in reactor power level
2. addition of demineralized water to the pool
3. secondary system control alarms
4. ion-chamber adjustments with final settings

QUESTION F.10 (.50)

ANSWER TRUE or FALSE.

After reaching 5 MW the console operator will make a complete survey of the area using a "Cutie Pie." (0.5)

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

QUESTION G.01 (1.00)

WHAT design feature reduces the radiation level at the pool surface due to N-16 at high power levels? (1.0)

QUESTION G.02 (2.25)

a. Give two (2) reasons WHY the beam tubes are normally kept full of water. (1.0)

b. WHY is water circulated through the liner? (1.25)

QUESTION G.03 (2.50)

WHAT are the first five (5) important actions to take in the event of a radioactive spill? (2.5)

QUESTION G.04 (2.50)

EXPLAIN WHAT actions the operator should take if the following conditions occur.

a. the hot lab ventilating system fails (1.0)

b. an alarm is received from the particulate stack monitor (1.5)

QUESTION G.05 (.50)

When entering a "high radiation area," WHAT is the minimum dose rate that you should expect to receive? (0.5)

QUESTION G.06 (1.00)

LIST two (2) potential places in the reactor facility where Ar-41 could originate. (1.0)

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

QUESTION G.07 (2.25)

LIST the three (3) types of portable radiation monitoring equipment available to the operator (INCLUDE ranges and type of radiation that can be measured). (2.25)

QUESTION G.08 (2.00)

The inverse square law is usually applied to the calculation of dose rates as a function of distance from a source using the formula

$$R_1 D_1^2 = R_2 D_2^2$$

a. For distances that are relatively close to the source, WHY might the inverse square relationship give incorrect results? WOULD the calculated value be high or low? EXPLAIN your answer. (1.0)

b. For distances that are especially far from the source, WHY might the inverse square relationship give incorrect results? WOULD the calculated value be high or low? EXPLAIN your answer. (1.0)

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

ANSWERS -- UNION CARBIDE CORP. -86/09/17-APLEY, W.

ANSWER A.01 (2.00)

CR(1)[1-K(1)] = CR(2)[1-K(2)]
20[1-0.950] = 36[1-K(2)]
10[0.05] = 18 - 18K(2)
0.5 - 18 = -18K(2)
-17.5/18.0 = K(2)
0.9722 = K(2)
0.9722
- 0.9500 = 0.0222% Delta K/K

[+2.0]

REFERENCE

1. Union Carbide Nuclear Reactor: Question Bank A.15 (modified), Training Manual page H-8.

ANSWER A.02 (1.00)

Excess reactivity - The reactivity left in the remaining control rod movement after attaining criticality. This excess is necessary to maintain criticality as it is replaced by negative factors (such as xenon, samarium poisoning, fuel depletion, negative sample insertions, and power coefficient). [+1.0]

REFERENCE

1. Union Carbide Nuclear Reactor: Question Bank A.19, Training Manual page M-11.

ANSWER A.03 (1.50)

1. coolant
2. shielding
3. reflection

[+0.5] each

REFERENCE

1. Union Carbide Nuclear Reactor: Question Bank A.24, Training Manual page B-1

ANSWERS -- UNION CARBIDE CORP. -86/09/17-APLEY, W.

ANSWER A.04 (2.00)

As the temperature of the moderator decreases, the moderator becomes more dense allowing neutrons to travel a shorter distance [+1.0]. This results in a less control rod effect since the moderation is more dense, more neutrons are captured by the moderator. Therefore, more competition for neutrons allow the rods to absorb less neutrons thus the control rods will be worth less [+1.0].

REFERENCE

1. Union Carbide Nuclear Reactor: Question Bank A.32 (modified), Training Manual page C-2.

ANSWER A.05 (1.00)

P = Poe**T/t
T = ln P/Po**t
T = ln 2000 watts/100 watts x 60 sec. = 180 sec.

[+1.0]

REFERENCE

1. Union Carbide Nuclear Reactor: Question Bank C.08 (modified), Training Manual page A-4.

ANSWER A.06 (1.50)

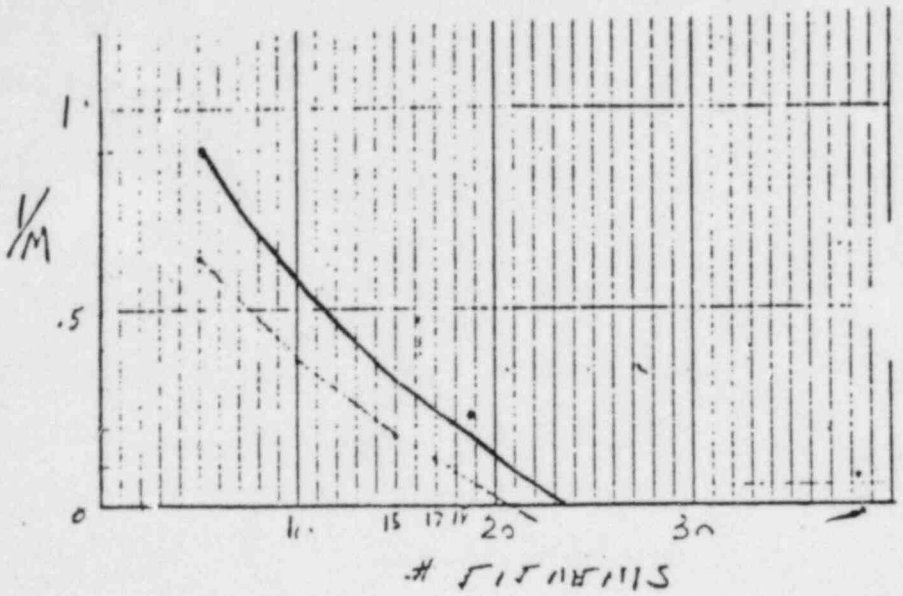
The few elements changed are in the center of the core. The majority of xenon in the core comes from the decay of the fission product iodine. The highest flux and greatest amount of fissioning takes place in the center of the core. [+1.5]

REFERENCE

1. Union Carbide Nuclear Reactor: Question Bank J.06 (modified), Training Manual page J-4 and J-9.

ANSWERS -- UNION CARBIDE CORP. -86/09/17-APLEY, W.

ANSWER A.07 (2.00)



Critical at 24 + or - 1 elements [+2.0]

REFERENCE

1. Union Carbide Nuclear Reactor: Question Bank K.02 (modified), Training Manual page N-1.

ANSWER A.08 (.50)

False [+0.5]

REFERENCE

1. Nuclear Energy Training, Module 3, 14.3-1.

ANSWER A.09 (1.00)

The introduction of one rod distorts the flux distribution and thereby affects the worth of the second rod, since rod worth is approximately proportional to the square of the thermal neutron flux at any one point. [+1.0]

REFERENCE

1. Nuclear Energy Training, Module 3, 4.4-1, Training Manual page J-3.

ANSWERS -- UNION CARBIDE CORP. -86/09/17-APLEY, W.

ANSWER A.10 (1.00)

a. True [+0.5]
b. True [+0.5]

REFERENCE

1. Nuclear Energy Training, Module 3, 10.2 through 10.4.

ANSWER A.11 (.50)

(c.) [+0.5]

REFERENCE

1. Nuclear Energy Training, Module 3, C-2.

ANSWERS -- UNION CARBIDE CORP. -86/09/17-APLEY, W.

ANSWER B.01 (1.50)

antimony beryllium Sb Be [+0.5]

During operation, the antimony became activated. It decays from Sb(151) by gamma emission. The gammas react with the beryllium to produce neutrons. [+1.0]

REFERENCE

1. Union Carbide Nuclear Reactor: Question Bank A.07, TS Design Features Section TS-27 + TS 24

ANSWER B.02 (2.50)

a.

	Composition	Linkage	Drive Speed
reg rod	stainless steel	bolted mechanical	24"/minute
Shim-safety rods	silver-indium-cadmium	electrical magnet	5"/minute

[+0.3] each

b. A hydraulic shock is provided for each control element. The rod must force the water out of the shock in order to seat. This has a dampening effect and prevent any bouncing of the rod. [+0.7]

REFERENCE

1. Union Carbide Nuclear Reactor: Question Bank B.38 (modified), TS Design Features Section TS-28 ~~and~~, Training Manual page B-5, ~~and~~ RM-24-10, and RM-09-5.

ANSWER B.03 (1.50)

Control element - extends above core, has control rod opening, ~~no outside fuel plate~~, and has guide tube [+1.0]

Standard element - fuel plate, lifting bar [+0.5]

REFERENCE

1. Union Carbide Nuclear Reactor: RM-10-8 (85 exam).

ANSWERS -- UNION CARBIDE CORP. -86/09/17-APLEY, W.

ANSWER B.04 (1.00)

The bottom of the storage tank is about 8 feet above the pool surface. [+1.0]

REFERENCE

1. Union Carbide Nuclear Reactor: Training Manual, B-8.

ANSWER B.05 (.50)

False [+0.5]

REFERENCE

1. Union Carbide Nuclear Reactor: XG-03-07.

ANSWER B.06 (1.50)

a. Core face, just above the number five beam tube. [+0.5]
b. stack [+1.0]

REFERENCE

1. Union Carbide Nuclear Reactor: B-11,12.

ANSWER B.07 (3.00)

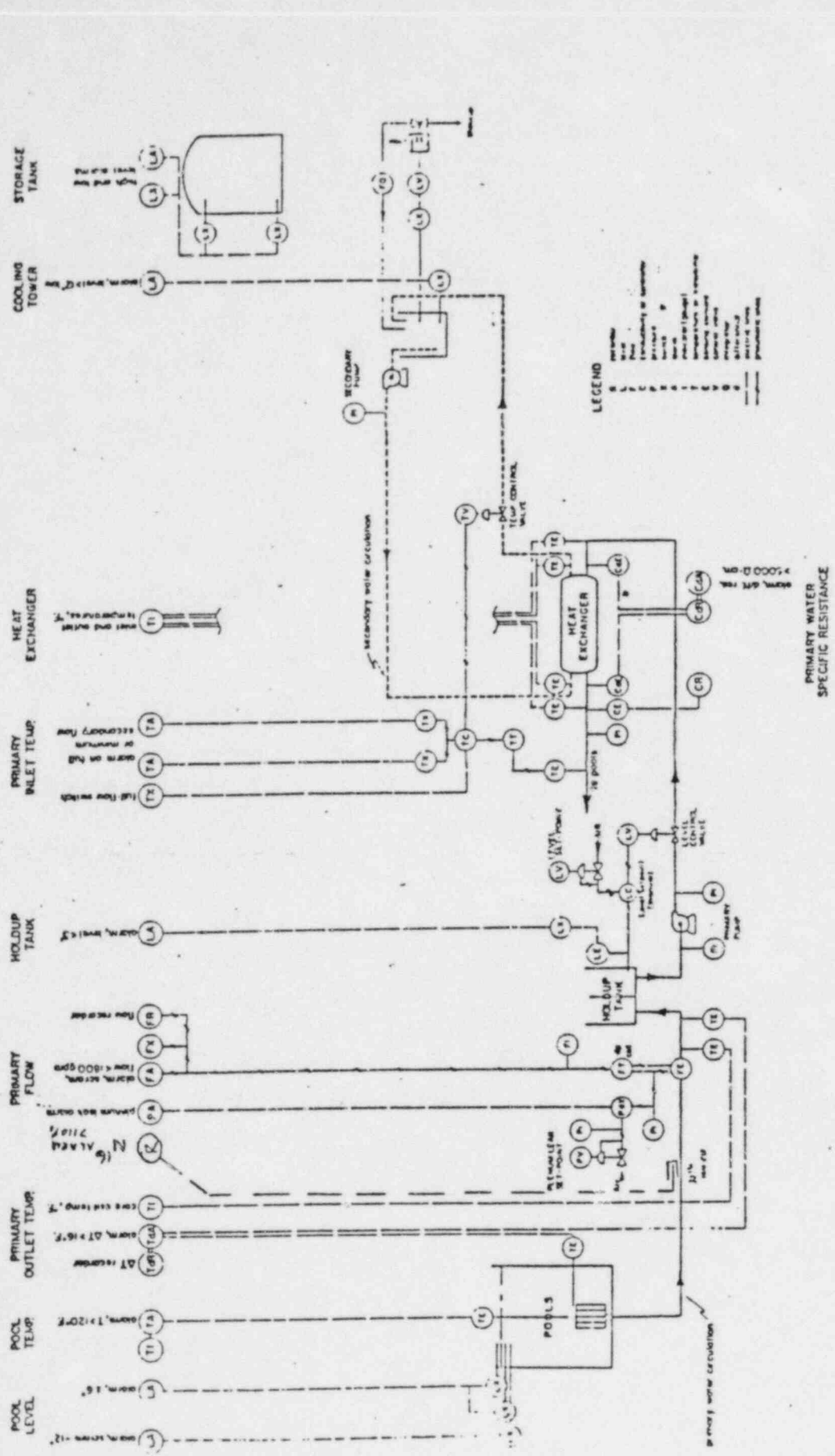
See attached drawing. [+3.0]

REFERENCE

1. Union Carbide Nuclear Reactor: D-47.

ANSWER B.08 (1.00)

With the gasket away from the higher radiation area, conventional rubber base materials can be used. [+1.0]



REACTOR COOLING SYSTEM-ELEMENTARY FLOW CONTROL DIAGRAM

ANSWERS -- UNION CARBIDE CORP. -86/09/17-APLEY, W.

REFERENCE

1. Union Carbide Nuclear Reactor: B-11.

ANSWER B.09 (1.00)

a. closes
b. shuts
c. shuts down
d. starts

[+0.25] each

REFERENCE

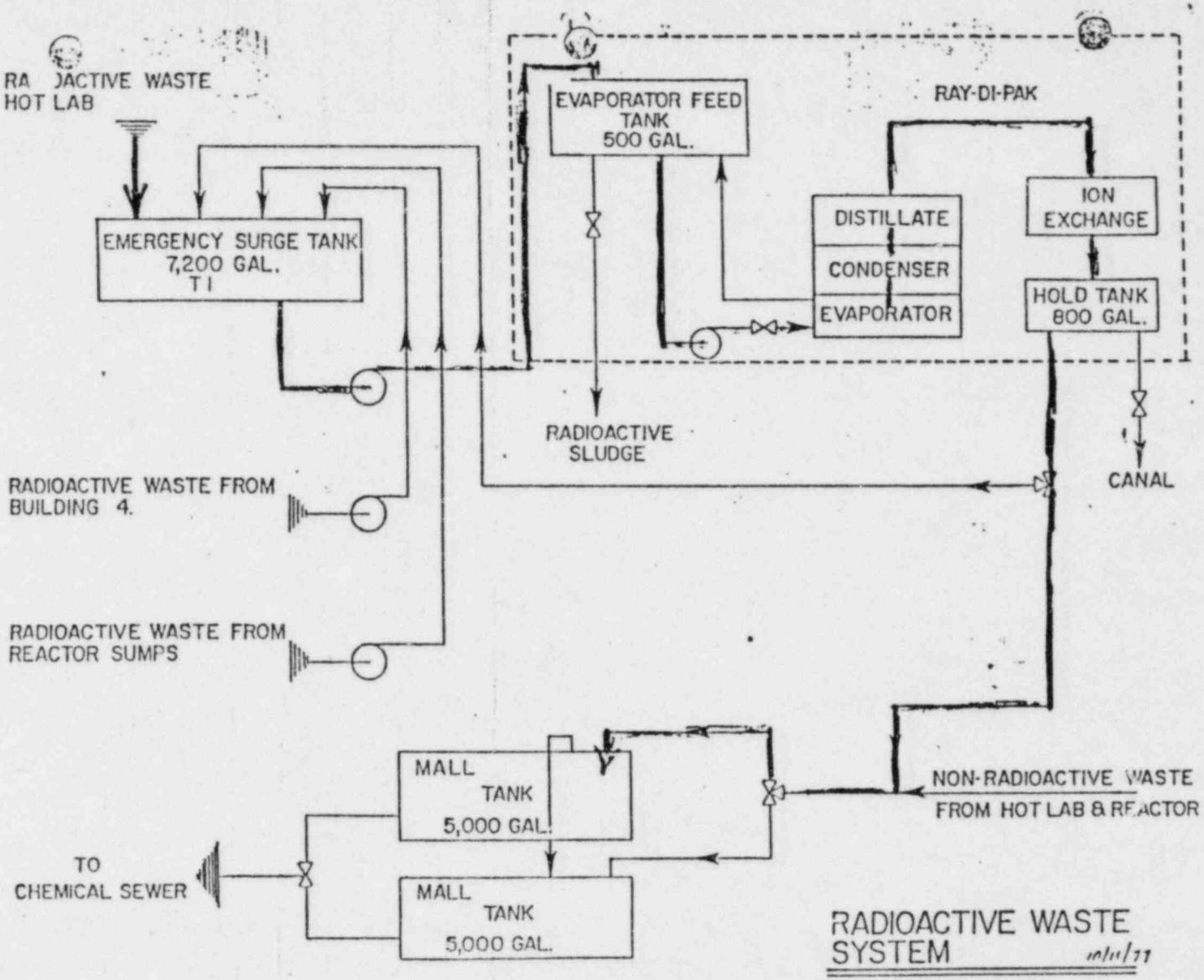
1. Union Carbide Nuclear Reactor: B-16.

ANSWER B.10 (1.50)

See attached figure. [+1.5]

REFERENCE

1. Union Carbide Nuclear Reactor: I-1.



RADIOACTIVE WASTE SYSTEM 10/11/71

ANSWERS -- UNION CARBIDE CORP. -86/09/17-APLEY, W.

ANSWER C.01 (1.50)

Boiling causes voids and because the core is under-moderated, the void coefficient is negative (i.e., the more boiling, the more voids are created). [+1.5]

REFERENCE

1. Union Carbide Nuclear Reactor: Question Bank A.03 (modified), Training Manual page J-21 and J-10

ANSWER C.02 (1.50)

If there were to be a shell to tube leak in the heat exchanger bundles, the possibility would exist for contaminated water to escape the designed containment boundaries and reach the environment. Primary water could mix with secondary water and reach the cooling tower, thereby breaching containment. [+1.5]

REFERENCE

1. Union Carbide Nuclear Reactor: Question Bank B.07, Training Manual page B-8, and RM-04-16.

ANSWER C.03 (3.00)

a. Convective circulation carries heat from fuel. [+0.5] Air in reactor building cools pool water which then falls to the bottom of the stall/pool. [+0.5]

b. 1. pool temperature
2. flapper open
3. heat swirls on surface
4. Erratic nuclear instrumentation

Any two (2) [+1.0] each, +2.0 maximum.

REFERENCE

1. Union Carbide Nuclear Reactor: Technical Specifications, p. 5,6 (85 exam), also TS-28.

ANSWERS -- UNION CARBIDE CORP. -86/09/17-APLEY, W.

ANSWER C.04 (1.00)

1. pH
2. resistivity
3. activity

Any two (2) [+0.5] each, +1.0 maximum

REFERENCE

1. Union Carbide Nuclear Reactor: Technical Specifications, p. 16 (85 exam).

ANSWER C.05 (.50)

False (actually about 4.29 but not required for full credit). [+0.5]

REFERENCE

1. Union Carbide Nuclear Reactor: J-23.

ANSWER C.06 (.50)

False [+0.5]

REFERENCE

1. Nuclear Energy Training, Module 2, 10.2.

ANSWER C.07 (1.50)

Count rate - steady state increase: closer reactor is to criticality, more sensitive count rate change is for the same reactivity addition. [+1.0]

Period - positive [+0.5]

REFERENCE

1. Nuclear Energy Training, Module 3, 13.6-5.

ANSWERS -- UNION CARBIDE CORP. -86/09/17-APLEY, W.

ANSWER C.08 (2.50)

See attached figure. [+2.5]

REFERENCE

1. Nuclear Energy Training, Module 3, 13.6-5.

ANSWER C.09 (1.00)

1. rod drop (RS-33)
2. rod bump (RS-45)

[+0.5] each

REFERENCE

1. Union Carbide Nuclear Reactor: RM-09-4.

ANSWER C.10 (1.00)

A 10 deg F pool temperature change results in a 5% variation in burnout flux, and maximum peaking factors were determined assuming pool at high end of temperature band. [+1.0]

REFERENCE

1. Union Carbide Nuclear Reactor: TS-04, RM-06-2

ANSWER C.08

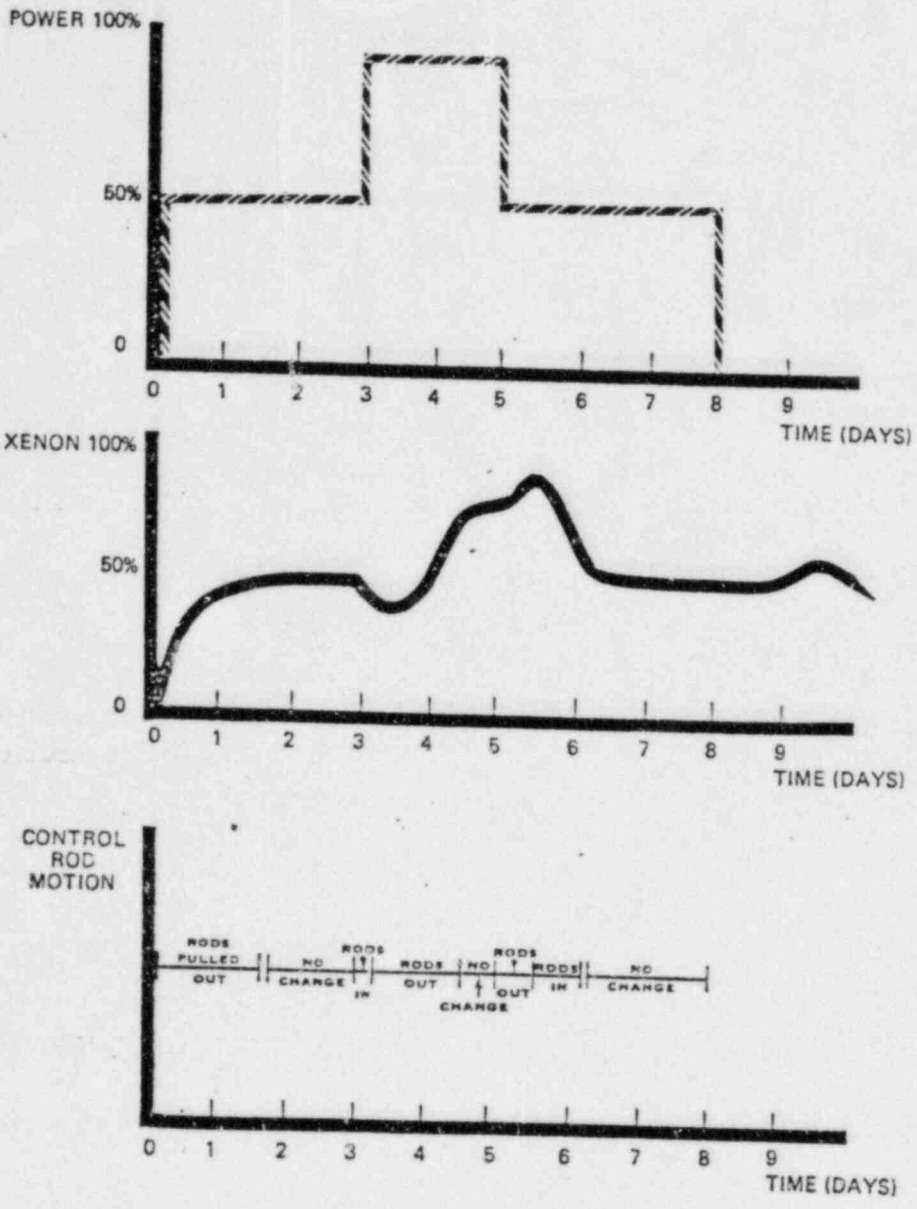


Figure 13.6-3. Power, Xenon, Control Rod Relationship

ANSWERS -- UNION CARBIDE CORP. -86/09/17-APLEY, W.

ANSWER D.01 (1.50)

1. shadowing
2. chamber positions can be adjusted to read any percentage of power
3. spatial core flux variations

[+0.75] each, 1.50 maximum

REFERENCE

1. Union Carbide Nuclear Reactor: Question Bank C.31, Training Manual pages D-19 and D-20.

ANSWER D.02 (1.50)

1. all reverses
2. manual movement of reg rod
3. manual button on console
4. loss of power to console

[+0.5] each, +1.5 maximum

REFERENCE

1. Union Carbide Nuclear Reactor: Question Bank D.19 (modified), Training Manual page D-29.

ANSWER D.03 (1.50)

a. 2.
b. 3.
c. 1.

[+0.5] each

REFERENCE

1. Union Carbide Nuclear Reactor: Question Bank D.30, Training Manual page D.18.

ANSWERS -- UNION CARBIDE CORP. -86/09/17-APLEY, W.

ANSWER D.04 (2.00)

OFF MAGNET - lights when actual control rod separates from magnet can and a reverse is actuated. This happens when a spring loaded lever held up by the armature on the control rod is released when the rod drops and a normally closed switch activates the OM light.

UP LIGHT - lights when rod drive reaches top of its travel range then stops.

DOWN LIGHT (DN) - lights when rod drive reaches lower limit of travel (travel stops).

ROD SEAT (RS) - lights when control rod seats in control element/shock assembly. They are actuated by magnetic switches located on the end of each guide tube adjacent to the shock.

[+0.5] each

REFERENCE

1. Union Carbide Nuclear Reactor: Question Bank D.39, RS-01-03

ANSWER D.05 (1.50)

a. Fire alarm resets after specified number of beeps while the evacuation alarm is continual. [+0.7]

b. 1. manual [+0.4]
   2. loss of commercial power [+0.4]

REFERENCE

1. Union Carbide Nuclear Reactor: EP-11-1 (85 exam).

ANSWER D.06 (1.00)

overcompensated [+1.0]

REFERENCE

1. Union Carbide Nuclear Reactor: Training Manual, C-5.

ANSWERS -- UNION CARBIDE CORP. -86/09/17-APLEY, W.

ANSWER D.07 (1.00)

Leakage at the flapper valve seat, or in the plenum, is monitored by a plenum leak detector that senses increase in plenum pressure and alarms in the control room. [+1.0]

REFERENCE

1. Union Carbide Nuclear Reactor: TS-28.

ANSWER D.08 (1.50)

a. 3.
b. 2.
c. 1.

[+0.5] each

REFERENCE

1. Union Carbide Nuclear Reactor: TS-01.

ANSWER D.09 (1.50)

a. One curve is obtained with the fission chamber withdrawn from the reactor core a distance large enough that most neutrons are absorbed and, thus, do not reach the chamber.

   The second curve is obtained with the chamber fully inserted close inserted close to the reactor core. [+1.0]

b. at least 2 cps due to neutrons [+0.5]

REFERENCE

1. Union Carbide Nuclear Reactor: D-21,22.

ANSWERS -- UNION CARBIDE CORP. -86/09/17-APLEY, W.

ANSWER D.10 (1.00)

The roving operator will proceed to the south loading dock. Utilizing the four intrusion alarm annunciator panels, the operator will attempt to establish in which area the intrusion is in. These buttons will only identify a window or door area remaining open, not a window or door area temporarily open, then closed. [+1.0]

REFERENCE

1. Union Carbide Nuclear Reactor: EP-10-01.

ANSWERS -- UNION CARBIDE CORP. -86/09/17-APLEY, W.

ANSWER E.01 (2.00)

The slow scrams de-energize the safety amp before rods drop. The fast scrams bypass the safety amplifier and cut off power to the magnet power supplies. [+2.0]

REFERENCE

1. Union Carbide Nuclear Reactor: Question Bank D.06 (modified), Training Manual page D-44 and D-24

ANSWER E.02 (2.80)

1. <2 cps
2. >9800 cps
3. fission chamber movement
4. LCR recorder off
5. 30 sec period LCR <0.001 log n
6. 30 sec per log n >0.001 log n
7. guide tube lift
8. rod drive toggle switch (on-off switch)

[+0.35] each

REFERENCE

1. Union Carbide Nuclear Reactor: Question Bank D.16 (modified), TS-09+10, Training Manual page D-23/24/46, RM-04-2 ~~[illegible]~~, DS-02-01

ANSWER E.03 (2.20)

1. 150% power scram on UICs [+0.4]
2. 3 second period scram from log n amp [+0.4]
3. manual scrams [+0.2]
4. >2nL scram when primary pump is off [+0.4]
5. <2nL flow scram with flow <2000 gpm [+0.4]
6. >2nL scram with flapper open [+0.4]

REFERENCE

1. Union Carbide Nuclear Reactor: Question Bank D.32, TS-09+10, RM-04-2, Training Manual page D-44.

ANSWERS -- UNION CARBIDE CORP. -86/09/17-APLEY, W.

ANSWER E.04 (2.00)

a. 50 kW
b. 50 kW
c. 45 kW
d. 50 kW

[+0.5] each

REFERENCE

1. Union Carbide Nuclear Reactor: Question Bank E.05 (modified), Training manual Figure B.13

ANSWER E.05 (2.00)

The reactor would be cooled by the emergency core spray which directs a spray of water onto the core [+1.0]. It is supplied by the municipal water supply [+0.5] and is initiated by manually opening a valve located outside the upper level air lock [+0.5].

REFERENCE

1. Union Carbide Nuclear Reactor: Question Bank E.19, TS-29 (5.4.3), Figure B-7

ANSWER E.06 (.50)

<95% [+0.5]

REFERENCE

1. Union Carbide Nuclear Reactor: RS-31-1.

ANSWER E.07 (.50)

True (450 gallons is the required 6 day supply; numbers not necessary for full credit) [+0.5]

REFERENCE

1. Union Carbide Nuclear Reactor: RM-08-2.

ANSWERS -- UNION CARBIDE CORP. -86/09/17-APLEY, W.

ANSWER E.08 (2.00)

1. 10 second period
2. manual
3. ~~guide tube lift~~
4. high flux
5. rods less than half out at power level of 100 kW or 2 N/L

~~Any four (4)~~ [+0.5] each, ~~+2.0 maximum.~~

REFERENCE

1. Union Carbide Nuclear Reactor: RM-03-2.

ANSWERS -- UNION CARBIDE CORP. -86/09/17-APLEY, W.

ANSWER F.01 (3.00)

Exhaust and supply dampers would close shut. All dampers are fail-safe to the closed position if HP air is lost. Being that the normal ventilation would be lost, you would shut down the reactor and go into evacuation sequence so that the building would remain negative and maintain containment. [+3.0]

REFERENCE

1. Union Carbide Nuclear Reactor: Question Bank B.13, Training Manual page B-16, RM-04-05, RM-07.

ANSWER F.02 (2.50)

If the reactor is operating at the time the operator must shut down the reactor because emergency transfer switch #1 relay may not automatically supply emergency power from the generators to the necessary loads in the event of a commercial power failure. Inform a senior operator and the instrument technician. [+2.5]

REFERENCE

1. Union Carbide Nuclear Reactor: Question Bank B.21, RM-04-04, RM-08-3

ANSWER F.03 (1.00)

While inserting the experiment in to the core, the console operator monitors the reg rod and determines the change in the reg rod. Then you would take the percent reg rod movement to the diff. reg rod chart to find out the samples reactivity value. [+1.0]

REFERENCE

1. Union Carbide Nuclear Reactor: Question Bank C.22, RM-04-8

ANSWER F.04 (.50)

False. [+0.5]

REFERENCE

1. Union Carbide Nuclear Reactor: Question Bank F.10 (modified), RM-04

ANSWERS -- UNION CARBIDE CORP. -86/09/17-APLEY, W.

ANSWER F.05 (1.00)

An isotope and service irradiation form signed by a senior operator. [+1.0]

REFERENCE

1. Union Carbide Nuclear Reactor: Question Bank F.17 (modified), XG-01-1.

ANSWER F.06 (1.00)

Heat balance is performed before any of the safety channels reach a reading of 60%. [+1.0]

REFERENCE

1. Union Carbide Nuclear Reactor: Question Bank J.04, RM-03-C.

ANSWER F.07 (2.00)

A senior operator must be present and in direct supervision either on the bridge or in the control room monitoring the count rate. At all times there will be at least one operator on the bridge and one in the control room monitoring the count rate channel. [+2.0]

REFERENCE

1. Union Carbide Nuclear Reactor: Question Bank K.05, TS-33

ANSWERS -- UNION CARBIDE CORP. -86/09/17-APLEY, W.

ANSWER F.08 (2.00)

1. A licensed reactor operator in the control room at the controls

2. A second licensed reactor operator present at the facility. Unexpected absence for two (2) hours is acceptable provided immediate action is taken to obtain a replacement.

3. A member of the operating staff shall be designated by level two management as knowledgeable in radiation control.

4. A SRO shall be readily available on call and his name shall be posted in the control room.

[+0.5] each

REFERENCE

1. Union Carbide Nuclear Reactor: Question Bank L.07, RM-03-4.

ANSWER F.09 (1.50)

a. No less than one entry every hour during reactor operation. [+0.75]

b. 3. [+0.75]

REFERENCE

1. Union Carbide Nuclear Reactor: RM-02-1,2.

ANSWER F.10 (.50)

False [+0.5]

REFERENCE

1. Union Carbide Nuclear Reactor: RM0306.

ANSWERS -- UNION CARBIDE CORP. -86/09/17-APLEY, W.

ANSWER G.01 (1.00)

N-16 radiation is reduced by the concrete in place over the embedded piping. The hold up tank is designed to allow for the decay of N-16. The operating limit of three feet minimum allows for an approximate 10 minute delay time. [+1.0]

REFERENCE

1. Union Carbide Nuclear Reactor: Question Bank A.05 (modified), Training Manual page B-8.

ANSWER G.02 (2.25)

a. Flooded beam tubes allow for the use of less shielding plugs in attempts to keep radiation levels outside the beam tube down. [+0.5] Water filled tubes prevent accidental or inadvertent filling: this would cause unintentional positive reactivity changes to the core. [+0.5]

b. Circulation will prevent stagnant water causing corrosion of the aluminum liner and also will reduce the radiation level at the outside face of the beam tubes. Without the circulation the water becomes very radioactive due to a build-up of Na-24 and Mg-27 formed by irradiation of the aluminum liner at the core face. [+1.25]

REFERENCE

1. Union Carbide Nuclear Reactor: Training Manual, B.11.

ANSWER G.03 (2.50)

1. hold your breath and evacuate the area
2. notify all other people in the area
3. notify supervisor and Health Physics
4. control access to the area
5. monitor and decontaminate all persons contaminated

[+0.5] each

REFERENCE

1. Union Carbide Nuclear Reactor: Question Bank F.21, EP-05-01

ANSWERS -- UNION CARBIDE CORP. -86/09/17-APLEY, W.

ANSWER G.04 (2.50)

a. Continue operating the reactor, hot labs system not necessary for operation of the reactor. [+1.0]

b. Notify HP, call hot lab to determine the source. If the source can not be determined the reactor power will be reduced to less than 2NL until the source is found. [+1.5]

REFERENCE

1. Union Carbide Nuclear Reactor: Question Bank F.44, RM-07, EP-03-5.

ANSWER G.05 (.50)

100 mrem/hr [+0.5]

REFERENCE

1. Union Carbide Nuclear Reactor: Question Bank G.11, Training Manual page G-12, RM-11-1.

ANSWER G.06 (1.00)

1. thermal column [+0.5]
2. dry and vented beam tubes [+0.5]
3. pneumatic rabbit tubes [+0.5], 1.0 maximum

REFERENCE

1. Union Carbide Nuclear Reactor: Question Bank G.19 (modified), Training Manual pages B-11/12

ANSWER G.07 (2.25)

1.	Cutie Pie	beta/gamma	0 to 50 R/hr
2.	GM Survey	beta/gamma	0 to 50 mR/hr
3.	Pic-6A	gamma	1 to 1000 mR/hr and 1 to 1000 R/hr

[+0.25] each

REFERENCE

1. Union Carbide Nuclear Reactor: Question Bank G.26 and G.28 (modified), Training Manual pages G6/8.

ANSWERS -- UNION CARBIDE CORP. -86/09/17-APLEY, W.

ANSWER G.08 (2.00)

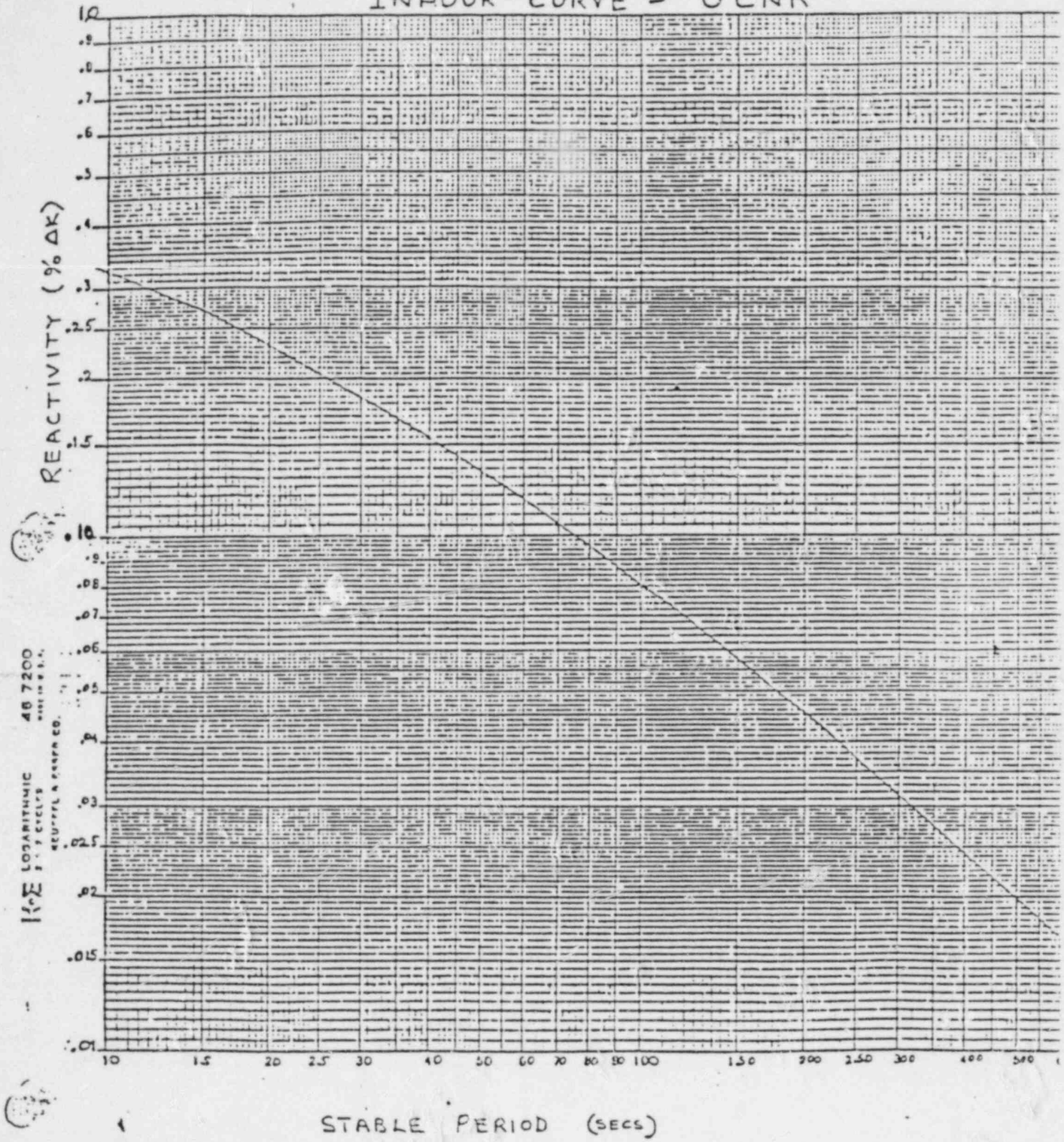
a. The calculated dose may be lower for distance closer to the source, because the source will show characteristics of a plane source rather than a point source. Your actual dose may be higher. [+1.0]

b. The calculated dose may be higher for distances farther from the source. This is because the inverse square law does not include a factor of air attenuation. [+1.0]

REFERENCE

1. Union Carbide Nuclear Reactor: Question Bank I.02, Training Manual page I-4

INHOUR CURVE - UCNR



EQUATION SHEET

Where $\dot{m}_1 = \dot{m}_2$

$(\text{density})_1(\text{velocity})_1(\text{area})_1 = (\text{density})_2(\text{velocity})_2(\text{area})_2$

$KE = \frac{mv^2}{2}$ $\quad PE = mgh$ $\quad PE_1 + KE_1 + P_1V_1 = PE_2 + KE_2 + P_2V_2$ where V = specific volume, P = Pressure

---

$Q = \dot{m}c_p(T_{out} - T_{in})$ $\quad Q = UA\,(T_{ave} - T_{stm})$ $\quad Q = \dot{m}(h_1 - h_2)$

$P = P_0 10^{(SUR)(t)}$ $\quad P = P_0 e^{t/T}$ $\quad SUR = \frac{26.06}{T}$ $\quad T = \frac{(B-p)t}{p}$

$\text{delta } K = (K_{eff} - 1)$ $\quad CR_1(1-K_{eff1}) = CR_2(1-K_{eff2})$ $\quad CR = S/(1-K_{eff})$

$M = \frac{(1-K_{eff1})}{(1-K_{eff2})}$ $\quad SDM = \frac{(1-K_{eff}) \times 100\%}{K_{eff}}$

$\text{decay constant} = \frac{\ln(2)}{t_{1/2}} = \frac{0.693}{t_{1/2}}$ $\quad A_1 = A_0 e^{-(\text{decay constant}) \times (t)}$

<u>Water Parameters</u>

1 gallon = 8.345 lbs
1 gallon = 3.78 liters

1 ft^3 = 7.48 gallons

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 psia = 29.9 in Hg

<u>Miscellaneous Conversions</u>

1 Curie = 3.7×10^{10} dps
1 kg = 2.21 lbs

1 hp = 2.54×10^3 Btu/hr

1 MW = 3.41×10^6 Btu/hr
1 Btu = 778 ft-lbf

Degrees F = (1.8 x Degrees C) + 32
1 inch = 2.54 centimeters
g = 32.174 $ft\text{-}lbm/lbf\text{-}sec^2$

Attachment 2

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

FACILITY: UNION CARBIDE CORP.

REACTOR TYPE: TEST

DATE ADMINISTERED: 86/09/17

EXAMINER: APLEY, W.

CANDIDATE: ANSWER KEY - 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	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	20.00			L.	ADMINISTRATIVE PROCEDURES, CONDITIONS AND LIMITATIONS
100.00		Final Grade			Totals

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

Reviewed: Walter J Apley

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)

The reactor is critical at 100 watts in the natural convection mode. A reactivity insertion of 0.1 percent delta K/K is made. HOW long will it take before a reactor scram occurs? ASSUME no operator action and no thermal reactivity feedback. Note that the In-hour curve is provided. (2.0)

QUESTION H.02 (2.00)

LIST four (4) reasons it is necessary to have "excess reactivity." (2.0)

QUESTION H.03 (1.50)

Indicate WHAT effect (increase or decrease) each of the following has upon the reactivity of the reactor:

a. replacing part of the reflector by a void (0.5)

b. fuel burnup (0.5)

c. removing a small steel canister that had been placed next to the core (0.5)

QUESTION H.04 (.50)

On a constant reactor period, WHICH will take longer? (0.5)

(a.) to go from 10% to 20% power
(b.) to go from 20% to 35% power

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

QUESTION H.05 (2.00)

Regarding xenon reactivity:

a. WHY does xenon reactivity peak later following a shutdown from high power than it does when following a shutdown from a low power level? (1.5)

b. WHICH one (1) of the following is NOT one of the four contributors or factors that establish equilibrium xenon? (0.5)

1. direct production of xenon from fission
2. decay of iodine
3. decay of xenon
4. burnout of iodine

QUESTION H.06 (1.00)

The following statements are concerned with subcritical multiplication. CHOOSE the one capitalized word that will make the sentence correct.

a. As Keff approaches unity, a LARGER/SMALLER change in neutron level results from a given change in Keff. (0.5)

b. As Keff approaches unity, a SHORTER/LONGER period of time is required to reach the equilibrium neutron level for a given change in Keff. (0.5)

QUESTION H.07 (1.00)

A moderator is necessary to slow neutrons down to thermal energies. WHICH of the following is the correct reason for operating with thermal instead of fast neutrons? (1.0)

(a.) Increased neutron efficiency since thermal neutrons are less likely to leak out of the core than fast neutrons.

(b.) Reactors operating primarily on fast neutrons are inherently unstable and cannot be safely controlled.

(c.) The fission cross section of the fuel is much higher for thermal energy neutrons than fast neutrons.

(d.) Doppler and moderator temperature coefficients become positive as neutron energy increases.

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

QUESTION H.08 (.50)

WHICH of the following statements is most nearly accurate regarding control rod worth? (0.5)

(a.) it is proportional to reactor power
(b.) it is higher in regions of higher relative neutron flux
(c.) it is proportional to rod speed
(d.) it is not dependent upon rod position

QUESTION H.09 (2.00)

MATCH the following core constants. (2.0)

a.	peak xenon	1.	+9.3% delta K/K
b.	equilibrium samarium	2.	+0.8% delta K/K
c.	thermal column worth	3.	-0.95% delta K/K
d.	total gang worth (5 safety)	4.	-7.3% delta K/K

QUESTION H.10 (.50)

ANSWER TRUE or FALSE.

The nominal thermal neutron flux for the NPT-1, NPT-2, and SPT facilities at 5 MW is higher than the fast neutron flux (based on AuCd ratio). (0.5)

QUESTION H.11 (2.00)

EXPLAIN Doppler broadening. When, during a startup, will the reactivity effects first be observable? (2.0)

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

QUESTION H.12 (.50)

ANSWER TRUE or FALSE.

The cold clean critical mass value for the stall is smaller than for the pool. (0.5)

QUESTION H.13 (.50)

Because of the relatively high concentration of U-238, WHAT fissionable isotope of significant concern is produced during reactor operation? (0.5)

QUESTION H.14 (1.50)

DOES the change in beta-bar-effective over core life significantly affect the stable reactor period after a scram? EXPLAIN. (1.5)

QUESTION H.15 (2.50)

If the pressure in a leaking pipe or tank is reduced by 50%, SHOW HOW much will the leak rate decrease? EXPLAIN any assumptions. (2.5)

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

QUESTION I.01 (1.50)

WHAT three (3) systems collect building wastes? (1.5)

QUESTION I.02 (3.00)

WHAT three (3) combinations of the radiation safety monitors will require reactor shutdown and evacuation? (3.0)

QUESTION I.03 (1.50)

During operation the operator notes that the dose from one end of the hold-up tank is much higher than the other. IS this normal? EXPLAIN. (1.5)

QUESTION I.04 (2.00)

The Cintichem regulations require that HP coverage be provided to the operating staff when handling experiments whose radiation may exceed certain criteria. LIST two (2) criteria which would require HP coverage. (2.0)

QUESTION I.05 (2.00)

As SRO you are asked to approve an experiment that will vent to the environment the following yearly average concentrations:

Xe-135 -- 5 x 10**-8 uc/ml
Kr-85 -- 1 x 10**-7 uc/ml
Ar-41 -- 2 x 10**-8 uc/ml

The MPC values are:

Xe-135 -- 1 x 10**-7 uc/ml
Kr-85 -- 3 x 10**-7 uc/ml
Ar-41 -- 4 x 10**-8 uc/ml

WOULD you approve this experiment? EXPLAIN. (2.0)

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

QUESTION I.06 (2.00)

WHAT are four (4) of the six (6) physical or chemical properties which must be evaluated prior to irradiating a sample in a rabbit tube? (2.0)

QUESTION I.07 (2.50)

The radiation level due to a known small radioactive deposit in a pipe fitting is 1 rem/hr measured 15 feet away. An operator must operate a valve located 5 feet from the pipe fitting. If it takes the operator 1 minute to operate the valve, WILL he receive a radiation dose in excess of 1/10th of the 10 CFR 20 quarterly whole body exposure limit? SHOW your work and assumptions. (2.5)

QUESTION I.08 (2.00)

Two (2) identical samples are irradiated in the same flux; one for 20 minutes, and the other for 10 minutes. Will the twenty minute sample contain twice the activity of the ten minute sample? EXPLAIN. (2.0)

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

QUESTION I.09 (1.00)

WHICH of the following is a correct statement concerning radioactive decay? Remember the atomic number is the number of protons and the mass number is the number of neutrons plus protons. (1.0)

(a.) When an element decays by beta emission, the new element will have increased in atomic number by one and the mass number will remain the same as the original element.

(b.) When an element decays by alpha emission, the new element will have decreased in atomic number and mass number by two, from the original element.

(c.) When an element decays by neutron emission, the new element will have increased in atomic number by one and decreased in mass number by one, from the original element.

(d.) When an element decays by gamma emission, the new element will have increased in atomic number by one and the mass number will remain the same as the original element.

QUESTION I.10 (1.00)

According to Technical Specifications WHICH is the one (1) radiation monitor listed below which may NOT be replaced by portable or substitute instruments for periods up to 24 hours provided the function will still be accomplished. (1.0)

(a.) exhaust duct monitor ("stack monitor")
(b.) excursion monitor
(c.) building continuous air monitor (CAM)
(d.) fixed area monitor

QUESTION I.11 (1.50)

Federal Regulation prescribe permissible limits for exposure of individuals to radiation. ANSWER the following:

a. For a restricted area WHAT is the maximum exposure to the hands permitted in one calendar quarter? (0.5)

b. For an unrestricted area WHAT whole-body dose is permitted in what period of time? (1.0)

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

QUESTION J.01 (2.00)

In the event of a fuel cladding failure during power operation, LIST four (4) of the five (5) instruments that would detect the release of fission products. (2.0)

QUESTION J.02 (2.00)

WHY must the bridge be positioned against the rail stops in the stall position, and WHAT could occur if this were not done? (2.0)

QUESTION J.03 (2.00)

During normal operation, all air duct dampers are open. WHAT four (4) signals or conditions will cause all dampers to close? (2.0)

QUESTION J.04 (1.50)

EXPLAIN the term "log n confidence point" and WHEN it is attained. (1.5)

QUESTION J.05 (2.00)

During reactor operations at full power, a seat leak develops in the valve connecting the discharge of the primary coolant pump to the storage tank. ASSUME a leak rate of 10 GPM, WHAT two (2) indications would alert the staff of this condition? (2.0)

QUESTION J.06 (1.50)

On a trip of the primary pump, EXPLAIN what happens to the water level in the holdup tank and the reactor pool. (1.5)

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

QUESTION J.07 (.50)

ANSWER TRUE or FALSE.

If core heat flux increased to the point where bulk boiling and steam formation over 10% of the surface of the fuel plate occurs, departure from nucleate boiling (DNB) conditions exist. (0.5)

QUESTION J.08 (1.00)

Gamma compensation isn't required in the power range for several reasons. WHICH of the statements below is NOT one of those reasons? (1.0)

(a.) Background (decay) gamma flux is insignificant in comparison to the neutron flux.

(b.) Fission gamma flux contributes approximately 1% of thermal power.

(c.) Power range instruments are calibrated to the heat balance.

(d.) Fission product decay gammas cause decay heat which can be approximately 5-7 percent of thermal power.

QUESTION J.09 (2.50)

a. WHAT is the pH specification for pool water? (1.0)

b. If the pH of the pool was 7.0, WOULD adding 1 gallon of pH 2 water have any measurable effect on the pool pH. EXPLAIN your answer. (1.5)

QUESTION J.10 (2.00)

LIST two (2) precautions which must be taken if the cooling tower fans are to be operated in the reverse direction (status of fans when shifting to reverse/length of time reverse condition allowed). (2.0)

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

QUESTION J.11 (.50)

ANSWER TRUE or FALSE.

In either forced or natural convection mode, a 0.5% delta K/K step insertion will NOT result in exceeding a safety limit. (0.5)

QUESTION J.12 (.50)

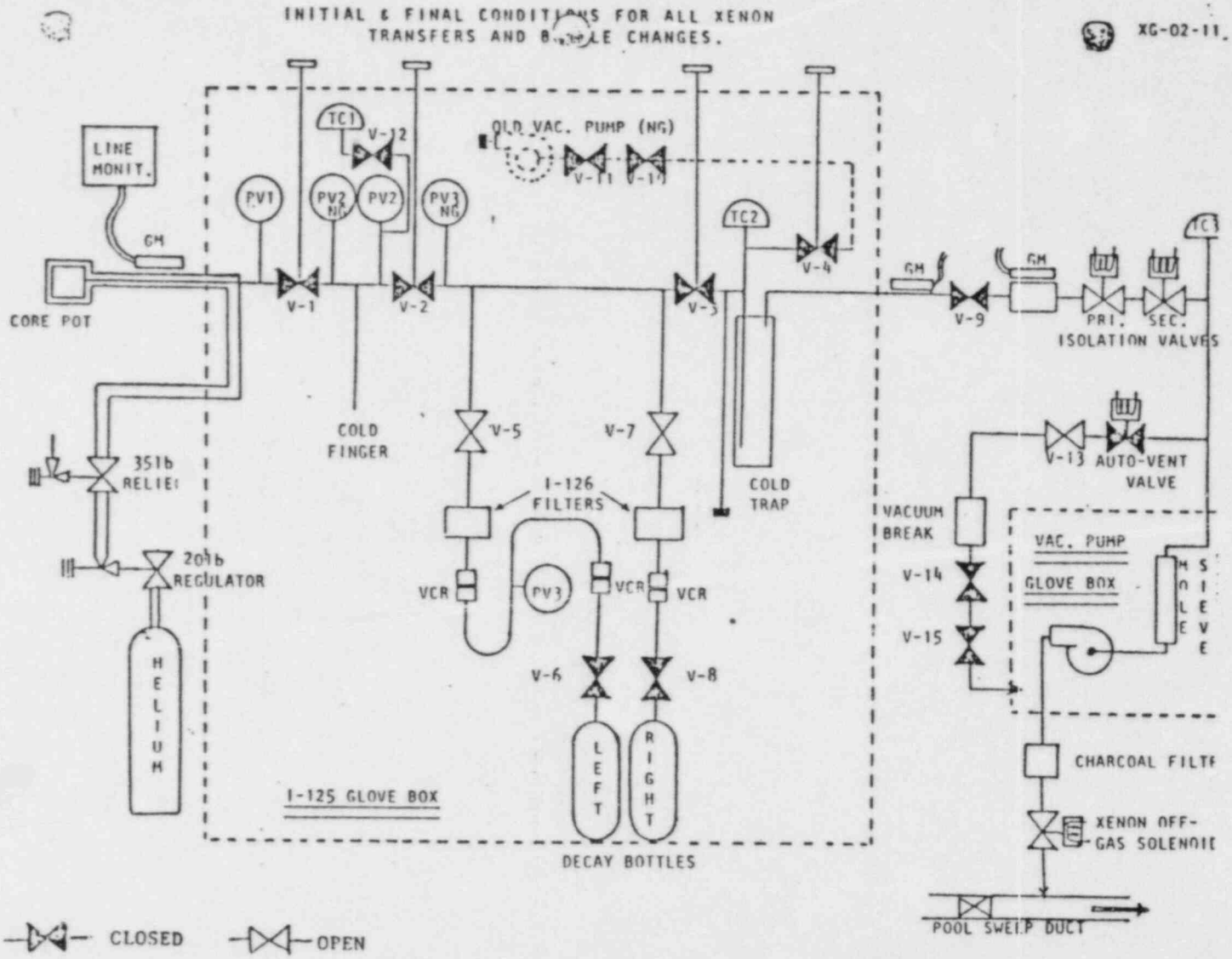
ANSWER TRUE or FALSE.

The cold trap (CT) section (see attached figure) allows for monitoring the operational conditions of the rest of the system. (0.5)

QUESTION J.13 (2.00)

Reactor power has been constant at 2.5 MW for three days. Power is increased to 5 MW for two (2) days, then returned to 2.5 MW for three (3) more days. PLOT the expected xenon reactivity and SHOW where different periods of rod motion (either out or in) would be required. (2.0)

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


INITIAL & FINAL CONDITIONS FOR ALL XENON TRANSFERS AND BOTTLE CHANGES.
XG-02-11.
LINE MONIT.
GM
CORE POT
TC1
V-12
OLD VAC. PUMP (NG)
V-11
V-10
PV1
PV2 NG
PV2
PV3 NG
V-1
V-2
V-3
TC2
V-4
GM
GM
TC3
V-9
PRI.
SEC.
ISOLATION VALVES
COLD FINGER
V-5
V-7
COLD TRAP
V-13
AUTO-VENT VALVE
35lb RELIEF
I-126 FILTERS
VACUUM BREAK
VAC. PUMP
GLOVE BOX
V-14
V-15
MOLE SIEVE
20lb REGULATOR
VCR
PV3
VCR
VCR
HELIUM
V-6
V-8
CHARCOAL FILTE
XENON OFF-GAS SOLENOIE
I-125 GLOVE BOX
LEFT
RIGHT
DECAY BOTTLES
POOL SWEEP DUCT
CLOSED
OPEN

QUESTION K.01 (2.00)

When moving the reactor from the "pool" to the "stall" position, a minimum of five (5) elements must be removed prior to moving the reactor. WHAT is the reason for this requirement? (2.0)

QUESTION K.02 (2.00)

If a start up is necessary after a shutdown of 12 hours, the center few fuel elements will have to be changed. WHY is this necessary and WHY not change all elements? (2.0)

QUESTION K.03 (1.50)

WHY is it not permissible to place materials other than stainless steel or aluminum near the core without approval of the Nuclear Safeguards Committee? (1.5)

QUESTION K.04 (2.00)

The reactor is operating and it is necessary to remove some item from inside a beam tube. WHAT conditions must be in effect prior to doing this? (2.0)

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

QUESTION K.05 (2.50)

Observance of the required minimum shutdown margin is important in avoiding inadvertent criticality should one rod somehow be removed from the core. INDICATE whether or not this requirement is satisfied in the following cases. SHOW your work. (2.5)

a. The reactor is critical at low power (with no Xe-135) with the rods at 13.00 inches, and the highest worth nonsecured experiment is worth -0.04% delta K/K.

b. The reactor is at 5 MW with equilibrium xenon, with no experiment, and with the gang at 15.20 inches.

Given in both cases: gang worth - 9.35%
13.00 - excess reactivity is 3.88%
15.20 - excess reactivity is 2.56%
highest worth rod - 2.65%
power coefficient - 0.35%
xenon coefficient - 3.5%

QUESTION K.06 (.50)

ANSWER TRUE or FALSE.

Fuel elements laid flat must not be laid on their concave side because the plates are fragile and could possibly be bent causing blockage of flow. (0.5)

QUESTION K.07 (2.00)

During a fuel handling operation, bubbles are observed coming from an element as it is withdrawn from the core. DESCRIBE your immediate actions. (2.0)

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

QUESTION K.08 (1.00)

a. WHAT are the minimum number of fuel elements required for operations by Technical Specifications? (0.5)

b. WHAT is the maximum number of fuel elements that can be removed from the Safe Storage of the fuel vault at one time for the purpose of core refueling? (0.5)

QUESTION K.09 (2.50)

According to Technical Specifications, there are six (6) conditions that must exist for the reactor to be considered SECURED. LIST five (5) of the six (6) conditions. (2.5)

QUESTION K.10 (.50)

ANSWER TRUE or FALSE.

Boron carbide rods and silver/indium/cadmium control rods are required to be gauged with the same periodicity-annually. (0.5)

QUESTION K.11 (2.00)

EXPLAIN the procedure and requirements for increasing the magnet current in the event a control rod becomes stuck in its control element shock. (2.0)

QUESTION K.12 (1.50)

WHAT operating characteristics, indications, or methods could be used to positively determine if a leaky fuel element or fuel target component existed. Three (3) required for full credit. (1.5)

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

QUESTION L.01 (1.50)

An operator informs you that he has increased the set point on one of the area monitors because it was continuously alarming. WAS this an acceptable course of action? EXPLAIN. (1.5)

QUESTION L.02 (2.00)

a. WHAT is the meaning of "great benefit" as applied to entry into a high radiation area? (1.0)

b. WHO can authorize such an entry and WHAT are the conditions and restrictions on the entry? (1.0)

QUESTION L.03 (2.00)

LIST four (4) reactivity limits for samples in the core. (2.0)

QUESTION L.04 (2.00)

LIST four (4) of the first duties of the shift crew immediately after leaving the reactor building following an evacuation caused by a high level radiation incident. (2.0)

QUESTION L.05 (2.00)

LIST the four (4) events that require immediate NRC notification. (2.0)

QUESTION L.06 (1.00)

LIST two (2) of the three (3) valid reasons for which it is permissible to unlock the fuel vault? (1.0)

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

QUESTION L.07 (3.00)

WHAT six (6) operations require the direct and personal supervision of an SRO? (3.0)

QUESTION L.08 (.50)

ANSWER TRUE or FALSE.

A fission product molybdenum target shall be clearly marked as a "restricted" target before scheduling it for loading into any unrestricted reactor position. (0.5)

QUESTION L.09 (1.00)

The control of maintenance work at the UCNR requires consideration be given to ALARA concerns. WHAT is the intent of an ALARA program? (1.0)

QUESTION L.10 (3.00)

According to UCNR Technical Specifications, there are four (4) levels of authority.

a. WHAT level is the reactor supervisor? (1.0)

b. WHAT level is the Health, Safety and Environmental Affairs Manager? (0.5)

c. WHAT is the minimum level of authority that can approve minor changes to an experiment that does not alter that experiment? (0.5)

d. To WHAT minimum level of authority should a safety limit violation promptly be reported? (0.5)

e. WHAT minimum level of authority may approve substantive changes to fuel loading procedures? (0.5)

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

QUESTION L.11 (2.00)

WHAT three (3) conditions constitute a violation of reactor building containment? (2.0)

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

ANSWERS -- UNION CARBIDE CORP. -86/09/17-APLEY, W.

ANSWER H.01 (2.00)

Po = 100 watts

Reactivity change 0.1% - converting it to period 75 seconds using supplied in-hour curve. [+0.75]

Assuming you are in convection mode cooling the flow scram interlocks will scram the reactor at 200 kW. [+0.5]

P = Po e**T/t

P/Po = e**T/t ---> ln P/Po (t) = T
ln 2000 (75) = 570 seconds = 9.5 min [+0.75]

REFERENCE

1. Union Carbide Nuclear Reactor: Question Bank A.18 (modified), TS-09, Training Manual page A-4

ANSWER H.02 (2.00)

1. overcome Xe poisoning
2. overcome power coefficient
3. compensate for fuel burnup
4. overcome temperature coefficient

[+0.5] each

REFERENCE

1. Union Carbide Nuclear Reactor: Question Bank A.19 (modified), Training Manual pages J 9/10/11

ANSWER H.03 (1.50)

a. decrease
b. decrease
c. increase

[+0.5] each

REFERENCE

1. Union Carbide Nuclear Reactor: Question Bank C.29 (modified), Training Manual pages 10/11/10

ANSWERS -- UNION CARBIDE CORP. -86/09/17-APLEY, W.

ANSWER H.04 (.50)

(a.) [+0.5]

REFERENCE

1. Nuclear Energy Training, Module 3, Reactor Operation, 14.2-5.

ANSWER H.05 (2.00)

a. Equilibrium iodine is proportional to power, while equilibrium xenon is not. Therefore, you have a higher ratio of I to Xe at higher power levels. The greater the I to Xe ratio, the longer it takes for sufficient I to decay to Xe such that an equilibrium production and decay of Xe is occurring (i.e., the peak). [+1.5]

b. 4. [+0.5] Iodine does not burnout (reason not required for full credit).

REFERENCE

1. Nuclear Energy Training, Module 3, 10.2 through 10.4.

ANSWER H.06 (1.00)

a. larger
b. longer

[+0.5] each

REFERENCE

1. Nuclear Energy Training, Module 3, 12.4-2.

ANSWER H.07 (1.00)

(c.) [+1.0]

REFERENCE

1. Nuclear Energy Training, Module 3, 1.5-2 and 2.6-1.

ANSWERS -- UNION CARBIDE CORP. -86/09/17-APLEY, W.

ANSWER H.08 (.50)

(b.) [+0.5]

REFERENCE

1. Nuclear Energy Training, Module 3, 7.3 through 7.5.

ANSWER H.09 (2.00)

a. 4.
b. 3.
c. 2.
d. 1.

[+0.5] each

REFERENCE

1. Union Carbide Nuclear Reactor: DS Data Sheets, DS-01-1.

ANSWER H.10 (.50)

True [+0.5]

REFERENCE

1. Union Carbide Nuclear Reactor: XG-03-6.

ANSWER H.11 (2.00)

Doppler Broadening is an effective broadening of resonance peaks as the fuel temperature increases resulting in greater resonance capture of neutrons because of the increased time that they spend in the resonance peaks [+1.5]. The negative effects are seen immediately upon entering the region of significant core heating (approximately 2NL) and continues to increase as power increases [+0.5].

REFERENCE

1. Union Carbide Nuclear Reactor: C-2.

ANSWERS -- UNION CARBIDE CORP. -86/09/17-APLEY, W.

ANSWER H.12 (.50)

True [+0.5]

REFERENCE

1. Union Carbide Nuclear Reactor: B-1.

ANSWER H.13 (.50)

Pu-239 [+0.5]

REFERENCE

1. Nuclear Energy Training, Module 3, 10.1.

ANSWER H.14 (1.50)

It has no significant effect [+0.5] since the STABLE period still depends on the longest lived pre-cursor [+1.0].

REFERENCE

1. Nuclear Energy Training, Module 3, 14.2.

ANSWER H.15 (2.50)

Leak rate is proportional to the area of leak times the velocity of fluid leaving the pipe or tank [+0.5]. From Bernoulli's equation, pressure is proportional to the SQUARE of the velocity [+0.5], so halving the pressure will only reduce velocity by the square root of two (or drop about 29.3%). [+1.5]

REFERENCE

1. Union Carbide Nuclear Reactor: Equation Sheet, Basic Fluid Thermodynamics Theory.

ANSWERS -- UNION CARBIDE CORP. -86/09/17-APLEY, W.

ANSWER I.01 (1.50)

1. ground water removal system
2. sanitary waste system
3. process waste system (radioactive water)

[+0.5] each

REFERENCE

1. Union Carbide Nuclear Reactor: Question Bank B.25 (modified), RM-03 (Process Water Systems)

ANSWER I.02 (3.00)

1. two or more unexplained area radiation monitor alarms
2. both reactor building CAMS alarms
3. one ARM or CAM together with a stack alarm

[+1.0] each

REFERENCE

1. Union Carbide Nuclear Reactor: Question Bank E.17 (modified), EP-03-03

ANSWER I.03 (1.50)

Yes. The far end of the hold-up tank contains more N-16. This results in the high reading. N-16 gives off a hard gamma. By the time water reaches the other end of the hold up tank the N-16 has decayed, (7 sec half-life), to negligible levels. [+1.5]

REFERENCE

1. Union Carbide Nuclear Reactor: Question Bank G.09, Training Manual page B-8 and Figure B-7.

ANSWERS -- UNION CARBIDE CORP. -86/09/17-APLEY, W.

ANSWER I.04 (2.00)

1. when a sample is >500 mR/hr is being removed from the pool to a shielded container

2. a sample that is being checked that is suspected of being >5 R/hr

[+1.0] each

REFERENCE

1. Union Carbide Nuclear Reactor: Question Bank G.13 (modified), ~~Reference~~ XG-03-3

ANSWER I.05 (2.00)

The formula for figuring a series of radionuclide released to the environment is:

$$\frac{\text{Concentration}}{\text{MPC1}} + \frac{\text{Concentration}}{\text{MPC2}} + \frac{\text{Concentration}}{\text{MPC3}} < 1$$

$$\frac{5 \times 10^{-8}}{1 \times 10^{-7}} + \frac{1 \times 10^{-7}}{3 \times 10^{-7}} + \frac{2 \times 10^{-8}}{4 \times 10^{-8}}$$

Since the amount to be released is greater than 1 the operator should not approve this experiment. [+2.0]

REFERENCE

1. Union Carbide Nuclear Reactor: Question Bank I.13 (modified), TS-19

ANSWERS -- UNION CARBIDE CORP. -86/09/17-APLEY, W.

ANSWER I.06 (2.00)

1. radiolysis decomposition
2. boiling and melting point
3. ignition temperature
4. pressure generation
5. induced radioactivity
6. internal temperature

Any four (4) [+0.5] each, +2.0 maximum.

REFERENCE

1. Union Carbide Nuclear Reactor: XG-03 (85 exam).

ANSWER I.07 (2.50)

dose rate (dr) = 1000 mrem/hr, distance (r1) = 15 feet,
distance (r2) = 5 feet, time (t) = 1 minute = 1/60 hr

dose/min = d rate x r1**2/r2**2 x hr/min [+1.0]
dose/min = 1000 x 15**2/5**2 x 1/60
dose/min = 150 mrm [+0.5]

the yearly dose limit = 5 rem, quarterly = 1.25 rem, [+1.0] 1/10 of quarterly = 0.125 rem = 125 mrem, so the operator would receive a dose in excess of 1/10 of the quarterly limit for whole body exposure. Would not exceed 1/10 of 3 rem per quarter limit.

REFERENCE

1. Union Carbide Nuclear Reactor: Training Manual, I-4, G-12.

ANSWERS -- UNION CARBIDE CORP. -86/09/17-APLEY, W.

ANSWER I.08 (2.00)

No. Activity is proportional to lambda, the decay constant for the material. l = lambda

A = A(o)e**-lt + (flux) N (cross section) (1-e**-lt)

If you double the time a material is irradiated, you will not double the activation. Because it is a LN function. The lower the lambda (l) (higher the half life), the closer you will come to almost having a doubling. [+2.0]

REFERENCE

1. Union Carbide Nuclear Reactor: Training Manual, A-2.

2. Nuclear Energy Training, Module 2, 10.1.

ANSWER I.09 (1.00)

(a.) [+1.0]

REFERENCE

1. Union Carbide Nuclear Reactor: Training Manual, G-12 through G-14.

ANSWER I.10 (1.00)

(b.) [+1.0]

REFERENCE

1. Union Carbide Nuclear Reactor: TS-11.

ANSWER I.11 (1.50)

a. -18.75 rem/qt [+0.5]
b. 500 mr/yr [1.0]

REFERENCE

1. Union Carbide Nuclear Reactor: Question Bank G.18 (modified).

ANSWERS -- UNION CARBIDE CORP. -86/09/17-APLEY, W.

ANSWER J.01 (2.00)

1. (CAMS) would detect increased airborne activity.
2. The (stack) would also show an increase.
3. (BRIDGE MONITORS) would alarm causing evacuation when level reached 5 R.
4. (AREA MONITORS) would also alarm as the source activity increased.
5. (N-16) also would increase.

Any four (4) [+0.5] each, +2.0 maximum.

REFERENCE

1. Union Carbide Nuclear Reactor: Question Bank G.16, TS-11.

ANSWER J.02 (2.00)

The bridge stop indicates the spool piece and the bellows beneath the core are in proper alignment. This allows for the forced cooling mode of reactor operation to be put into use [+1.0]. Misalignment would not allow or permit efficient cooling flow [+1.0].

REFERENCE

1. Union Carbide Nuclear Reactor: Question Bank B.09, Training Manual page B-6, RM-09-1

ANSWER J.03 (2.00)

1. loss of commercial power
2. bridge excursion monitors tripped at 5 R/hr set points
3. loss of high pressure air
4. shutdown of fans
5. manual

[+0.5] each, four required for full credit

REFERENCE

1. Union Carbide Nuclear Reactor: Question Bank B.23, Training Manual page B-15.

ANSWER J.04 (1.50)

The term log n confidence refers to when the log n becomes reliable as the primary neutron tracking channel. This occurs at 0.001% log n. [+1.5]

(Log n confidence is important because prior to reaching this point the log count rate channel is the only neutron reading channel and the need to move the fission chamber occurs at least once during startup from the source range. Before log n confidence is reached, the reactor must be made subcritical to move the fission chamber.)

REFERENCE

1. Union Carbide Nuclear Reactor: Question Bank D.42, Training Manual page D-24

ANSWER J.05 (2.00)

There is a pressure gage on the storage tank line which indicates the presence of water in the line [+1.5]. Also, should the leak continue over a long period, the holdup tank level alarm would come on when the level reaches <3 feet [+0.5]. Credit will also be given (+1.0) for storage tank level alarm, 2 pts maximum.

REFERENCE

1. Union Carbide Nuclear Reactor: Question Bank E.08, Training Manual Figure B.7, DS0203

ANSWER J.06 (1.50)

The pool is above the holdup tank. The water will run from the pool to the holdup tank until it fills up and the water equalizes [+1.0]; dropping the water level of the pool approximately 6.4 feet [+0.5].

REFERENCE

1. Union Carbide Nuclear Reactor: Question Bank J.02, Training Manual Figure B.7

ANSWER J.07 (.50)

False (must have 100% vapor lock on fuel plate--reason not required for full credit) [+0.5]

ANSWERS -- UNION CARBIDE CORP. -86/09/17-APLEY, W.

REFERENCE

1. Union Carbide Nuclear Reactor: Training Manual, J-21.

ANSWER J.08 (1.00)

(d.) [+1.0]

REFERENCE

1. Union Carbide Nuclear Reactor: Training Manual, D-10.

ANSWER J.09 (2.50)

a. ~~6.0~~ 5.0 to 7.5 [+1.0]

b. Yes. [+0.5] pH is a logarithmic function, meaning an addition of pH 2 water involves a concentration 10**5 greater than pH 7. Example: If 1 gal pH 2 added to 100,000 gal pH 7; resultant pH = 6.7.

REFERENCE

1. Union Carbide Nuclear Reactor: TS-16., J-23.

ANSWER J.10 (2.00)

The cooling tower fans are not to be put in reverse mode while they are still turning in the downward direction. [+1.0]

The cooling tower fans shall not be operated in the reverse direction for more than 30 minutes. [+1.0]

REFERENCE

1. Union Carbide Nuclear Reactor: RM-06-4.

ANSWER J.11 (.50)

True [+0.5]

ANSWERS -- UNION CARBIDE CORP. -86/09/17-APLEY, W.

REFERENCE

1. Union Carbide Nuclear Reactor: TS-14.

ANSWER J.12 (.50)

True [+0.5]

REFERENCE

1. Union Carbide Nuclear Reactor: XG-02-05.

ANSWER J.13 (2.00)

See attached figure. [+2.0]

REFERENCE

1. Nuclear Energy Training, Module 3, 13.6-5.

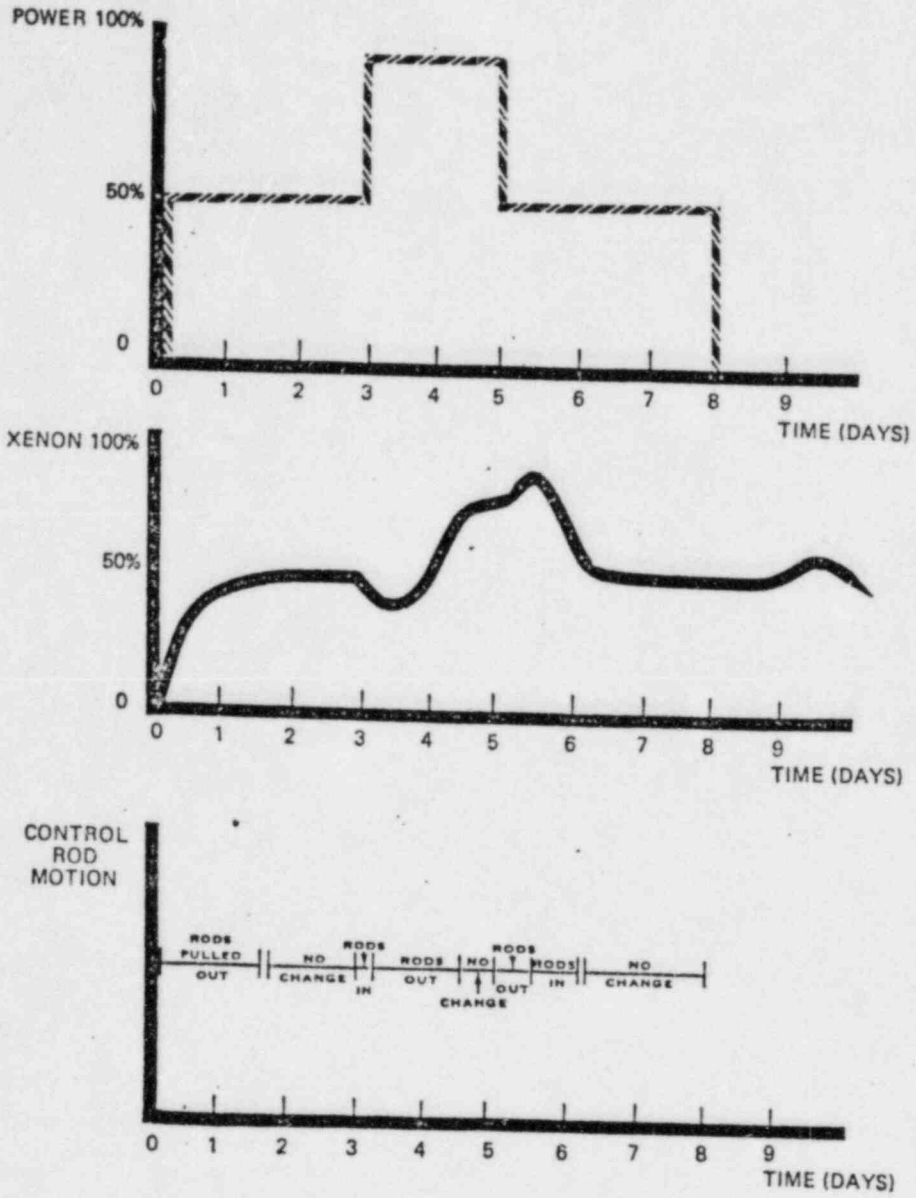


Figure 13.6-3. Power, Xenon, Control Rod Relationship

ANSWERS -- UNION CARBIDE CORP. -86/09/17-APLEY, W.

ANSWER K.01 (2.00)

The thermal column has a large reactivity effect on the reactor-- >0.8% delta K/K. If the reactor had the larger fuel load needed to operate in the pool side and was rolled against the thermal column you could cause an excursion. The reactor would be increasing in power on prompt neutrons alone. This would be a very destructive accident. [+2.0]

REFERENCE

1. Union Carbide Nuclear Reactor: Question Bank B.36, Training Manual page B-12, TS-07.

ANSWER K.02 (2.00)

The xenon re-load will be needed [+1.0]. The maximum number of fuel elements that may be replaced without a criticality check is 15. Normally three or four central fuel elements are replaced with xenon poison-free elements. These central elements have the highest concentration of xenon present [+1.0].

REFERENCE

1. Union Carbide Nuclear Reactor: Question Bank C.21, Training Manual page J-9

ANSWER K.03 (1.50)

Materials reactivity effect [+1.0], and potential solubility and/or corrosion introducing contaminants [+0.5].

REFERENCE

1. Union Carbide Nuclear Reactor: Question Bank F.12 (modified), ~~Training Manual~~ RM-06-02

ANSWER K.04 (2.00)

The reactor must be shutdown and moved away from the tube [+1.0], and under HP surveillance [+1.0].

REFERENCE

1. Union Carbide Nuclear Reactor: Question Bank F.15, RM-09-8

ANSWERS -- UNION CARBIDE CORP. -86/09/17-APLEY, W.

ANSWER K.05 (2.50)

minimum shutdown margin is 0.5% delta K/K [+0.5]

a. at 13.00 excess reactivity is 3.88%
xenon and power coefficient are 0
highest worth rod fully withdrawn is 2.65%
nonsecured experiment is 0.04%
9.35-3.88-0-2.65-0.04 = 2.78
OK--shutdown margin satisfied [+1.0]

b. at 15.20 excess reactivity is 2.56%
xenon power coefficient are 3.5% and 0.35% respectively
highest worth rod fully withdrawn is 2.65%
nonsecured experiment is 0
9.35-2.56-3.5-0.35-2.65-0 = 0.29
Not OK--less than minimum shutdown margin [+1.0]

REFERENCE

1. Union Carbide Nuclear Reactor: Question Bank J.15 (modified), TS-07

ANSWER K.06 (.50)

False (convex side) [+0.5]

REFERENCE

1. Union Carbide Nuclear Reactor: Question Bank K.06 (modified), RM-10-8.

ANSWER K.07 (2.00)

Lower the element back into position leaving the tool attached [+0.75]. Leave the bridge and leave the building and initiate the evacuation sequence [+0.5]. Given sufficient time for the bubbles to break the surface, then reenter the building and try to determine if a hazard was present. If not, try to determine the cause. If a hazard were present, use the emergency call list and notify the necessary persons of the situation [+0.75].

REFERENCE

1. Union Carbide Nuclear Reactor: Question Bank K.14, RM10-7, RM-04-11.

ANSWERS -- UNION CARBIDE CORP. -86/09/17-APLEY, W.

ANSWER K.08 (1.00)

a. 30 [+0.5]
b. 2 [+0.5]

REFERENCE

1. Union Carbide Nuclear Reactor: Question Bank L.19 (modified), RM-10-6.
2. Union Carbide Nuclear Reactor: RM-10-8.

ANSWER K.09 (2.50)

1. the core contains insufficient fuel to attain criticality under optimum conditions of moderation and reflection
2. the moderator has been removed
3. the minimum number of control rods are fully inserted as required by Technical Specifications
4. the console key switch is in the OFF position and the key is removed from the lock
5. no work is in progress involving core fuel, core structure, installed control rods or control rod drives unless they are physically decoupled from the control rods
6. no in-core experiments are being moved or serviced with a reactivity worth exceeding the maximum value allowed for a single experiment or one dollar, whichever is smaller

Any five (5) [+0.5] each, +2.5 maximum.

REFERENCE

1. Union Carbide Nuclear Reactor: TS-02.

ANSWER K.10 (.50)

False [+0.5]

REFERENCE

1. Union Carbide Nuclear Reactor: TS-23.

ANSWERS -- UNION CARBIDE CORP. -86/09/17-APLEY, W.

ANSWER K.11 (2.00)

An external control rod magnet power supply can be utilized to increase the magnet current. The external power supplies output current to the rod magnet shall not exceed 400 ma. Only one control rod can be powered from an external power supply at any one time. Prior to connecting an external power supply to a stuck control rod drive, a spare control rod is to be placed into the core. The spare control rod shall remain in the core until the external power supply is disconnected. [+2.0]

REFERENCE

1. Union Carbide Nuclear Reactor: RM-09-06.

ANSWER K.12 (1.50)

1. Comparisons of underwater fueled target weights before and after irradiation.
2. Water sampling in the immediate vicinity of a suspected component.
3. Pulling a vacuum on a suspected component and sampling the vacuum chamber air.
4. Reactor restarts if the release is suspected to be from fuel elements.

Any three (3) [+0.5] each, +1.5 maximum.

REFERENCE

1. Union Carbide Nuclear Reactor: RM-04-11, EP-03

5. Sample for Cs/Rb - 32 min half life
6. Sample water for analysis of isotope.

ANSWERS -- UNION CARBIDE CORP. -86/09/17-APLEY, W.

ANSWER L.01 (1.50)

The action is acceptable [+0.5] as long as the reactor operator properly logged the alarm and change, notified a SRO as soon as possible and the operator continued to monitor the actual radiation level and took steps to determine the cause and corrective action if applicable. [+1.0]

REFERENCE

1. Union Carbide Nuclear Reactor: Question Bank L.14, RM-04-04, EP-03, RM-09-9.

ANSWER L.02 (2.00)

a. A great benefit can be gained to save a life or save vital safety equipment. [+1.0]

b. To save a life the director can authorize [+0.5] volunteers to receive up to 75 rem [+0.25] and to save vital equipment volunteers are allowed to receive up to 25 rem [+0.25].

REFERENCE

1. Union Carbide Nuclear Reactor: Question Bank F.06, EP-02-02

ANSWER L.03 (2.00)

1. The combined worth of all non-secured experiments that can add + reactivity in a common mode failure shall not exceed 1.7% delta K/K.

2. The combined worth of all experiments that can add + reactivity in a common mode failure shall not exceed 2% delta K/K.

3. The reactivity of any single experiment shall not exceed 0.5% delta K/K.

4. No samples to be loaded during critical operation shall exceed 0.25% delta K/K.

[+0.5] each

ANSWERS -- UNION CARBIDE CORP. -86/09/17-APLEY, W.

REFERENCE

1. Union Carbide Nuclear Reactor: Question Bank F.18, TS-13

ANSWER L.04 (2.00)

1. account for and assemble all personnel at the south loading dock
2. classify the emergency
3. make a brief radiation survey of the south loading dock area
4. call persons on the emergency call list
5. make any log entries
6. check personnel for contamination while awaiting the arrival of emergency personnel

Any four (4) [+0.5] each, +2.0 maximum

REFERENCE

1. Union Carbide Nuclear Reactor: Question Bank F.22, EP-02-01/02

ANSWER L.05 (2.00)

1. exposure of any individual to 25 rem or exposure of skin to 150 rem or any extremity to 375 rem
2. release of radioactive material in excess of 5000 times the limit specified in Appendix B, if averaged over a 24 hr period
3. a loss of one operating week
4. damage in excess of $200,000

Will also give credit for TS38 responses ([redacted] ½)
[+0.5] each

REFERENCE

1. Union Carbide Nuclear Reactor: Question Bank I.17, 10CFR20 Part 403, TS38 - Section 6.6.2

ANSWERS -- UNION CARBIDE CORP. -86/09/17-APLEY, W.

ANSWER L.06 (1.00)

1. fuel movement
2. intrusion alarm check
3. maintenance on fuel vault

Any two (2) [+0.5], +1.0 maximum

REFERENCE

1. Union Carbide Nuclear Reactor: Question Bank K.08 (modified), EP-13-01.

ANSWER L.07 (3.00)

1. all fuel element or control rod alterations within the core region
2. relocation of any experiment = or > than one dollar (0.82% delta K/K)
3. recovery from an unplanned shutdown except those types that have been previously excluded by level 2 management
4. major water level changes
5. criticality test of new core configuration (approach to criticality)
6. moving the reactor bridge

[+0.5] each

REFERENCE

1. Union Carbide Nuclear Reactor: Question Bank L.05, RM-09-2, RM-03-6, RM-05-2.

ANSWER L.08 (.50)

True [+0.5]

REFERENCE

1. Union Carbide Nuclear Reactor: RM-04-08.

ANSWERS -- UNION CARBIDE CORP. -86/09/17-APLEY, W.

ANSWER L.09 (1.00)

to maintain radiation exposures as low as reasonably achievable [+1.0]

REFERENCE

1. Union Carbide Nuclear Reactor: TS-10.

ANSWER L.10 (3.00)

a. 3
b. 2
c. 3
d. 1
e. 2

REFERENCE

1. Union Carbide Nuclear Reactor: Technical Specifications, pp. 32, 35, and 36.

ANSWER L.11 (2.00)

1. loss of the water seal in the canal [+0.5]

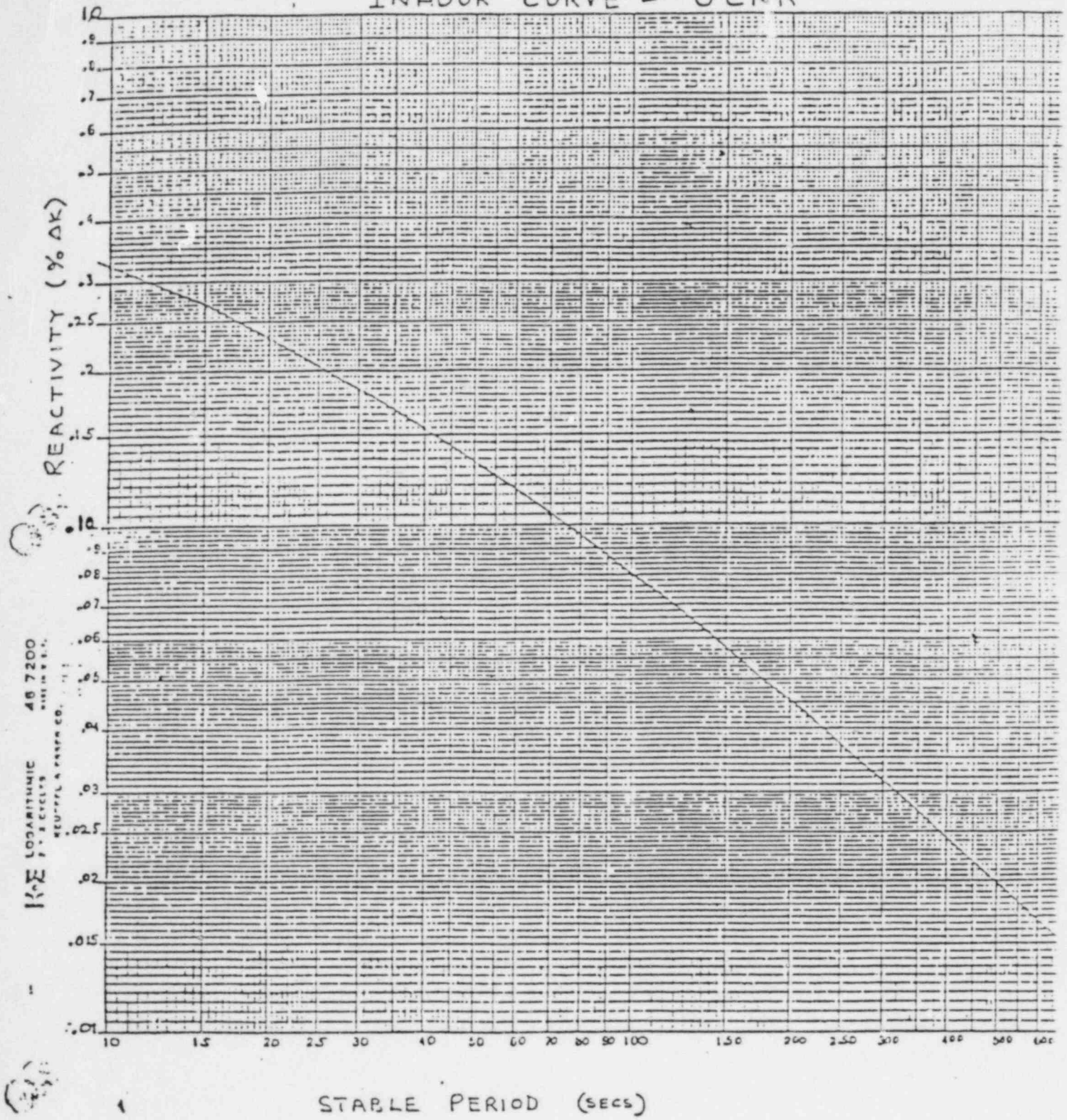
2. the opening of both doors, either in the personnel airlocks [+0.5] or the equipment airlocks [+0.5]

3. inability of the emergency exhaust system to perform its required function [+0.5]

REFERENCE

1. Union Carbide Nuclear Reactor: RM-04-5.

INHOUR CURVE - UCNR



EQUATION SHEET

Where $\dot{m}_1 = \dot{m}_2$

$(\text{density})_1(\text{velocity})_1(\text{area})_1 = (\text{density})_2(\text{velocity})_2(\text{area})_2$

$KE = \frac{mv^2}{2}$ $\quad PE = mgh$ $\quad PE_1 + KE_1 + P_1V_1 = PE_2 + KE_2 + P_2V_2$ where V = specific volume, P = Pressure

$Q = \dot{m}c_p(T_{out} - T_{in})$ $\quad Q = UA\,(T_{ave} - T_{stm})$ $\quad Q = \dot{m}(h_1 - h_2)$

$P = P_0 10^{(SUR)(t)}$ $\quad P = P_0 e^{t/T}$ $\quad SUR = \frac{26.06}{T}$ $\quad T = \frac{(B-p)t}{p}$

$\text{delta } K = (K_{eff} - 1)$ $\quad CR_1(1-K_{eff1}) = CR_2(1-K_{eff2})$ $\quad CR = S/(1-K_{eff})$

$M = \frac{(1-K_{eff1})}{(1-K_{eff2})}$ $\quad SDM = \frac{(1-K_{eff}) \times 100\%}{K_{eff}}$

$\text{decay constant} = \frac{\ln(2)}{t_{1/2}} = \frac{0.693}{t_{1/2}}$ $\quad A_1 = A_o e^{-(\text{decay constant})x(t)}$

Water Parameters

1 gallon = 8.345 lbs
1 gallon = 3.78 liters

1 ft^3 = 7.48 gallons

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 psia = 29.9 in Hg

Miscellaneous Conversions

1 Curie = 3.7×10^{10} dps
1 kg = 2.21 lbs

1 hp = 2.54×10^3 Btu/hr

1 MW = 3.41×10^6 Btu/hr
1 Btu = 778 ft-lbf

Degrees F = (1.8 x Degrees C) + 32
1 inch = 2.54 centimeters
g = 32.174 $ft\text{-}lbm/lbf\text{-}sec^2$

Attachment 3

SEP 22 1986

CINTICHEM, INC.
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September 19, 1986

Mr. Walter J. Apley P.E.
Manager of Research Operations
Engineering Physics Department
Battelle Pacific Northwest Laboratories
Battelle Boulevard
Richand, WA 99352

Dear Walt:

We have quickly reviewed the R.O. and S.R.O. exams you administered this week. We wanted to send our preliminary comments to you as soon as possible and so will mail them out to you the day after the test. We may send you more next week after we have had some more time to look at the exams.

Attached are our preliminary comments. Most of these comments were discussed while you were here but some of them you have not seen. I hope you receive them before you are done with your exam marking. Thank you.

Sincerely,

W. G. Ruzicka

William G. Ruzicka
Manager, Nuclear Operations

WGR:mag
Attachment

A. 04. Answer key answer is obscure. Actually there is little change over our temperature range. Also, many core parameters are changing as core temperature changes. These changing parameters will have various effects on rod worths.

B9b. Candidate exam did not have a question B9b although answer key did.

C.03b. There are more than two correct answers to this question. Another correct answer, not on the answer key, is that if insufficient core heat removal caused boiling in the core, this would be seen on the reactor instrumentation in extra noise on period and level meters.

C.05. The subject of PH is only briefly covered with R.O. candidates. PH determinations of this sort would be S.R.O. material. No training, where PH computations of this type were necessary, was given to candidate.

C.07. The answer key answer gives only one of several possible correct answers. Another correct answer is what is seen when one is exactly critical and not supercritical, i.e. that the period goes to infinity and the power level does not increase.

C.10. The answer key answer is inappropriate. The actual answer to question is that the allowable core power can remain at 5MW as the pool temperature goes from 100°F to 130°F. The question implies, though, that a discussion of reverse setpoints with pool temperature changes was wanted. See RM-06-02 for reverse setpoints versus pool temperature.

D.01. The answer key answers are not the only correct answers. Another correct answer is spacial core flux distributions. If the flux is tilted away from the chambers because of fuel element loading distributions this will not be picked up accurately by the ion chambers. Only a heat balance will accurately measure total power in this case.

D.05b. The R.O. candidate interpreted this to mean where could the alarms be actuated. This interpretation of the question is not wrong as a location does provide the "means" to activate the alarms. See EP-11-01.

D.06. The question is somewhat misleading. Our CIC on the Log N is generally kept slightly undercompensated. After a shutdown, the degree of compensation changes from under to perfect to over. Depending on how long you are shutdown will determine how compensated you are. The candidate should basically know that in the condition described that bucking current adjustments should be made. See training manual pg. C4 and RM-03-3.

D.09. The answer in the answer key is from the training manual. This discusses one acceptable method of setting the PHS and gain control settings. Another method, and the one we presently use, is that the fission chamber is removed from the core and a separate neutron source (Pu - Be) and gamma source (Co-60) is used to set the setpoints.

E.04. A simplified electrical schematic of the emergency generators loads is posted in the control room and the motor control center room. We therefore do not require trainees to memorize all of the loads.

E.06. See RS-31-1. A filter efficiency of <99% requires action to bring the filter efficiency back to 99%. A shutdown is required when <95% but partial credit should be given for a 99% answer.

F.10. The answer requires verbatim memorization of the procedures. The candidate knew a survey had to be made but did not pick up the subtle distinction of who was to do the survey. The console duty can change quickly between the two operators on duty and it is always implied that one of the operators will man the console. The question does not do a good job of testing the candidates knowledge in this area and can mislead a knowledgeable candidate into the wrong answer.

G.4a. The answer key answer is correct but other answers are also correct and in fact more correct. The Reactor Operator does have a responsibility as Emergency Director to become involved in hot lab ventilation problems. An answer I would feel is correct would be a discussion of the required hot lab evacuation and the attempts one should make to understand and solve problem. A knowledgeable candidate might not even discuss reactor status as it is common knowledge and many times unsaid but implied that hot lab ventilation problems are separate from the reactor. Only evacuating the hot laboratory implies the reactor status can remain unchanged.

G.06. The answer key answer is correct but there are other correct answers to the question. The question came from the question bank. The question bank stated that argon 40 represents approximately 1% of normal air and that when this is activated by neutrons it forms Argon 41. It therefore can be made anywhere Argon 40 comes into contact with neutrons. Other examples of correct answers are therefore our pneumatic rabbit tubes (P-tubes) or the water itself.

S.R.O. EXAM

H.14. The answer key answer is simplistic. The correct answer is that there is a negligible effect. See Lamarsh "Nuclear Reactor Theory" 1972 printing.

I.07. The answer key answer is correct but another correct answer is the 3 Rem/quarter limit implied by 10 CFR 20.101. This uses the 5(N-18).

I.01. The normal site terminology for our contaminated water system is either the "radioactive waste system" or "process water system". See Training Manual I-1 diagram labeled "Radioactive Waste System".

J.03. The answer key should also include manual initiation.

J.05 The answer key should also include storage tank low level alarm. See Procedure DS-02-03.

J.09. Typo on answer key. Correct answer is 5.0 to 7.5 for PH limits. See Technical Specifications TS-16.

K.12. The candidate asked the inspector if the inspector wanted the indications that there was a leaky element or if he wanted the ways a leaky element could be isolated. The inspector answered the former. The answer key answers are from RM-04-11 and are generally methods used to identify and then locate and isolate a leak after preliminary indications show there is a leak. Section EP and EP-03 developes means of preliminary identification. Also correct answers are the fission product gases I and Xe come out of the pool water then decay to particulates Cs and Rb. These are picked up on air filters and a half life study of the filter can show the approximate 32 minutes combined half life. Also, multichannel analyzer determinations on air samples and water samples will also confirm a fission product release.

L.05. Answer key should also include the responses required in our Technical Specifications. See Tech. Spec. Section 6.6.2 page Ts-38.

Attachment 4

Resolution of Facility Comments

Reactor Operator Examination

QUESTION A.04

Resolution:

The examiner sees no reason to change the key.

QUESTION B.9b

Resolution:

Review copy had extra sheet in it that was not in copy provided to NRC; sheet deleted.

QUESTION C.036

Resolution:

Alternative answer added.

QUESTION C.05

Resolution:

RO candidate not asked to compute pH, only to know that pH was logarithmic function. The examiner sees no reason to change the key.

QUESTION C.07

Resolution:

The examiner sees no reason to change the key.

QUESTION C.10

Resolution:

The examiner sees no reason to change the key.

QUESTION D.01

Resolution:

Alternative answer added.

QUESTION D.05b

Resolution:

The examiner sees no reason to change the key.

QUESTION D.06

Resolution:

The examiner sees no reason to change the key.

QUESTION D.09

Resolution:

Alternative answer added; did not change grading of candidate.

QUESTION E.04

Resolution:

The examiner sees no reason to change the key.

QUESTION F.10

Resolution:

The examiner sees no reason to change the key, though it is recognized that the question itself should probably be clarified for future use.

QUESTION G.4a

Resolution:

The examiner sees no reason to change the key.

QUESTION G.06

Resolution:

Alternative answer of pneumatic rabbit tubes added; water response was not.

QUESTIONS H.14, I.01, I.07, J.03, J.05, J.09

Resolution:

Alternative answer added.

QUESTION KI.12

Resolution:

Facility comments are incorrect. Candidate clearly instructed to provide indications which would confirm a leaky element versus another type of event. Suggested other indications which would provide that information were added to the key.

QUESTIONS L.05

Resolution:

Alternative answer added, but did not change grading of examination.