July 16, 2015

Dr. George E. Miller
Department of Chemistry
University of California, Irvine
516 Physical Sciences 1
Irvine, CA 92697-2025

SUBJECT: EXAMINATION REPORT NO. 50-326/OL-15-01, UNIVERSITY OF CALIFORNIA - IRVINE

Dear Dr. Miller:

During the week of June 15, 2015, the U.S. Nuclear Regulatory Commission (NRC) administered operator licensing examinations at your University of California – Irvine TRIGA Reactor. The examinations were conducted according to NUREG-1478, "Operator Licensing Examiner Standards for Research and Test Reactors," Revision 2. Examination questions and preliminary findings were discussed with you and Mr. Jonathan T. Wallick at the conclusion of the examination.

In accordance with Title 10 of the *Code of Federal Regulations,* Section 2.390, a copy of this letter and the enclosures will be available electronically for public inspection in the NRC Public Document Room or from the Publicly Available Records component of NRC's Agencywide Documents Access and Management System (ADAMS). ADAMS is accessible from the NRC Web site at http://www.nrc.gov/reading-rm/adams.html (the Public Electronic Reading Room). The NRC is forwarding the individual grades to you in a separate letter which will not be released publicly. If you have any questions concerning this examination, please contact Mr. John T. Nguyen at (301) 415-4007, or by e-mail at John.Nguyen@nrc.gov.

Sincerely,

/RA/

Kevin Hsueh, Chief
Research and Test Reactors Oversight Branch
Division of Policy and Rulemaking
Office of Nuclear Reactor Regulation

Docket No. 50-326

Enclosures:
1. Examination Report No. 50-326/OL-15-01
2. Written Examination

cc w/enclosures: Dr. A.J. Shaka

cc: w/o enclosures: See next page

July 16, 2015

Dr. George E. Miller, Director
Department of Chemistry
516 Physical Sciences 1
University of California, Irvine
Irvine, CA 92697-2025

SUBJECT: EXAMINATION REPORT NO. 50-326/OL-15-01, UNIVERSITY OF CALIFORNIA - IRVINE

Dear Dr. Miller:

During the week of June 15, 2015, the U.S. Nuclear Regulatory Commission (NRC) administered operator licensing examinations at your University of California – Irvine TRIGA Reactor. The examinations were conducted according to NUREG-1478, "Operator Licensing Examiner Standards for Research and Test Reactors," Revision 2. Examination questions and preliminary findings were discussed with you and Mr. Jonathan T. Wallick at the conclusion of the examination.

In accordance with Title 10 of the *Code of Federal Regulations,* Section 2.390, a copy of this letter and the enclosures will be available electronically for public inspection in the NRC Public Document Room or from the Publicly Available Records component of NRC's Agencywide Documents Access and Management System (ADAMS). ADAMS is accessible from the NRC Web site at http://www.nrc.gov/reading-rm/adams.html (the Public Electronic Reading Room). The NRC is forwarding the individual grades to you in a separate letter which will not be released publicly. If you have any questions concerning this examination, please contact Mr. John T. Nguyen at (301) 415-4007, or by e-mail at John.Nguyen@nrc.gov.

Sincerely,
/RA/
Kevin Hsueh, Chief
Research and Test Reactors Oversight Branch
Division of Policy and Rulemaking
Office of Nuclear Reactor Regulation

Docket No. 50-326

Enclosures:
1. Examination Report No. 50-326/OL-15-01
2. Written Examination

cc: w/enclosures: Dr. A.J. Shaka
cc: w/o enclosures: See next page

DISTRIBUTION: w/enclosure
PUBLIC RidsNrrDprPrta Resource RidsNrrDprPrtb Resource CRevelle, NRR

ADAMS ACCESSION #: ML15187A353 **NRR-079**

OFFICE	NRR/DPR/PROB	NRR/DPR/PROB	NRR/DPR/PROB
NAME	Nguyen	NParker	KHsueh
DATE	07/02/15	07/07/15	07/16/15

OFFICIAL RECORD COPY

cc:

Dr. Reginald M. Penner, Chair
Department of Chemistry
University of California, Irvine
Irvine, CA 92697-2025

Radiological Health Branch
California Department of Public Health
P.O. Box 997414, MS 7610
Sacramento, CA 95899-7414

Dr. A.J. Shaka
Nuclear Reactor Facility
Department of Chemistry
University of California
231A Rowland Hall
Irvine, CA 92697-2025

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

Dr. Howard Gillman
Provost and Executive Vice Chancellor
509 Aldrich Hall
University of California, Irvine
Irvine, CA 92697-2025

EXAMINATION REPORT NO: 50-326/OL-15-01

FACILITY: UNIVERSITY OF CALIFORNIA - IRVINE

FACILITY DOCKET NO.: 50-326

FACILITY LICENSE NO.: R-116

SUBMITTED BY: ***/RA/*** 7/02/2015
John T. Nguyen, Chief Examiner Date

SUMMARY:

During the week of June 15, 2015, the NRC administered operator licensing examinations to three license candidates including two Reactor Operator (RO) and one Senior Reactor Operator - Upgrade (SRO-U) license candidates. All candidates passed the examinations and will be issued licenses to operate the University of California - Irvine reactor.

REPORT DETAILS

1. Examiner: John T. Nguyen, Chief Examiner

2. Results:

	RO PASS/FAIL	SRO PASS/FAIL	TOTAL PASS/FAIL
Written	2/0	0/0	2/0
Operating Tests	2/0	1/0	3/0
Overall	2/0	1/0	3/0

3. Exit Meeting:

George Miller, UCINRF, Reactor Supervisor
Jonathan T. Wallick, UCINRF, Senior Reactor Operator
John Nguyen, NRC, Chief Examiner

The NRC examiner thanked the facility for their support in the administration of the examinations. Mr. John Nguyen discussed with the Reactor Supervisor regarding the training program, updating of the procedures, and the generic weaknesses observed during their operating tests.

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

FACILITY: UNIVERSITY OF CALIFORNIA-IRVINE

REACTOR TYPE: TRIGA

DATE ADMINISTERED: June 15, 2015

CANDIDATE: _____

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

CATEGORY VALUE	% OF TOTAL	CANDIDATE'S SCORE	% OF CATEGORY VALUE	CATEGORY
19.00	33.3	_____	_____	A. REACTOR THEORY, THERMODYNAMICS AND FACILITY OPERATING CHARACTERISTICS
19.00	33.3	_____	_____	B. NORMAL AND EMERGENCY OPERATING PROCEDURES AND RADIOLOGICAL CONTROLS
19.00	33.3	_____	_____	C. FACILITY AND RADIATION MONITORING SYSTEMS
57.00	100.00	_____ FINAL GRADE	_____	% TOTALS

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

_____
Candidate's Signature

Enclosure 2

A. RX THEORY, THERMO & FAC OP CHARS

A N S W E R S H E E T

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

A01 a b c d ___

A02 a b c d ___

A03 a b c d ___

A04 a b c d ___

A05 a b c d ___

A06 a b c d ___

A07 a b c d ___

A08 a b c d ___

A09 a b c d ___

A10 a b c d ___

A11 a b c d ___

A12 a b c d ___

A13 a b c d ___

A14 a b c d ___

A15 a b c d ___

A16 a b c d ___

A17 a b c d ___

A18 a b c d ___

A19 a b c d ___

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

B. NORMAL/EMERG PROCEDURES & RAD CON

A N S W E R S H E E T

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

B01 a b c d ___

B02 a b c d ___

B03 a ___ b ___ c ___ d ___ (0.25 each)

B04 a b c d ___

B05 a b c d ___

B06 a b c d ___

B07 a b c d ___

B08 a b c d ___

B09 a b c d ___

B10 a b c d ___

B11 a b c d ___

B12 a b c d ___

B13 a b c d ___

B14 a b c d ___

B15 a b c d ___

B16 a b c d ___

B17 a b c d ___

B18 a b c d ___

B19 a b c d ___

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

C. PLANT AND RAD MONITORING SYSTEMS

A N S W E R S H E E T

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

C01 a b c d ___

C02 a b c d ___

C03 a b c d ___

C04 a b c d ___

C05 a b c d ___

C06 a ___ b ___ c ___ d ___ (0.25 each)

C07 a b c d ___

C08 a b c d ___

C09 a b c d ___

C10 a b c d ___

C11 a b c d ___

C12 a b c d ___

C13 a b c d ___

C14 a b c d ___

C15 a b c d ___

C16 a b c d ___

C17 a b c d ___

C18 a b c d ___

C19 a b c d ___

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

NRC RULES AND GUIDELINES FOR LICENSE EXAMINATIONS

During the administration of this examination the following rules apply:

1. Cheating on the examination means an automatic denial of your application and could result in more severe penalties.

2. After the examination has been completed, you must sign the statement on the cover sheet indicating that the work is your own and you have neither received nor given assistance in completing the examination. This must be done after you complete the examination.

3. Restroom trips are to be limited and only one candidate at a time may leave. You must avoid all contacts with anyone outside the examination room to avoid even the appearance or possibility of cheating.

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

5. Print your name in the blank provided in the upper right-hand corner of the examination cover sheet and each Answer sheet.

6. Mark your Answers on the Answer sheet provided. USE ONLY THE PAPER PROVIDED AND DO NOT WRITE ON THE BACK SIDE OF THE PAGE.

7. The point value for each question is indicated in [brackets] after the question.

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

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

10. Ensure all information you wish to have evaluated as part of your Answer is on your Answer sheet. Scrap paper will be disposed of immediately following the examination.

11. To pass the examination you must achieve a grade of 70 percent or greater in each category.

12. There is a time limit of three (3) hours for completion of the examination.

EQUATION SHEET

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

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

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

$$P = P_0 \; e^{t/\mathrm{T}}$$

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

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

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

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

$$CR_1 (-\rho_1) = CR_2 (-\rho_2)$$

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

$$M = \frac{1}{1 - K_{eff}} = \frac{CR_2}{CR_1} \qquad P = P_0 \; 10^{SUR(t)}$$

$$M = \frac{1 - K_{eff_1}}{1 - K_{eff\,2}}$$

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

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

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

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

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

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

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

$$DR_1 \, d_1^{\,2} = DR_2 d_2^{\,2}$$

$$DR = \frac{6 Ci \, E(n)}{R^2}$$

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

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

1 Curie = 3.7 x 10^{10} dis/sec

1 Horsepower = 2.54 x 10^3 BTU/hr

1 BTU = 778 ft-lbf

1 gal (H_2O) ≈ 8 lbm

c_P = 1.0 BTU/hr/lbm/°F

1 kg = 2.21 lb

1 Mw = 3.41 x 10^6 BTU/hr

°F = 9/5 °C + 32

°C = 5/9 (°F - 32)

c_p = 1 cal/sec/gm/°C

Section A ℞ Theory, Thermo, and Facility Characteristics

QUESTION A.01 [1.0 point]
In a just critical reactor, the reactor operator immediately inserts a rabbit of $0.50 reactivity worth into the core. This insertion will cause:
Given:
T: reactor period, ℓ*: Prompt neutron lifetime; ρ: reactivity insertion; β: beta fraction; λ-eff: delayed neutron precursor constant

a. A sudden drop in delayed neutrons

b. A number of prompt neutrons is twice as much as a number of delayed neutrons

c. The resultant period is a function of the prompt neutron lifetime (T=ℓ*/ρ)

d. The resultant period is a function of the delayed neutron precursors $T = \left[\frac{\overline{\beta} - \rho}{\lambda_{eff} \rho} \right]$

QUESTION A.02 [1.0 point]
Reactor is increasing power from 10 W to 100 kW in prompt criticality. Which ONE of the following best describes the values of K_{eff} and ρ during the power increment?

a. $K_{eff} < 1$ and $0 < \rho < 1$

b. $K_{eff} = 1$ and $\rho > 1$

c. $K_{eff} > 1$ and $0 < \rho <$ β-eff

d. $K_{eff} > 1$ and β-eff $< \rho < 1$

QUESTION A.03 [1.0 point]
Few minutes following a reactor scram of 200 kW, the reactor period has stabilized and the power level is decreasing at a **CONSTANT** rate. What is the power level at one minute later from 1 kW?

a. 0.2 kW

b. 0.5 kW

c. 0.8 kW

d. 2.1 kW

Section A Rx Theory, Thermo, and Facility Characteristics

QUESTION A.04 [1.0 point]
The MAJOR source of energy released during fission comes from:

a. Fission neutrons

b. Fission fragments

c. Prompt gamma rays

d. Fission product gamma decay

QUESTION A.05 [1.0 point]

Reactor A with a K_{eff} of 0.1 and reactor B with a K_{eff} of 0.8, K_{eff} is increased by 0.1 for each reactor. For the same increment, the amount of reactivity added in reactor A is _____ in reactor B. (note: Keff in reactor A increases from 0.1 to 0.2 and Keff in reactor B increases from 0.8 to 0.9)

a. less than

b. same

c. eight times

d. thirty-six times

QUESTION A.06 [1.0 point]
Which ONE of the following correctly describes the SIX- FACTOR FORMULA?

a. $K_\infty = K_{eff}$ * the utilization factor

b. $K_\infty = K_{eff}$ * the total leakage probability

c. $K_{eff} = K_\infty$ * the total non-leakage probability

d. $K_{eff} = K_\infty$ * (the resonance escape probability * the reproduction factor)

Section A ℞ Theory, Thermo, and Facility Characteristics

QUESTION A.07 [1.0 point]
Which ONE of the following describes the term **PROMPT JUMP**?

a. A reactor is increasing power at 80-second period

b. A reactor has attained criticality on prompt neutrons alone

c. The instantaneous change in power level due to adding of a negative (-)$0.30 worth

d. The instantaneous change in power level due to removing of a negative (-)$0.30 worth

QUESTION A.08 [1.0 point]
Given the associated graph, which of the following answers best describe the neutron behavior within Region II?

a. The neutron cross section is inversely proportional to the neutron velocity (1/V)

b. The neutron cross section decreases steadily with increasing neutron energy (1/E)

c. Neutrons of specific energy levels (e.g., 0.05 ev, 100 ev) have more likely leakage from the reactor core

d. Neutrons of specific energy levels (e.g., 0.05 ev, 100 ev) are more likely to be absorbed than neutrons at other energy levels

Section A ℞ Theory, Thermo, and Facility Characteristics

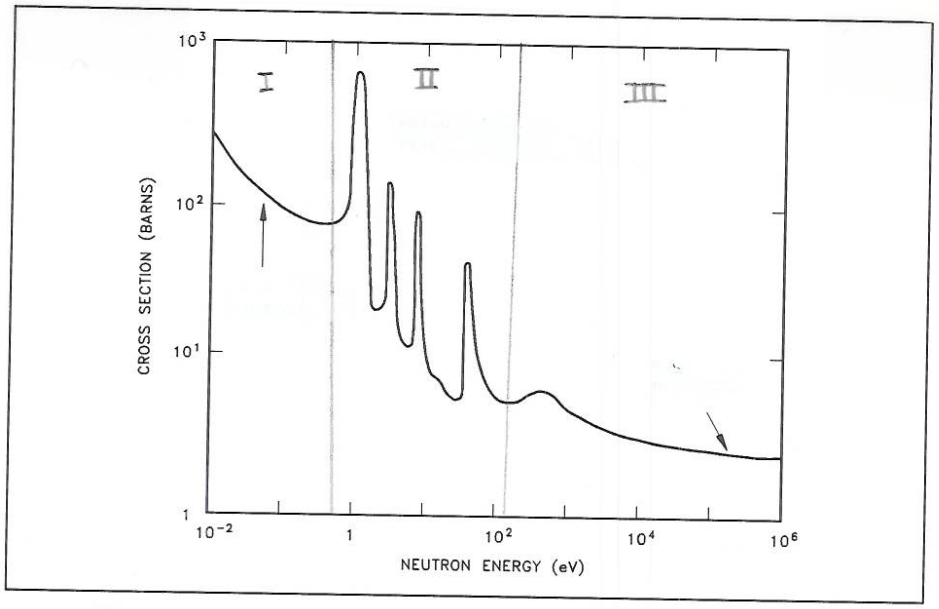


Figure 1 Typical Neutron Absorption Cross Section vs. Neutron Energy

Section A ℞ Theory, Thermo, and Facility Characteristics

QUESTION A.09 [1.0 point]
Given a reactor period of 32 seconds, approximately how long will it take for power to triple?

a. 22 seconds

b. 35 seconds

c. 46 seconds

d. 64 seconds

QUESTION A.10 [1.0 point]
The reactor is on a **CONSTANT** positive period. Which ONE of the following power changes will take the **longest time** to complete?

a. 5%, from 95% to 100%

b. 10%, from 80% to 90%

c. 15%, from 15% to 30%

d. 20%, from 60% to 80%

Section A ℞ Theory, Thermo, and Facility Characteristics

QUESTION A.11 [1.0 point]
Delayed neutrons are produced by:

a. decay of N-16

b. Photoelectric Effect

c. decay of fission fragments

d. directly from the fission process

QUESTION A.12 [1.0 point]
A reactor is slightly supercritical with the following values for each of the factors in the six-factor formula:

Fast fission factor	1.03
Fast non-leakage probability	0.84
Resonance escape probability	0.96
Thermal non-leakage probability	0.88
Thermal utilization factor	0.70
Reproduction factor	1.96

A control rod is inserted to bring the reactor back to critical. Assuming all other factors remain unchanged, the new value for the thermal utilization factor is:

a. 0.698

b. 0.702

c. 0.074

d. 0.076

QUESTION A.13 [1.0 point]
Which ONE of the following conditions will INCREASE the core excess of a reactor?

a. Higher moderator temperature (assume negative temperature coefficient)

b. Insertion of a negative reactivity worth experiment

c. Burnout of a burnable poison

d. Fuel depletion

Section A ℞ Theory, Thermo, and Facility Characteristics

QUESTION A.14 [1.0 point]
A reactor is subcritical with K_{eff} of 0.955. Which ONE of the following is the MINIMUM reactivity (ρK/K) that must be added to PROMPT criticality? Given βeff=0.007

a. 0.0045

b. 0.0047

c. 0.0540

d. 1.0500

QUESTION A.15 [1.0 point]
Given a source strength of 100 neutrons per second (N/sec) and a multiplication factor (k) of 0.9, which ONE of the following is the expected stable neutron count rate?

a. 900 N/sec

b. 1000 N/sec

c. 1500 N/sec

d. 2000 N/sec

QUESTION A.16 [1.0 point]
Which ONE of the following nuclides will cause a fast neutron to lose its most energy per collision?

a. H-1

b. B-10

c. C-12

d. U-235

Section A Rx Theory, Thermo, and Facility Characteristics

QUESTION A.17 [1.0 point]
Two common FISSION PRODUCTS that have especially large neutron capture cross sections and play a significant role in reactor physics. One is Sm-149 and the other is:

a. B-10

b. Ar-41

c. Xe-135

d. Cs-137

QUESTION A.18 [1.0 point]
Reactor is at 100 % power. The following graph shows the reactor time behavior following a reactor scram. Which ONE of the following best describes the transition of power between point A and B after the initial rod insertion? .

a. An immediate decrease in the prompt neutron fraction due to leakage, absorption, and a reduction in the fission rate

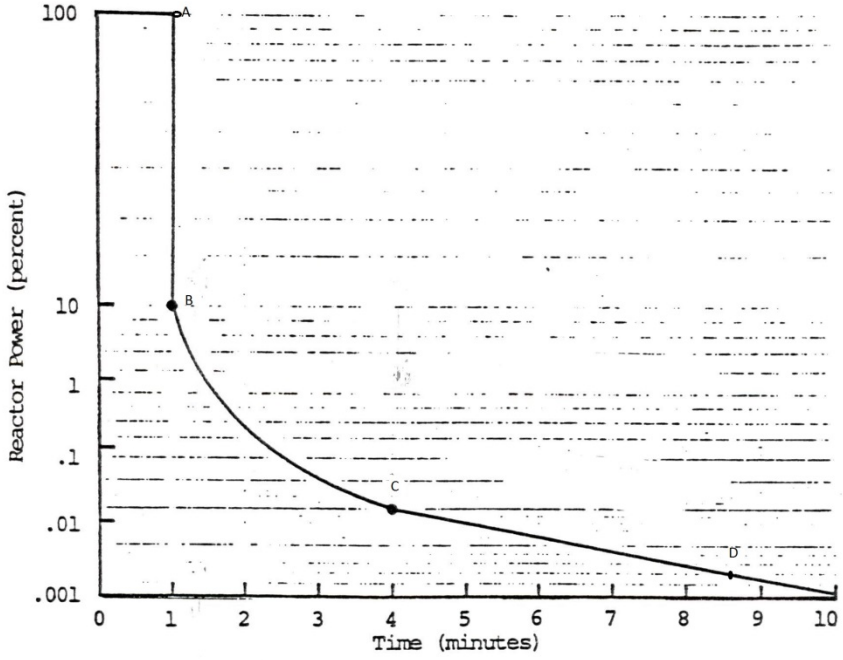
b. Fission product gases such as xenon begin to buildup causing the expansion of fuel density

c. The **longest** lived delayed neutron precursor begins to effect

d. The **short** lived delayed neutron precursors begin to effect

INTRODUCTION TO NUCLEAR REACTOR OPERATIONS
Reactor Kinetics
Reed Robert Burn
December 1988

Figure 4.3 Reactor Time Behavior Following a Reactor Scram



Section A ℞ Theory, Thermo, and Facility Characteristics

QUESTION A.19 [1.0 point]
Which ONE of the following physical characteristics of the TRIGA fuel is the main contributor for the prompt negative temperature coefficient?

a. As the fuel heats up the resonance absorption peaks broaden and increases the likelihood of neutron absorption in U-238

b. As the fuel heats up a rapid increase in moderator temperature occurs through conduction and convection heat transfer mechanisms which adds negative reactivity

c. As the fuel heats up fission product poisons (e.g., Xe) increase in concentration within the fuel matrix and add negative reactivity via neutron absorption

d. As the fuel heats up the oscillating hydrogen in the ZrH lattice imparts energy to a thermal neutron, thereby increasing its mean free path and probability of escape

********** End of Section A **********

Section B Normal, Emergency and Radiological Control Procedures

QUESTION B.01 [1.0 point]
Per UCI Emergency Classification, a significant seismic activity felt in the reactor facility is an example of:

a. Class 0, Events Less Severe Than the Lowest Category

b. Class 1, Notification of Unusual Events

c. Class 2, Alert

d. Class 3, Site Area Emergency

QUESTION B.02 [1.0 point]
The reactor is in a SHUTDOWN condition, as defined by UCI Technical Specifications, when:

a. all rods are inserted to the reactor core

b. the reactor is subcritical by at least $1.00 in the reference core condition, but EXCLUDED the reactivity worth of all installed experiments

c. the console key is OFF position and no work is in progress involving core fuel, core structure, installed control rods, or control rod drives

d. the reactor is subcritical by at least $1.00 in the reference core condition with the reactivity worth of all installed experiments INCLUDED

QUESTION B.03 [1.0 point, 0.25 each]
Match each of the Technical Specification Limits in column A with its corresponding value in column B. (Each limit has only one answer, values in Column B can be used once, more than once or not at all.)

Column A		Column B (limit shall not exceed)	
a.	Maximum excess reactivity	1.	$0.25
b.	Maximum movable experiment worth	2.	$0.50
c.	Minimum Shutdown Margin	3.	$1.00
d.	Maximum Reactivity Insertion in Pulse Mode	4.	$2.00
		5.	$3.00
		6.	$4.00

Section B Normal, Emergency and Radiological Control Procedures

QUESTION B.04 [1.0 point]
Assume an individual has received whole body occupational exposures of:

- 1 mrads of gamma
- 1 mrads of alpha

What would be the cumulative dose equivalent (H_T) in **mrem** for this individual?

a. 2 mrem

b. 11 mrem

c. 21 mrem

d. 31 mrem

QUESTION B.05 [1.0 point]
Assume that there is no leak to the outside of the demineralizer tank. You use a survey instrument with a window probe to measure the dose rate from the demineralizer tank. Compare to the reading with a window **CLOSED,** the reading with a window **OPEN** will :

a. increase, because it can receive an additional alpha radiation from (Al-27) (n,α), (Na-24) reaction

b. remain the same, because the Quality Factors for gamma and beta radiation are the same

c. increase, because the Quality Factor for beta and alpha is greater than for gamma

d. remain the same, because the survey instrument would not be detecting beta and alpha radiation from the tank

QUESTION B.06 [1.0 point]
Which ONE of the listed radioisotopes produces the highest ionizing energy gamma?

a. H^3

b. N^{16}

c. Ar^{41}

d. U^{235}

Section B Normal, Emergency and Radiological Control Procedures

QUESTION B.07 [1.0 point]
The radiation from an unshielded source is 1 rem/hr. When you insert 60 mm thickness of lead sheet, the radiation level reduces to 250 mrem/hr. What is the half-value-layer of lead? (HVL: thickness of lead required so that the original intensity will be reduced by half)?

a. 10 mm

b. 20 mm

c. 30 mm

d. 40 mm

QUESTION B.08 [1.0 point]
Which ONE of the following conditions is NOT a violation of a Limiting Condition for Operations?

a. Reactor operator conducted a pulse. The peak power reached 1000 MW

b. Reactor operator conducted a pulse during a repair of the facility ventilation system

c. During a reactor startup, high voltage to Wide Range Channel detector failed the Channel Test

d. Reactor operator withdrew the SHIM rod in the PULSE Mode

QUESTION B.09 [1.0 point]
A radioactive source reads 2 Rem/hr on contact. Five hours later, the same source reads 1.0 Rem/hr. How long is the time for the source to decay from a reading of 2 Rem/hr to 20 mRem/hr?

a. 8 hours

b. 16 hours

c. 33 hours

d. 41 hours

Section B Normal, Emergency and Radiological Control Procedures

QUESTION B.10 [1 point]
In the event of a suspected fuel leak, which ONE of the following nuclides would most likely be found in a Continuous Air Monitor?

a. Ar-41

b. Kr-85

c. N-16

d. Co-60

QUESTION B.11 [1.0 point]
Which ONE of the following materials shall NOT be irradiated at UCI?

a. Any fuel experiment

b. Any short half-life material

c. Any explosive material

d. A moveable experiment with $1.0 worth

QUESTION B.12 [1.0 point]
Exposing a 1 mCi check source to the continuous air monitor (CAM) detector to verify whether it is operable is considered to be _____.

a. a channel calibration

b. a channel check

c. a channel test

d. a channel validation

Section B Normal, Emergency and Radiological Control Procedures

QUESTION B.13 [1.0 point]
Which ONE of the following requires the NRC APPROVAL for changes?

a. Revise the Fuel Element Inspection Procedure

b Change a frequency of the requalification written examination from once per year to twice per year

c Delete one of the procedures listed in the Test and Maintenance Procedures

d Reduce a minimum of the Reactor Operations Committee from five to three members

QUESTION B.14 [1.0 point]
You perform a fuel element inspection. In measuring the lateral bend, you find the bend of one fuel element exceeds the original bend by 1/32 inches. For this measurement, you will:

a. continue the fuel inspection because this bend is within TS limit

b. continue the fuel inspection because the Technical Specifications require the elongation measurement only

c. stop the fuel inspection; you immediately report the result to the supervisor because it is considered a damaged fuel element

d stop the fuel inspection, you immediately report the result to the U.S. NRC since it is a reportable occurrence

QUESTION B.15 [1.0 point]
Fuel experiments shall be limited such that a MAXIMUM of the total radioactivity inventory of iodine isotopes 131 through 135 does NOT exceed _____.

a. 1.0 millicuries

b. 3.0 millicuries

c. 0.3 curies

d. 1.0 curies

Section B Normal, Emergency and Radiological Control Procedures

QUESTION B.16 [1.0 point]
Which ONE of the following modifications would be considered a "50.59" and the UCI Reactor Facility must file a request to NRC for change? The facility plans to:

a. Replace an identical control rod drive

b. Change a control rod worth calibration from stop watch to computer

c. Replace a fission chamber with a compensated ion chamber for the Wide Range Monitor (WRM) Channel

d. Measure a control rod drop time with new technique

QUESTION B.17 [1.0 point]
A significant loss of water occurs in the reactor pool during a rupture of the pool wall. Which ONE of the following is most likely the greatest concern as a result of this event?

a. Zirconium-Hydrides interact with oxygen in air, releasing explosive hydrogen gas due to TRIGA fuel overheat

b. Cladding rupture, fission products release

c. Groundwater contamination to the surrounding water table

d. Increased personnel exposure due to higher amounts of radiation

QUESTION B.18 [1.0 point]
"The reactor room shall contain a minimum free volume of 1,000 cubic feet." This is an example of :

a. Design Features

b. Surveillance Requirements

c. Limiting Conditions for Operation (LCO)

d. Limiting Safety System Setting (LSSS)

Section B Normal, Emergency and Radiological Control Procedures

QUESTION B.19 [1.0 point]
Which ONE of the following events does **NOT** require the presence of a licensed Senior Reactor Operator in the facility?

a. Fuel relocations within the core region

b. Initial start-up and approach to power

c. Insertion of experiment worth of $0.50

d. Restart following an unplanned shutdown

********** End of Section B **********

Section C Plant and Radiation Monitoring Systems

QUESTION C.01 [1.0 point]
The UCI Fast Transient Rod is located at:

a. B-ring.

b. C-ring.

c. D-ring

d. F-ring.

QUESTION C.02 [1.0 point]
Which **ONE** of the following is the actual design feature which prevents siphoning of primary water on a failure of the primary piping?

a. Signal from a float switch shuts off the primary pump

b. Signal from a float switch shuts a valve in the pump suction line

c. Level in the pool drops below the Net Positive Suction Head pressure minimum required to operate the pump

d. All components of the water piping on both systems are above pool water level

QUESTION C.03 [1.0 point]
Graphite inserts are placed in the top and bottom of the fuel element. Which **ONE** of the following best describes the function of these inserts?

a. Reduce gamma radiation

b. Increase fast neutron flux

c. Absorb fission product gases

d. Reduce neutron leakage

Section C Plant and Radiation Monitoring Systems

QUESTION C.04 [1.0 point]
Which **ONE** of the following substances is MAINLY used as the neutron absorber in the UCI control rods?

a. boron

b. zirconium-hydride

c. borated graphite

d. gold-indium-cadmium

QUESTION C.05 [1.0 point]
The low-source-interlock signal comes from:

a. Fuel Temperature Monitor

b. Wide Range Monitor

c. Wide Range Linear Monitor

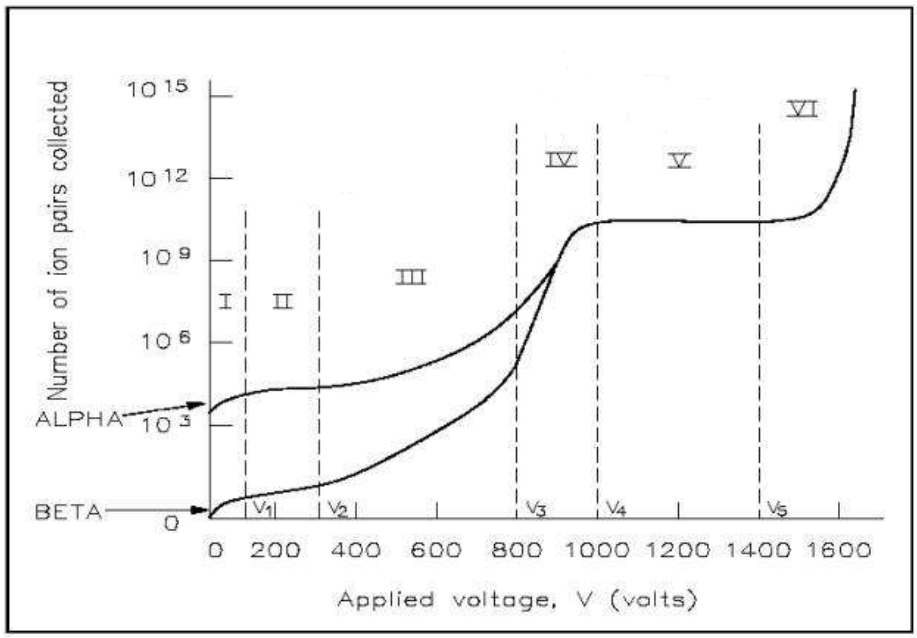
d. Power Range Monitor

QUESTION C.06 [1.0 point, 0.25 each]
Reactor is in operation. Match the input signals listed in column A with their AUTOMATICAL responses listed in column B. (Items in column B may be used more than once or not at all.)

Column A		Column B	
a.	Pool water temperature = 75 °F	1.	Normal Operation
b.	Withdraw SHIM Rod in Pulse Mode	2.	Alarm ONLY
c.	Wide Range Linear Channel = 110% power	3.	Interlock
d.	Wide Range Monitor Detector HV failure	4.	Scram (with or without Alarm)

Section C Plant and Radiation Monitoring Systems

QUESTION C.07 [1 point]
The figure below is an example of the gas ionization curve for gas-filled detectors. Which of the following ROMAN NUMERALS corresponds to the GEIGER-MUELLER REGION?



a. Region II

b. Region III

c. Region IV

d. Region V

QUESTION C.08 [1.0 point]
A neutron flux will activate isotopes in air. The primary isotope we worry about in the pneumatic transfer system is …

a. N^{16} (O^{16} (n,p) N^{16}).

b. Kr^{80} (Kr^{79} (n, γ) kr^{80}).

c. Ar^{41} (Ar^{40} (n, γ) Ar^{41}).

d. H^{2} (H^{1} (n, γ) H^{2}).

Section C Plant and Radiation Monitoring Systems

QUESTION C.09 [1.0 point]
Which ONE of the following is the correct parameter used for the calibration of control rods by positive period method at UCI? The operator will stabilize the reactor power and determine:

a. count rate vs. K-effective

b. temperature vs. period

c. pool level vs. coolant flow

d. reactivity vs. rod height

QUESTION C.10 [1.0 point]
Which ONE of the following best describes the thermocouples in the instrumented fuel elements (IFE)? There consists of:

a. two chromel-alumel thermocouples embedded at the midpoint and one inch above vertical center in the IFE.

b. three chromel-alumel thermocouples embedded at the midpoint, one inch above, and below vertical center in the IFE.

c. two Resistance Temperature Detectors (RTDs) embedded at the midpoint and one inch below vertical center in the IFE.

d. three platinum-rhodium thermocouples embedded at the midpoint, one inch above, and below vertical center in the IFE.

QUESTION C.11 [1.0 point]
The surveillance requirement for the channel calibration by the calorimetric method shall be conducted:

a. monthly

b. quarterly

c. semi-annually

d. annually

Section C Plant and Radiation Monitoring Systems

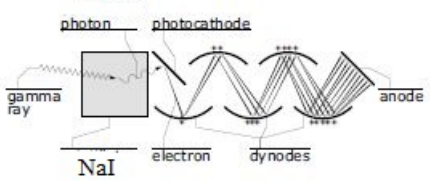
QUESTION C.12 [1.0 point]
The figure attached is a basic design of :

a. Thermoluminescent Dosimeter (TLD)

b. Film badge

c. Pocket ionization chamber

d. Scintillation detector



QUESTION C.13 [1.0 point]
Which ONE of the following is the best description on how the Compensated Ion Chamber (CIC) operates?

	Material used in CIC	Interact with	Results
a.	Pu-239 +	neutron	B-10 + alpha --> N-14 + gamma
b.	B-10 +	neutron	B-11 --> Li-7 + alpha
c.	U-235 +	neutron	Fission fragments + gamma
d.	Am-239 +	neutron	Be-9 + gamma --> Li-8 + beta

Section C Plant and Radiation Monitoring Systems

QUESTION C.14 [1.0 point]
In an event of a loss of normal electrical power, an emergency diesel generator will **not** distribute its power to:

a. CAM system

b. Coolant pumps

c. RAM system

d. Emergency lightning in the control room

QUESTION C.15 [1.0 point]
You conducted a control drop test for a SHIM rod. Which ONE of the following is the MOST acceptable value?

a. 1500 msec

b. 1000 msec

c. 800 msec

d. 50 msec

QUESTION C.16 [1.0 point]
Which ONE of the following is the main function performed by the **DISCRIMINATOR** circuit in the Wide Range Monitor Channel?

a. To convert the signal from a fission counter to **LINEAR** output over a range of 10^{-8} to 150 percent of full power.

b. To convert the signal logarithmic output of the metering circuit to a δt (delta time) output for period metering purposes.

c. To filter out small pulses due to gamma interactions, passing only pulses due to neutron events within the Wide Range Monitor Channel.

d. To generate a current signal equal and of opposite polarity as the signal due to gamma generated within the Wide Range Monitor Channel.

Section C Plant and Radiation Monitoring Systems

QUESTION C.17 [1.0 point]
The UCI fuel element contains:

a. a mixture of U-**Zn**-O alloy with a maximum of 9.0 weight percent uranium which has a maximum enrichment of 20 percent

b. a mixture of U-**Zn**-H alloy with a maximum of 20 weight percent uranium which has a maximum enrichment of 9 percent

c. a mixture of U-**Zr**-O alloy with a maximum of 20 weight percent uranium which has a maximum enrichment of 9 percent

d. a mixture of U-**Zr**-H alloy with a maximum of 9.0 weight percent uranium which has a maximum enrichment of 20 percent

QUESTION C.18 [1.0 point]
The reactor operator places the CAM in the EMERGENCY ALARM MODE. Which ONE of the following is the correct mode of ventilation system?

a. Fume hood: ON; Main air inlets: ON; purge exhaust fan: ON

b. Fume hood: OFF; Main air inlets: OFF; purge exhaust fan: ON

c. Fume hood: ON; Main air inlets: ON; purge exhaust fan: OFF

d. Fume hood: OFF; Main air inlets: OFF; purge exhaust fan: OFF

Section C Plant and Radiation Monitoring Systems

QUESTION C.19 [1.0 point]
Which ONE of the following can trip the Transient control rod interlock when a steady state mode is selected?

a. SHIM rod drive DOWN and SHIM control rod DOWN

b. Pneumatic cylinder DOWN and supply air energized

c. SHIM rod drive UP and SHIM control rod DOWN

d. Pneumatic cylinder UP and supply air energized

********** End of Section C **********
********** End of the Exam **********

Section A Rx Theory, Thermo, and Facility Characteristics

Answer Key

A.01
Answer d
Reference: Burn, R., *Introduction to Nuclear Reactor Operations,* © 1988, Sec 4.6, page 4-17.

A.02
Answer: d
Reference: Burn, R., *Introduction of Nuclear Reactor Operations*, © 1988, Sec 4.2

A.03
Answer: b
Reference: $P = P_0 e^{-t/T} = 1 \text{ kW} \mid e^{(60sec/-80sec)} = 1 \text{ kW} * e^{-0.75} = 0.472 \mid 1 \text{ kW} = 0.47 \text{ kW}$

A.04
Answer: b
Reference: Burn, R., *Introduction to Nuclear Reactor Operations,* © 1988, Sec 3.2.1, page 3-5.

A.05
Answer: d
Reference: Burn, R., *Introduction to Nuclear Reactor Operations,* © 1982, Sec 3.3.3, page 3-21.
$\Delta\rho$ reactor A = $(Keff_1-Keff_2)/(Keff_1*Keff_2)$. (0.2-0.1)/(0.2*0.1) = 5 $\Delta k/k$
$\Delta\rho$ reactor B = $(Keff_1-Keff_2)/(Keff_1*Keff_2)$. (0.9-0.8)/(0.9*0.8) = 0.139 $\Delta k/k$
5/0.139 = 36

A.06
Answer: c
Reference: Burn, R., *Introduction of Nuclear Reactor Operations*, © 1988, Sec 3.3

A.07
Answer: d
Reference: Burn, R., *Introduction to Nuclear Reactor Operations,* © 1982, Page 4-21.

A.08
Answer d
Reference: DOE Fundamentals Handbook *Nuclear Physics and Reactor Theory Vol. 2*

Section A ℞ Theory, Thermo, and Facility Characteristics

A.09
Answer: b
Reference: $P=P_o e^{t/\tau}$ $3=1* e^{t/32}$ t = 32 sec*ln(3) = 35.2 sec

A.10
Answer: c
Reference: Time is related to ratio of final power to initial power. 2:1 is the largest ratio.

A.11
Answer: c
Reference: Burn, R., *Introduction to Nuclear Reactor Operations,* © 1982, Sec 3.2.

A.12
Answer: a
Reference: K eff = 1.03*0.84*0.96*0.88*1.96*x
X= 1/1.4326 = 0.698

A.13
Answer c
Reference: Standard NRC question

A.14
Answer: c
Reference: from k=0.955 to criticality (k=1), ρρ = (k-1)/k = -0.047 ρk/k or ρρ = 0.047 ρk/k needed to reach criticality. From criticality to JUST prompt, ρk/k = βeff required, so minimum reactivity added to produce prompt criticality will be: 0.047+0.007= 0.054

A.15
Answer: b
Reference: CR = S/(1-K) → CR = 100/(1 - .9) = 1000 N/sec

A.16
Answer: a
Reference: Burn, R., *Introduction of Nuclear Reactor Operations*, © 1988, Sec 2.4.5

A.17
Answer c
Reference: Burn, R., Introduction to Nuclear Reactor Operations, © 1988, Sec 8.1

Section A ℞ Theory, Thermo, and Facility Characteristics

A.18
Answer: a
Reference: Burn, R., Introduction to Nuclear Reactor Operations, ©4.5, 1988

A.19
Answer: d
Reference: TRIGA Fuel Design

Answer Key

B.01
Answer: b
Reference: EP 4.2

B.02
Answer: d
Reference: TS 1.1

B.03
Answer: a(5) b(3) c(2) d(5)
Reference: TS 3.1

B.04
Answer: c

Qualify factor(Q) - adjusts absorbed dose to dose equivalent
Q = 1 for x, gamma or beta
Q = 20 for alphas and other heavy particles
Q = 10 for neutrons of unknown energy; table 1004(b).2. is for known energies
Q = 10 for high-energy protons

Reference: 10 CFR 20

B.05
Answer: d
Reference: BASIC Radiological Concept (Betas and alpha don't make through the demineralizer tank)

B.06
Answer: b
Reference: Chart of the Nuclides

B.07
Answer: c
Reference: $DR = DR_{\circ} * e^{-\mu X}$
Find μ : $250 = 1000 * e^{-\mu * 60}$; μ = 0.0231
If insertion of an HVL (thickness of lead), the original intensity will be reduced by half.
Find X: $1 = 2 * e^{-0.0231 * X}$; X= 30 mm
Find HVL by shortcut:
1000mR- 500 mR is the 1st HVL
500 mR – 250 mR is the 2nd HVL
So HVL=60mm/2 = 30 mm

Section B Normal, Emergency and Radiological Control Procedures

B.08
Answer: a
Reference: TS 3.3 and 3.4

B.09
Answer: c
Reference: $DR = DR_{\circ} * e^{-\lambda t}$
$1 \text{ rem/hr} = 2 \text{ rem/hr} * e^{-\lambda(5hr)}$
$\text{Ln}(1.0/2) = -\lambda * 5 \rightarrow$ $\lambda = 0.1386$; solve for t: $\text{Ln}(.02/2) = -0.1386\ (t) \rightarrow t = 33$ hours

B.10
Answer: b
Reference: NRC standard question for TRIGA design

B.11
Answer: d
Reference: TS 3.1 and 3.8

B.12
Answer: c
Reference: TS 1.2

B.13
Answer: d
Reference: TS 6.2 (TS changes required an amendment)

B.14
Answer: a
Reference: TS 4.1

B.15
Answer: c
Reference: TS 3.8

B.16
Answer: c
Reference: 10 CFR 50.59

B.17
Answer: d
Reference: NRC Standard Question

Section B Normal, Emergency and Radiological Control Procedures

B.18
Answer: a
Reference: TS 5.2

B.19
Answer: c
Reference: TS Section 6.1.3d

Answer Key

C.01
Answer: d
Reference: SAR 4.5.5

C.02
Answer: d
Reference: SAR13.4.1, page 13-15

C.03
Answer: d
Reference: SAR 4.2

C.04
Answer: c
Reference: SAR 4.3.1

C.05
Answer: b
Reference: UCI Instruction Manual for Operators, Section 6.4.1

C.06
Answer: a(1) b(3) c(4) d(4)
Reference: SAR 7.2

C.07
Answer: d
Reference: Bevelacqua, J. Basic Health Physics

C.08
Answer: c
Reference: UCI Training Manual 10.3.2

C.09
Answer: d
Reference: NRC Standard Question

C.10
Answer: b
Reference: NRC Standard Question

C.11
Answer: d
Reference: TS 4.3

Section C Plant and Radiation Monitoring Systems

C.12
Answer: d
Reference: UCI Training Manual 7.1.2

C.13
Answer: b
Reference: UCI Training Manual 7.1.1.4

C.14
Answer: b
Reference: Instruction Manual for Operators, Sec 4.9

C.15
Answer: c
Reference: Technical Specifications 3.1 (d is within a TS but it is too short)

C.16
Answer: c
Reference: SAR 6.2.1

C.17
Answer: d
Reference: UCI Instruction Manual for Operators, Section 5.2

C.18
Answer: b
Reference: UCI SOP, Section 4.7.3

C.19
Answer: d
Reference: UCI Instruction Manual for Operators, Section 6.3.2

**********END OF THE EXAM **********