February 16, 2017

Dr. George E. Miller, Reactor Supervisor
Nuclear Reactor Facility
Department of Chemistry
1102 Natural Sciences 2
University of California, Irvine
Irvine, CA 92697-2025

SUBJECT: EXAMINATION REPORT NO. 50-326/OL-17-01, UNIVERSITY OF CALIFORNIA - IRVINE

Dear Dr. Miller:

During the week of December 12, 2016, the U.S. Nuclear Regulatory Commission (NRC) administered an operator licensing examination at your University of California - Irvine research 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 those members of your staff identified in the enclosed report 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 (PARS) 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 NRC is forwarding the individual grades to you in a separate letter which will not be released publicly. Should you have any questions concerning this examination, please contact Mr. John T. Nguyen at (301) 415-4007 or via internet e-mail John.Nguyen@nrc.gov.

Sincerely,
/RA/

Anthony J. Mendiola, 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-17-01
2. Written examination

cc: Jonathan T. Wallick, UCINRF
cc: w/o enclosures: See next page

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NAME	JNguyen	ABaxter	AMendolia
DATE	01/03/2017	01/23/2017	02/16/2017

OFFICIAL RECORD COPY

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

REPORT NO.: 50-326/OL-17-01

FACILITY DOCKET NO.: 50-326

FACILITY LICENSE NO.: R-116

FACILITY: Triga

EXAMINATION DATES: December 12-15, 2016

SUBUCITED BY: /RA/ 01/03/17
John T. Nguyen, Chief Examiner Date

SUMMARY:
During the week of December 12, 2016, the NRC administered operator licensing examinations to four Reactor Operator (RO) and one Senior Reactor Operator Upgrade (SROU) candidates. All candidates passed the examinations.

REPORT DETAILS

1. Examiners: John T. Nguyen, Chief Examiner, NRC

2. Results:

	RO PASS/FAIL	SRO PASS/FAIL	TOTAL PASS/FAIL
Written	4/0	0/0	4/0
Operating Tests	4/0	1/0	5/0
Overall	4/0	1/0	5/0

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

At the conclusion of the meeting, the NRC Examiner thanked the facility for their support in the administration of the examinations. The facility licensee had no comments on the written examination. The examiner noticed that all candidates were well prepared for the examinations.

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

FACILITY: Pool

REACTOR TYPE: TRIGA

DATE ADMINISTERED: 12/13/2016

CANDIDATE: ______________________

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

CATEGORY VALUE	**% OF TOTAL**	**CANDIDATE'S SCORE**	**% OF CATEGORY VALUE**	**CATEGORY**
20.00	**33.3**	____________	_____	**A. REACTOR THEORY, THERMODYNAMICS AND FACILITY OPERATING CHARACTERISTICS**
20.00	**33.3**	____________	_____	**B. NORMAL AND EMERGENCY OPERATING PROCEDURES AND RADIOLOGICAL CONTROLS**
20.00	**33.3**	____________	_____	**C. FACILITY AND RADIATION MONITORING SYSTEMS**
60.00		____________ **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 ___ (0.25 each)

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 ___

A20 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 ___ (0.25 each)

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

B04 a b c d ___

B05 a b c d ___

B06 a ___ b ___ c ___ d ___ (0.25 each)

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 ___ (0.25 each)

B16 a b c d ___

B17 a b c d ___

B18 a ___ b ___ c ___ d ___ (0.25 each)

B19 a b c d ___

B20 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 ___ (0.5 each)

C06 a b c d ___

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 UCI 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 <u>only</u> 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

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

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

$$\lambda^* = 1 \times 10^{-4} \text{ seconds}$$

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

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

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

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

$$M = \frac{1 - K_{eff_0}}{1 - K_{eff_1}}$$

$$M = \frac{1}{1 - K_{eff}} = \frac{CR_1}{CR_2}$$

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

$$P = P_0 \, e^{\frac{t}{T}}$$

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

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

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

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

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

$$T_{\text{‰}} = \frac{0.693}{\lambda}$$

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

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

$$DR = \frac{6CiE(n)}{R^2}$$

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

$\lambda_{eff} = 0.1/sec$

---

1 Curie = $3.7x10^{10}$ dps	1 kg = 2.21 lbm
1 hp = $2.54x10^{3}$ BTU/hr	1 Mw = $3.41x10^{6}$ BTU/hr
1 BTU = 778 ft-lbf	°F = 9/5°C + 32
931 Mev = 1 amu	°C = 5/9 (°F - 32)

QUESTION A.01 [1.0 point]
Which ONE of the following isotopes has the largest microscopic absorption cross-section for thermal neutrons?

a. Sm^{149}

b. U^{235}

c. Xe^{135}

d. B^{10}

QUESTION A.02 [1.0 point]
You're increasing reactor power on a steady +10 second period. How long will it take to increase power by a factor of 10?

a. 10 seconds

b. 23 seconds

c. 33 seconds

d. 43 seconds

QUESTION A.03 [1.0 point]
You are conducting a reactor startup after installing 2 new fuel assemblies in the core. Given the following rod withdrawal data, estimate the rod position when criticality would occur. The initial count rate on the nuclear instrumentation prior to rod withdrawal is 55 cps.

a. 11 in

b. 13 in

c. 15 in

d. 18 in

Rod Withdrawal (Inches)	Count Rate (cps)
0	55
2	58
4	60
6	61
8	69
10	85
12	275

QUESTION A.04 [1.0 point]
Reactor operator performs a $1.35 pulse. Which ONE of the following best describes the values of K_{eff} and ρ during the power increment?

a. $K_{eff} = 1$ and $\rho = 1$

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

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

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

QUESTION A.05 [1.0 point]
If the multiplication factor, k, is increased from 0.800 to 0.950, the amount of reactivity added is:

a. 0.150

b. 0.163

c. 0.184

d. 0.197

QUESTION A.06 [1.0 point]
Which ONE of the following correctly describes the SIX- FACTOR FORMULA at the UCI reactor? The multiplication factor between generation, K-effective, is the product of k-infinitive and the:

a. Reproduction factor

b. Thermal utilization factor

c. Resonance escape probability

d. Total non-leakage probability

QUESTION A.07 [1.0 point]
A number of neutrons in the tritium nucleus ($_1T^3$ or $_1H^3$) is:

a. 1

b. 2

c. 3

d. 4

QUESTION A.08 [1.0 point]
The reactor is critical at 10 W. A rod is pulled to insert a positive reactivity of $0.18. Which ONE of the following will be the stable reactor period as a result of this reactivity insertion? Given beta effective = 0.007

a. 10 seconds

b. 46 seconds

c. 55 seconds

d. 66 seconds

QUESTION A.09 [1.0 point]
Which ONE of the following is the MINIMUM amount of reactivity that makes the UCI (**finite)** critical reactor to be a prompt critical reactor? This MINIMUM amount is equal to:

a. the shutdown margin

b. the k-effective value

c. 1.0 % ΔK/K

d. the β-effective value

QUESTION A.10 [1.0 point]
A few minutes following a reactor scram, the reactor period has stabilized and the power level is decreasing at a CONSTANT rate. What is a reactor power level two minutes later from 1 kW?

a. 803 W

b. 223 W

c. 94 W

d. 54 W

QUESTION A.11 [1.0 point]
Reactor A increases power from 10% to 30% with a period of 25 seconds. Reactor B increases power from 70% to 100% with a period of also 25 seconds. Compared to Reactor A, the time required for the power increase of Reactor B is:

a. longer than A

b. exactly the same as A

c. twice that of A

d. shorter than A

QUESTION A.12 [1.0 point, 0.25 each]
Match the following Neutron Interactions in Column A with the appropriate definition in Column B (each used only once)

Column A	Column B
a. Fission	1. Neutron enters nucleus, forms a compound nucleus, then decays by gamma emission
b. Radiative capture	2. Particle enters nucleus, forms a compound nucleus and is excited enough to eject a new particle with incident neutron remaining in nucleus
c. Scattering	3. Nucleus absorbs neutron and splits into two similarly sized parts
d. Particle ejection	4. Nucleus is struck by a neutron and emits a single neutron

QUESTION A.13 [1.0 point]
Which ONE of the following types of neutrons has a mean neutron generation time of 12.5 seconds?

a. Prompt

b. Delayed

c. Fast

d. Thermal

QUESTION A.14 [1.0 point]
The following shows part of a decay chain for the radioactive element Pa-234:
$_{91}Pa^{234} \rightarrow {}_{92}U^{234}$
This decay chain is an example of _______ decay.

a. Alpha

b. Beta

c. Gamma

d. Neutron

QUESTION A.15 [1.0 point]
Given the following Core Reactivity Data (not at UCI):

Control Rod	Total Worth ($)	Worth Removed ($) (reactor at 10 watts)
Rod 1	1.60	1.60
Rod 2	3.00	1.80
Rod 3	2.70	1.70
Rod 4	1.20	0.80

Which one of the following is the calculated shutdown margin that would satisfy the Technical Specification Minimum Shutdown Margin? Assume that all rods are scrammable.

a. 2.6

b. 2.9

c. 5.9

d. 8.5

QUESTION A.16 [1.0 point]
Which ONE of the following describes the term **PROMPT JUMP**?

a. A reactor is subcritical at negative 80-second period

b. A reactor has attained criticality on prompt neutrons alone

c. The instantaneous change in power level due to inserting a control rod

d. The instantaneous change in power level due to withdrawing a control rod

QUESTION A.17 [1.0 point]
Which ONE of the following is a correct statement describing prompt and delayed neutrons? Prompt neutrons:

a. are released during U-238 interacts with fast neutrons, while delayed neutrons are released during U-235 interacts with thermal neutrons

b. account for less than 1% of the neutron population, while delayed neutrons account for the rest

c. are released during the fission process, while delayed neutrons are released during the decay process

d. are the dominating factor in determining reactor period, while delayed neutrons have no effect on reactor period

QUESTION A.18 [1.0 point]
What is the condition of the reactor when $k = \frac{1}{1-\beta}$?

a. Subcritical

b. Critical

c. Super critical

d. Prompt critical

QUESTION A.19 [1.0 point]
Which ONE of the following conditions will INCREASE the shutdown margin of a reactor?

a. Lowering moderator temperature (assume negative temperature coefficient)

b. Insertion of a positive reactivity worth experiment

c. Burnout of a burnable poison

d. Fuel depletion

QUESTION A.20 [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 CATEGORY A *****)

Section B Normal/Emergency Procedures and Radiological Controls

QUESTION B.01 [1.0 point]
Per UCI Emergency Plan, the individual who is responsible for the termination of an emergency related to the nuclear operations is the:

a. UCI Police Chief

b. USNRC

c. UCI Radiation Protection Officer

d. UCI Incident Commander

QUESTION B.02 [1.0 points, 0.25 each]
Match the radiation reading from Column A with its corresponding radiation area classification (per 10 CFR 20) listed in Column B. Answer in Column B can be used more than once, or not at all.

	Column A	Column B
a.	1 mrem/hr at 30 cm	1. Public Area
b.	50 mrem/hr at 30 cm	2. Radiation Area
c.	20 mrem/hr at 1 m	3. High Radiation Area
d.	5.5 grays/hr at 1 m	4. Very High Radiation Area

QUESTION B.03 [1.0 point, 0.25 each]
Identify each of the following surveillances as a channel check (**CHECK)**, a channel test (**TEST)**, or a channel calibration (**CAL)**.

a. During the startup, you verify a reactor high voltage scram

b. During the startup, you verify the reactor interlock system by performing simultaneous manual withdrawal of two control rods

c. During reactor operation, you compare readings of a reactor power

d. Adjust the Linear Power Channel in accordance with recent data collected on the reactor thermal power calibration

QUESTION B.04 [1.0 point]
A room contains a source which, when exposed, results in a general area dose rate of 175 millirem per hour. This source is scheduled to be exposed continuously for 35 days. Select an acceptable method for controlling radiation exposure from the source within this room.

a. Lock the room to prevent inadvertent entry into the room

b. Equip the room with a device to monitor who entries into the room

c. Equip the room with a motion detector that will alarm in the control room

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

QUESTION B.05 [1.0 point]
An annual channel calibration of the radiation monitoring systems was performed. Which ONE of the following is the latest the test that must be performed again?

a. 7.5 months after

b. 14 months after

c. 16 months after

d. 24 months after

QUESTION B.06 [1.0 point, 0.25 each]
Fill out the blanks for the Technical Specification trip level setting.

	Safety Channel		Function and trip level setting
a.	Fuel Element Temperature	1.	Scram ≤ ______ °C
b.	Reactor Power level	2.	Scram ≤ ______ kw(t)
c.	Preset Timer	3.	Scram pulse rods < ______ seconds after pulse
d.	Pool Water Temperature	4.	Manual scram if greater than ______ °C

Section B Normal/Emergency Procedures and Radiological Controls

QUESTION B.07 [1.0 point]
Per UCI Tech. Spec, which ONE of the following will violate the Limiting Safety System Settings?

a. An unanticipated change in reactivity of two dollars

b. Instrumented fuel temperature exceeds 430 °C

c. Steady State power exceeds 275 kw(t)

d. Reactivity insertion pulse exceeds $3.00

QUESTION B.08 [1.0 point]
Which ONE of the following changes must be submitted to NRC for approval prior to implementation?

a. Replace a primary cooling pump with an identical pump

b. Add new limitation to the Pre-Startup Checklist Procedure

c. Add more responsibilities to the Radiation Protection Officer listed in the health physics procedure

d. Delete a definition of Channel Test listed in the UCI Technical Specifications

QUESTION B.09 [1.0 point]
What is the **HALF LIFE** of the isotope contained in a sample which produces the following count rates?

Time (Minutes)	Counts per Minute (cpm)
Initial count	840
30	740
60	615
90	512
180	270

a. 310 minutes

b. 210 minutes

c. 110 minutes

d. 60 minutes

Section C Facility and Radiation Monitoring Systems

QUESTION B.10 [1.0 point]
In order to ensure the health and safety of the public, 10CFR50 allows the operator to deviate from SOPs. What is the minimum level of authorization needed to deviate from SOPs?

a. Reactor Director

b. Reactor Supervisor

c. Licensed Senior Reactor Operator

d. Licensed Reactor Operator

QUESTION B.11 [1.0 point]
An example of Byproduct Material would be:

a. Pu-239

b. U-238

c. U-235

d. Xe-135

QUESTION B.12 [1.0 point]
A three-curie source, emitted 100% of 1 Mev gamma, is to be stored in the reactor building. How far from the source should a HIGH RADIATION AREA sign be posted?

a. 7 feet

b. 13 feet

c. 25 feet

d. 34 feet

Section C Facility and Radiation Monitoring Systems

QUESTION B.13 [1.0 point]
Which ONE of the following statements describes the basis for the Technical Specifications limit on the maximum power level to initiate a pulse?

a. To prevent power peaking effects

b. To allow the maximum allowed worth of the pulse rod without exceeding the safety limit

c. To allow the negative feedback coefficient of the fuel to turn power prior to exceeding the Limiting Safety System Setting

d. To prevent exceeding the maximum pool water temperature setting

QUESTION B.14 [1.0 point]
The OPERATIONS BOUNDARY is defined as:

a. the area within Rowland Hall, comprising five rooms:B54,B54A, B54B, B62, and B62A

b. the entire Rowland Hall building

c. the reactor bay and control room

d. the Rowland Hall and Frederick Reines Hall

QUESTION B.15 [1.0 point, 0.25 each]
Match type of radiation listed in column A with their quality factor listed in column B. Items in column B can be used once, more than once or not at all.

	Column A		Column B
a.	X-ray	1.	1
b.	Gamma	2.	5
c.	Alpha particles	3.	10
d.	High-energy photons	4.	20

Section C Facility and Radiation Monitoring Systems

QUESTION B.16 [1.0 point]
Which ONE of the following is the definition of Total Effective Dose Equivalent (TEDE)?

a. The sum of thyroid dose and external dose

b. The sum of the external deep dose and the organ dose

c. The sum of the deep dose equivalent and the committed effective dose equivalent

d. The dose that your whole body is received from the source, but excluded from the deep dose

QUESTION B.17 [1.0 point]
According to UCI procedures and Technical Specifications, which ONE of the following is NOT considered an UNSHEDULED SHUTDOWN?

a. During a pulse operation, a reactor scram is within two seconds after pressing a “fire” button

b. Suddenly loss of the high voltage supplied to the safety channels and caused all the safety rods to scram

c. The operator was not watching the reactor power increase and caused all the control rods to scram

d. The operator inadvertently leaned on the scram bar with their elbow and caused all the control rods to scram

QUESTION B.18 [1.0 point, 0.25 each]
Match the events listed in column A with its emergency classification listed in column B. Items in column B can be used once, more than once or not at all.

	Column A	Column B
a.	You drop a TLD into the reactor pool	1. Less Severe than the Lowest Category
b.	Fire in the reactor room	2. Unusual Event
c.	Earthquake causing the level of pool water dropped to 4 feet above the reactor core and RAM alarm	3. Alert
d.	Severe failure of fuel cladding, causing significant releases of radioactive material	

QUESTION B.19 [1.0 point]
Per UCI Tech. Spec, a minimum total exhaust flow rate from the reactor room is ______ cubic feet per minute (cfm).

a. 1800

b. 3600

c. 4500

d. 5200

QUESTION B.20 [1.0 point]
Reactor Operator works in a high radiation area for eight (8) hours a day. The dose rate in the area is 280 mR/hour. Which ONE of the following is the MAXIMUM number of days in which Reactor Operator may perform his duties WITHOUT exceeding 10 CFR 20 limits?

a. 1 days

b. 2 days

c. 3 days

d. 4 days

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

Section C Facility and Radiation Monitoring Systems

QUESTION C.01 [1.0 point]
Given the following sequence of events during the course of pulsing for the Adjustable Transient Rod (ATR):

(1) The steady state power = 1.5 watts
(2) Power is applied to the pulse integrator
(3) The mode selector in the pulse mode
(4) A preset time sets at 2 seconds

Reactor operator initiates a pulse by pressing the fire button. Which ONE of the following sequences of events takes place?

a. The transient rod air energizes. When the ATR anvil reaches its limit position, it will de-energize. The ATR drops back into the core and the transient cylinder automatically drives down.

b. The transient rod air energizes and de-energizes in 2 seconds. The ATR drops back into the core and the transient cylinder automatically drives down.

c. The transient rod air energizes and immediately de-energizes in 100 msec. The ATR drops back into the core and the transient cylinder stays at the same location.

d. The transient rod air energizes and then de-energizes in 2 second. The ATR drops back into the core and the cylinder stay at the same location.

QUESTION C.02 [1.0 point]
The reactor operator is preparing for the Reactor Power Calibration. Which ONE of the following prerequisites is NOT required prior to the calibration?

a. Completing a normal start-up

b. Removing any non-fixed experiments

c. Reducing the reactor pool temperature below 18.5 °C

d. Verifying the shutdown margin is greater than $1.00

Section C Facility and Radiation Monitoring Systems

QUESTION C.03 [1.0 point]
The fuel element used at UCI reactor is a mixture of U-**Zr**-H alloy:

a. containing 8.5% weight of uranium enriched to 20% U^{235}

b. containing 20% weight of uranium enriched to 8.5% U^{235}

c. containing 10% weight of uranium enriched to 30% U^{235}

d. containing 30% weight of uranium enriched to 10% U^{235}

QUESTION C.04 [1.0 point]
During reactor operation, which ONE of the following is the MAIN reason for not operating the coolant pumps in dry (no prime of water) for no longer than two minutes?

a. Increasing the amount of Ar-41 released to the reactor bay

b. Increasing the amount of N-16 in the reactor pool

c. Damaging the pump

d. Damaging the coolant pipes

QUESTION C.05 [2.0 points, 0.5 each]
Match the input signals listed in column A with their AUTOMATIC Control Systems responses (reactor will automatically response when exceeding the conditions) in column B. (Items in column B may be used once, more than once or not at all). Assume that the reactor is in operation.

	Column A		Column B
a.	Pool water temperature = 26 °C	1.	Indication ONLY
b.	Wide Rang Power Level Channel (log) = 1.0 X10^{-7} % of full power	2.	Rod withdraw prohibit
c.	Seismic motion = 4%g	3.	Scram
d.	Withdrawal of shim rod during a pulse mode	4.	Rod run-in

Section C Facility and Radiation Monitoring Systems

QUESTION C.06 [1.0 point]
Which ONE of the following reactor safety system provides a reactor scram in any mode of operation?

a. fuel temperature

b. Preset timer

c. Reactor power level

d. Pool conductivity

QUESTION C.07 [1 point]
Which ONE of the following has a fuel follower control rod (FFCR)?

a. FTR rod

b. ATR rod

c. SHIM rod

d. UCI reactor does NOT have any FFCR

QUESTION C.08 [1.0 point]
Which ONE of the following best describes on how the Uncompensated Ion Chamber (UIC) and Compensated Ion Chamber (CIC) operate?

a. The CIC has two chambers, both can sense gamma rays but only one is coated with boron-10 for (n,α) reaction; whereas the UIC has only one chamber coated with boron-10 for (n,α) reaction.

b. The CIC has two chambers, one is coated with U-235 for fission reaction and the other is coated with boron-10 for (n,α) reaction; whereas the UIC has only one chamber coated with U-235 for fission reaction.

c. The CIC has only one chamber coated with boron-10 for (n,α) reaction; whereas the UIC has two chambers, one is coated with U-235 for fission reaction and the other is coated with boron-10 for (n,α) reaction.

d. The CIC has only one chamber coated with U-235 for fission reaction, whereas the UIC has two chambers, both can sense gamma rays but only one is coated with boron-10 for (n,α) reaction.

Section C Facility and Radiation Monitoring Systems

QUESTION C.09 [1.0 point]
Nominal Hydrogen- Zirconium atom ratio in the UCI TRIGA LEU fuel elements is:

a. 1.65 H atoms to 1.0 Zr atom

b. 1.0 H atom to 1.65 Zr atoms

c. 8.5 H atoms to 20 Zr atoms

d. 10 H atoms to 30 Zr atoms

QUESTION C.10 [1.0 point]
Significant quantities of Nitrogen-16 are produced by the irradiation of :

a. air in the beam ports

b. oxygen-16 in the reactor pool

c. air in irradiation cell

d. Ar-40 in the rabbit system

QUESTION C.11 [1.0 point]
The Main purpose for setting a conductivity limit of the pool water is to:

a. Maintain the departure of nucleate boiling ratio (DNBR) greater than the unity

b. Minimize the possibility of corrosion of the cladding on the fuel elements

c. Extend integrity of resin bed on the demineralizer

d. Minimize Ar-41 released to the public

Section C Facility and Radiation Monitoring Systems

QUESTION C.12 [1.0 point]
Which ONE of the following channels will display the Peak Power (nv) and Energy (nvt) data?

a. Power Range Monitor

b. Wide Range Linear Power Monitor

c. Wide Range Monitor

d. Dual-pen strip chart recorder

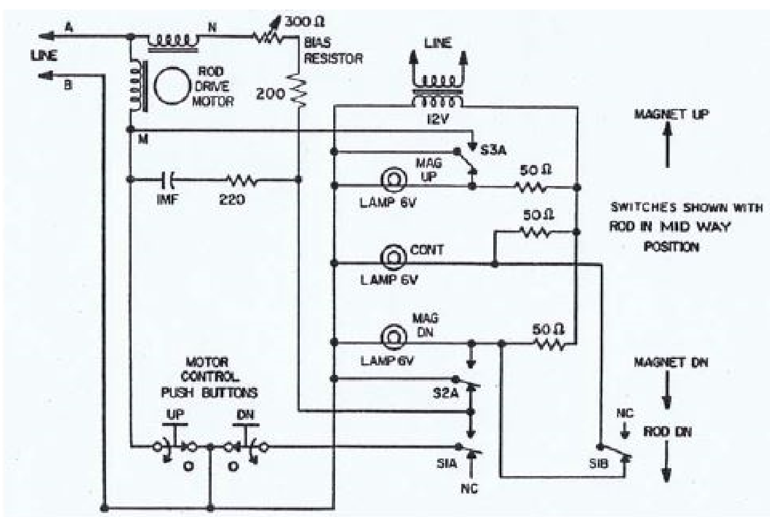
QUESTION C.13 [1.0 point]
The figure below depicts:

a. Fuel temperature scram schematic

b. ATR control rod drive schematic

c. FTR control rod drive schematic

d. SHIM and REG control rod drive schematic



QUESTION C.14 [1.0 point]
25 mm increase in the pool water level corresponds about _______ gallons of water added to the pool.

a. 25

b. 80

c. 120

d. 160

QUESTION C.15 [1.0 point]
Per UCI Tech Spec, the k-eff limit in the fuel storage is less than _____ for all conditions of moderation and reflection.

a. 0.9

b. 0.8

c. 0.7

d. 0.6

QUESTION C.16 [1.0 point]
An illuminated YELLOW light alarm on an iR7040 indicates:

a. calibration is required

b. battery power has switched OFF

c. the unit may be failing or malfunctioning

d. alert for radiation level in its immediate area

QUESTION C.17 [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. Pneumatic system blower: ON; Fume hood: ON; purge exhaust fan: ON

b. Pneumatic system blower: OFF; Fume hood: OFF; purge exhaust fan: ON

c. Pneumatic system blower: ON; Fume hood: ON; purge exhaust fan: OFF

d. Pneumatic system blower: OFF; Fume hood: OFF; purge exhaust fan: OFF

QUESTION C.18 [1.0 point]
Given the configuration of the LIGHTS associated with the SHIM rod/drive as follows: UP: OFF, DOWN: ON, CONT/ON: OFF, and no failure of switch lights. Identify the condition of the SHIM rod.

a. Normal condition, rod insertion permissible

b. Abnormal condition, misadjusted rod down limit switch

c. Normal condition, either rod insertion or withdrawal permissible

d. Abnormal condition, rod has stuck above lower limit switch

QUESTION C.19 [1.0 point]
Which ONE of the following can cause the ATR rod interlock when the steady state mode is selected?

a. SHIM rod drive DOWN and SHIM control rod DOWN

b. Pneumatic cylinder DOWN and FIRE button depressed

c. SHIM rod drive UP and SHIM control rod DOWN

d. Pneumatic cylinder UP and FIRE button depressed

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

Section A L Theory, Thermo & Fac. Operating Characteristics

A.01
Answer c
Reference: Introduction to Nuclear Operation, Reed Burn, 1988, Sec 8.1

A.02
Answer: b
Reference: ln (P/P_0) × period = time, ln(10) × 10 = 2.30 × 10 = 23 seconds

A.03
Answer: b
Reference: Burn, R., *Introduction to Nuclear Reactor Operations,* © 1982, Sec 5.5

A.04
Answer: d
Reference: Burn, R., *Introduction of Nuclear Reactor Operations*, © 1988, Sec 4.2

A.05
Answer: d
Reference: Burn, R., *Introduction to Nuclear Reactor Operations,* © 1982, Sec 3.3.3, page 3-21.
In order to solve the question A.05, the applicant can use one of the following methods:
At k=0.8; ρ = ∆Keff/Keff or ρ = Keff-1/Keff = -0.2/0.8 =-0.25. At k=0.95, ρ =-0.05/0.95
ρ = -0.053. The difference between ρ is the answer ,i.e. -0.053-(-0.25)=0.197
∆ ρ = ρ1 – ρ2 where ρ1 = Keff1-1/Keff1 and ρ2 = Keff2-1/Keff2. Substitute ρ1 and ρ2 with Keff1 and Keff2 into the equation above, the result is ∆ρ = keff1-keff2/(keff1 x keff2) = 0.95-0.8 /(0.8*0.95)=0.197

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

A.07
Answer: b
Reference: Nuclides and Isotopes
Z=1, A=3 , N=2

A.08
Answer: b
Reference:
Reactivity added = $0.18 x .007 = 0.00126

$$\tau = (\beta-\rho)/\lambda_{eff}\rho = \frac{.007 - .00126}{(.1)\,(.00126)} = 45.6 \text{ seconds}$$

A.09
Answer: d
Reference: Burn, R., *Introduction of Nuclear Reactor Operations*, © 1988, Sec 4.6

Section A L Theory, Thermo & Fac. Operating Characteristics

A.10
Answer: b
Reference: P = P0 $e^{-t/T}$ = 1 kW * e(120sec/-80sec) = 1 kW * exp(-1.5) = 0.22 * 1 kW = 0.223 kW = 223 W

A.11
Answer: d
Reference: The power of reactor A increases by a factor of 3, while the power of reactor B increases by a factor of 1.43. Since the periods are the same (rate of change is the same), power increase of reactor B takes a shorter time.

A.12
Answer: a (3) b (1) c (4) d (2)
Reference: DOE Fundamentals Handbook *Nuclear Physics and Reactor Theory*, Volume 1, Module 1, Page 43-46

A.13
Answer b
Reference: Burn, R., *Introduction to Nuclear Reactor Operations,* © 1988, Sec 3.2 & 3.3

A.14
Answer: b
Reference: Chart of the Nuclides

A.15
Answer: b
Reference: Minimum SDM = Sum(B) - Max. (A) = $5.90 - $3.0 = $2.9

A.16
Answer: d
Reference: Burn, R., *Introduction to Nuclear Reactor Operations,* © 1982, Page 4-21.

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

A.18
Answer: d
Reference: LaMarsh, Introduction to Nuclear Engineering, Page 340-341
$(1-\beta)k=1$ manipulated reads $k=1/(1-\beta)$

A.19
Answer: d
Reference: Decreasing the reactivity worth in the core, it will increase the shutdown margin.

A.20
Answer: d
Reference: TRIGA Fuel Design

Section B Normal/Emergency Procedures and Radiological Controls

B.01
Answer: d
Reference: EP 3.8

B.02
Answer: a(1); b(2); c(3); d(4)
Reference: 10 CFR 20.1003 Definitions
For part c, 20 mrem/hr at 1m will be equal to 222 mrem/hr at 30 cm :=> high radiation area
5.5 grays→ 550 rad/hr at 1 m ➔ very high radiation area
Definition
High Radiation Area: 100 mrem/hr at 30 cm
Radiation Area : 5 mrem/hr at 30 cm
Very High Radiation Area: 500 rads/hr at 1 m

B.03
Answer: a = TEST; b = TEST; c = CHECK; d = CAL
Reference: UCI Technical specification, Definitions

B.04
Answer: a
Reference: 10CFR20.1601(a)(3)

B.05
Answer: b
Reference: TS Definitions: Annual- interval: NOT to exceed 15 months

B.06
Answer: a, 425 b,275 c,15 d,25
Reference: TS 3.2.3

B.07
Answer: b
Reference: TS 2.2

B.08
Answer: d
Reference: 10 CFR 50.59

B.09
Answer: c
Reference: $A = A_o e^{-\lambda t}$
$270 = 840e^{-180\lambda}$, $180\lambda = -\ln(0.321)$, $\lambda = 0.00631\ min^{-1}$
$t_{1/2} = 0.693 / \lambda$, $= 0.693 / 0.00631\ min^{-1} = 109.8$ minutes

B.10
Answer: c
Reference: 10CFR50.54(y)

Section B Normal/Emergency Procedures and Radiological Controls

B.11
Answer: d
Reference: Byproduct material is any radioactive material (except special nuclear material) made radioactive by the process of producing or using special nuclear material. 10 CFR Part 20.1003

B.12
Answer: b
Reference: 6CEN = R/hr @ 1 ft. -> 6 x 3 x 1 x 1 = 18 R/hr at 1ft. $I_0D_0^2 = I*D^2$
18 R/hr*(1 ft)^2 = 0.1 R/hr *D ^{2}
D= sqrt(18/0.1) = 13.4 ft.

B.13
Answer: b
Reference: TS 3.1.4, Basis

B.14
Answer: a
Reference: EP 2.0

B.15
Answer: a(1) b(1) c(4) d(3)
Reference: 10 CFR 20

B.16
Answer: c
Reference: 10 CFR 20.1003

B.17
Answer: a
Reference: NRC Standard Question

B.18
Answer: a(1) b(2) c(3) d(3)
Reference: EP 4.1, EP 4.2, and EP 4.3

B.19
Answer: b
Reference: TS 3.5

B.20
Answer: b
Reference: 10CFR20.1201(a)(1) $\left[\frac{5000\text{ mr x 1 hr x day}}{280\text{ mr} \quad 8\text{ hr}}\right]$ = 2.23 days

Section C Facility and Radiation Monitoring Systems

C.01
Answer: d
Reference: UCI Instruction Manual for Operators, Section 6.3.2

C.02
Answer: d
Reference: UCI SOP, Section 4.3

C.03
Answer: a
Reference: UCI Instruction Manual for Operators, Section 5.2

C.04
Answer: c
Reference: NRC Standard Question

C.05
Answer: a(1) b(2) c(3) d(2)
Reference: TS 3.2

C.06
Answer: a
Reference: TS 3.2.3

C.07
Answer: c
Reference: UCI Instruction Manual for Operators, Section 5.3.1

C.08
Answer: a
Reference: NRC Standard Question

C.09
Answer: a
Reference: TS 5.2

C.10
Answer: b
Reference: NRC Standard Question

C.11
Answer: b
Reference: TS 3.3.3 Basis

C.12
Answer: a
Reference: UCI Instruction Manual for Operators, Section 6.2

Section C Facility and Radiation Monitoring Systems

C.13
Answer: d
Reference: UCI Instruction Manual for Operators, Section 6.3

C.14
Answer: b
Reference: UCI Instruction Manual for Operators, Section 5.6.3

C.15
Answer: b
Reference: TS 5.4

C.16
Answer: d
Reference: UCI Instruction Manual for Operators, Section 8.7.2

C.17
Answer: b
Reference: UCI SOP, Section 4.7.3

C.18
Answer: b
Reference: UCI Instruction Manual for Operators, Table 6.1

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