



UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

July 5, 2019

Professor Enrique Lavernia
Provost and Executive Vice Chancellor
University of California, Irvine
509 Aldrich Hall
Irvine, CA 92697-2025

SUBJECT: EXAMINATION REPORT NO. 50-326/OL-19-01, UNIVERSITY OF CALIFORNIA - IRVINE

Dear Professor Lavernia:

During the week of June 3, 2019, the U.S. Nuclear Regulatory Commission (NRC) administered an operator licensing examination at your University of California – Irvine (UCI) 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,

A handwritten signature in black ink, appearing to read "Anthony J. Mendiola".

Anthony J. Mendiola, Chief
Research and Test Reactors Oversight Branch
Division of Licensing Projects
Office of Nuclear Reactor Regulation

Docket No. 50-326

Enclosures:

1. Examination Report No. 50-326/OL-19-01
2. Written examination

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

University of California - Irvine

Docket No. 50-326

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

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

Test, Research and Training
Reactor Newsletter
Attention: Amber Johnson
Dept of Materials Science and Engineering
University of Maryland
4418 Stadium Drive
College Park, MD 20742-2115

Dr. Howard Gilman, Chancellor
University of California, Irvine
510 Aldrich Hall
Irvine, CA 92697

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

REPORT NO.: 50-326/OL-19-01

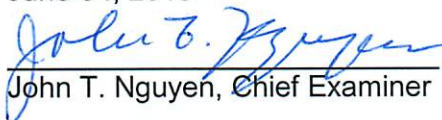
FACILITY DOCKET NO.: 50-326

FACILITY LICENSE NO.: R-116

FACILITY: TRIGA

EXAMINATION DATES: June 04, 2019

SUBMITTED BY:


John T. Nguyen, Chief Examiner

06/18/2019
Date

SUMMARY:

During the week of June 3, 2019, the NRC administered an operator licensing examination to one Reactor Operator (RO) candidate. The candidate passed all applicable portions of the examination.

REPORT DETAILS

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

2. Results:

	RO PASS/FAIL	SRO PASS/FAIL	TOTAL PASS/FAIL
Written	1/0	N/A	1/0
Operating Tests	1/0	N/A	1/0
Overall	1/0	N/A	1/0

3. Exit Meeting:

John T. Nguyen, Chief Examiner, NRC
Jonathan T. Wallick, UCI, Training Supervisor

Per discussion with the facility, prior to administration of the examination, adjustments were accepted. At the conclusion of the meeting, the NRC Examiner thanked the facility for their support during the administration of the examinations. The examiner noticed that the candidate was well prepared for the examinations.

ENCLOSURE 1

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

FACILITY: University of California - Irvine

REACTOR TYPE: Pool

DATE ADMINISTERED: 06/04/2019

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.

<u>CATEGORY</u>	<u>% OF</u>	<u>CANDIDATE'S</u>	<u>% OF</u>	<u>CATEGORY</u>
<u>VALUE</u>	<u>TOTAL</u>	<u>SCORE</u>	<u>VALUE</u>	<u>CATEGORY</u>
<u>20.00</u>	<u>33.3</u>	_____	_____	A. REACTOR THEORY, THERMODYNAMICS AND FACILITY OPERATING CHARACTERISTICS
<u>20.00</u>	<u>33.3</u>	_____	_____	B. NORMAL AND EMERGENCY OPERATING PROCEDURES AND RADIOLOGICAL CONTROLS
<u>20.00</u>	<u>33.3</u>	_____	_____	C. FACILITY AND RADIATION MONITORING SYSTEMS
<u>60.00</u>		_____	_____	% TOTALS
		FINAL GRADE		

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

Candidate's Signature

Category A – Reactor Theory, Thermodynamics, & Facility Operating Characteristics

ANSWER SHEET

Multiple Choice (Circle or X your choice)

If you change your Answer, write your selection in the blank.

A01 a ___ b ___ c ___ d ___ (0.25 each)

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 ___

A20 a b c d ___

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

Category B – Normal/Emergency Operating Procedures and Radiological Controls

ANSWER SHEET

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 ____

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 ____ (0.25 each)

B11 a b c d ____

B12 a b c d ____

B13 a ____ b ____ c ____ d ____ (0.5 each)

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

ANSWER SHEET

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 ____ (0.5 each)

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 ____ (0.25 each)

(***** 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

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

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

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

$$P = P_0 e^{t/\tau}$$

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

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

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

$$CR_1 (1 - K_{\text{eff}1}) = CR_2 (1 - K_{\text{eff}2})$$

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

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

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

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

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

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

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

$$T_{\frac{1}{2}} = \frac{0.693}{\Delta \rho} \frac{K_{\text{eff}2} - K_{\text{eff}1}}{K_{\text{eff}1} K_{\text{eff}2}}$$

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

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

$$DR_1 d_1^2 = DR_2 d_2^2$$

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

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

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

1 Curie = 3.7 x 10¹⁰ dis/sec

1 kg = 2.21 lb

1 Horsepower = 2.54 x 10³ BTU/hr

1 Mw = 3.41 x 10⁶ BTU/hr

1 BTU = 778 ft-lb

°F = 9/5 °C + 32

1 gal (H₂O) ≈ 8 lb

°C = 5/9 (°F - 32)

c_p = 1.0 BTU/hr/lb/°F

c_p = 1 cal/sec/gm/°C

Category A: Reactor Theory, Thermodynamics, and Facility Operating Characteristics

QUESTION A.01 [1.0 point, 0.25 each]

Identify whether each of the following conditions will INCREASE or DECREASE the shutdown margin of a reactor.

- a. Burnout of a burnable poison.
- b. Insertion of cadmium (Cd) experiment to the reactor core.
- c. Moving one fuel element from reactor core to fuel storage.
- d. Decreasing moderator temperature (assume negative temperature coefficient).

QUESTION A.02 [1.0 point]

What is the difference between prompt and delayed neutrons?

- a. Prompt neutrons are released during fast fission while delayed neutrons are released during thermal fissions.
- b. Prompt neutrons are released directly from fission within $\sim 10^{-13}$ seconds, whereas delayed neutrons are emitted following the beta decay of a fission fragment.
- c. Prompt neutrons are released virtually instantaneously, and delayed neutrons are a very small fraction of the total number of neutrons and do not have an important role in the control of the reactor.
- d. Prompt neutrons are 99% of the neutron produced in fission and are therefore the dominating factor in determining the reactor period, whereas delayed neutrons account for less than 1% of the neutron population and have little effect on the reactor period.

QUESTION A.03 [1.0 point]

The reactor is critical at 10 watts. A control rod is withdrawn to insert a positive reactivity of 0.140% $\Delta k/k$. Which ONE of the following will be the stable reactor period because of this reactivity insertion? Given beta effective = 0.007 and neglect the negative temperature coefficient

- a. 10 seconds
- b. 40 seconds
- c. 55 seconds
- d. 80 seconds

Category A: Reactor Theory, Thermodynamics, and Facility Operating Characteristics

QUESTION A.04 [1.0 point]

For the alpha decay of a nuclide, the number of protons will _____ and its atomic mass number will _____.

- a. increase by 2 / increase by 2
- b. decrease by 2 / decrease by 4
- c. decrease by 2 / decrease by 2
- d. increase by 2 / increase by 4

QUESTION A.05 [1.0 point]

Which ONE of the following best describes the likelihood of fission occurring in U-235 and U-238?

- a. Neutrons at low energy levels (eV) are more likely to cause fission with U-235 than neutrons at higher energy levels (MeV).
- b. Neutron cross section of U-235 increases with increasing neutron energy, whereas neutron cross section of U-238 decreases with increasing neutron energy.
- c. Neutrons at low energy levels (eV) are more likely to cause fission with U-238 than neutrons at higher energy levels (MeV).
- d. Neutron cross sections of U-235 and U-238 are independent from the neutron energy levels.

QUESTION A.06 [1.0 point]

Reactor operator performs a \$1.20 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 $\beta\text{-eff} < \rho < 1$
- c. $K_{eff} > 1$ and $0 < \rho < \beta\text{-eff}$
- d. $K_{eff} = 1$ and $-1 < \rho < 0$

Category A: Reactor Theory, Thermodynamics, and Facility Operating Characteristics

QUESTION A.07 [1.0 point]

Reactor power is 10 watts. Reactor Operator inserts a sample worth of $0.006 \Delta k/k$ into the reactor core. Which ONE of the following best describes the reactor kinetic? The reactor is:

- a. subcritical.
- b. critical.
- c. supercritical.
- d. prompt critical.

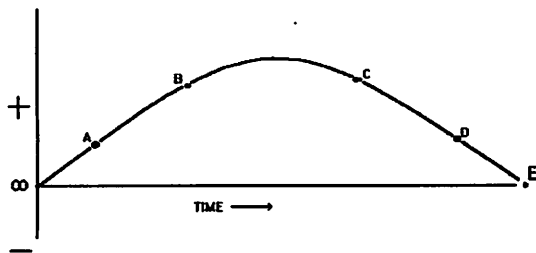
QUESTION A.08 [1.0 point]

Reactor power is rising on a 10 second period. Approximately how long will it take for power to quadruple?

- a. 14 seconds
- b. 29 seconds
- c. 55 seconds
- d. 72 seconds

QUESTION A.09 [1.0 point]

Shown below is a trace of reactor period as a function of time. Between points B and E reactor power is:



- a. constant.
- b. continually increasing.
- c. increasing, then constant.
- d. increasing, decreasing, then constant.

Category A: Reactor Theory, Thermodynamics, and Facility Operating Characteristics

QUESTION A.10 [1.0 point]

Given source strength of 1000 neutrons per second (N/sec) and a multiplication factor of 0.8, which ONE of the following is the expected stable neutron count rate?

- a. 700 N/sec
- b. 5000 N/sec
- c. 10000 N/sec
- d. 20000 N/sec

QUESTION A.11 [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 $\Delta k/k$
- b. 0.197 $\Delta k/k$
- c. 0.250 $\Delta k/k$
- d. 0.297 $\Delta k/k$

QUESTION A.12 [1.0 point]

You're increasing reactor power on a steady +52 second period. How long will it take to increase power by a factor of 10?

- a. 2 minute
- b. 5 minutes
- c. 10 minutes
- d. 20 minutes

Category A: Reactor Theory, Thermodynamics, and Facility Operating Characteristics

QUESTION A.13 [1.0 point]

A reactor is slightly supercritical with the thermal utilization factor = 0.900. 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. 0.898
- b. 0.900
- c. 0.902
- d. 0.904

QUESTION A.14 [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.15 [1.0 point]

Which ONE of the following atoms will cause a neutron to lose the most energy in an elastic collision?

- a. U-238
- b. Ar-40
- c. O-16
- d. H-1

Category A: Reactor Theory, Thermodynamics, and Facility Operating Characteristics

QUESTION A.16 [1.0 point]

Calculate the shutdown margin by the Technical Specifications. Assume that all control rods are scrammable. Given the following worth:

ρ_{excess}	= \$0.90
Rod #1	= \$1.05
Rod # 2	= \$1.35
Rod # 3	= \$2.25

- a. \$1.25
- b. \$1.50
- c. \$2.50
- d. \$3.75

QUESTION A.17 [1.0 point]

Which ONE of the following is the stable reactor period which will result in a power rise from 10% to 100% power in 10 seconds?

- a. 4 seconds
- b. 10 seconds
- c. 24 seconds
- d. 43 seconds

QUESTION A.18 [1.0 point]

Which ONE of the following factors in the "six factor formula" is the MOST affected by the MODERATOR?

- a. Fast fission factor
- b. Reproduction factor
- c. Thermal utilization factor
- d. Fast non leakage probability

Category A: Reactor Theory, Thermodynamics, and Facility Operating Characteristics

QUESTION A.19 [1.0 point]

Delayed neutrons are produced by:

- a. decay of N-16
- b. Pair Production process
- c. decay of fission fragments
- d. directly from the fission

QUESTION A.20 [1.0 point]

A reactor with $K_{\text{eff}} = 0.8$ contributes 1000 neutrons in the first generation. Changing from the FIRST generation to THIRD generation, the TOTAL neutrons after the third generation are between:

- a. 1000 – 1500 neutrons
- b. 2000 – 2500 neutrons
- c. 3000 – 3500 neutrons
- d. 4000 – 4500 neutrons

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

Category B: Normal/Emergency Operating Procedures and Radiological Controls

QUESTION B.01 [1.0 point]

Per University of California-Irvine (UCI) Technical Specifications (TS), changes to existing experiments or classes shall be made only after review by:

- a. Radiation Safety Officer Only.
- b. Senior Reactor Operator and Reactor Operations Committee.
- c. Reactor Operations Committee and the Reactor Director.
- d. Radiation Safety Officer and Reactor Operations Committee.

QUESTION B.02 [1.0 point]

How long will it take a 2 Curie source, with a half-life of 2 year, to decay to 0.2 Curie?

- a. 4.6 Years
- b. 6.6 Years
- c. 10.6 Years
- d. 16.6 Years

QUESTION B.03 [1.0 point]

An irradiated sample provides a dose rate of 0.5 rem/hr at 5 ft. Approximately how far from the sample reads 5 mrem/hr?

- a. 15 ft.
- b. 25 ft.
- c. 50 ft.
- d. 75 ft.

Category B: Normal/Emergency Operating Procedures and Radiological Controls

QUESTION B.04 [1.0 point]

The CURIE content of a radioactive source is a measure of:

- a. number of radioactive atoms in the source.
- b. number of nuclear disintegrations per unit time.
- c. amount of damage to soft body tissue per unit time.
- d. amount of energy emitted per unit time by the source.

QUESTION B.05 [1.0 point]

Per UCI Technical Specifications, a minimum radiation monitoring instruments required to be operable are:

- a. 1 Radiation Area Monitor (RAM) + 1 Continuous Air Particulate Monitor (CAM)
- b. 1 Portable Radiation Monitor + 1 CAM
- c. 2 RAMs + 1 CAM
- d. 1 RAM + 2 CAM

QUESTION B.06 [1.0 point, 0.25 each]

Fill out the blanks with the Limiting Conditions of Operation (LCO) listed in the UCI Technical Specifications.

<u>Safety System</u>	<u>LCO</u>
a. Core excess reactivity	_____ (\$) (2.5/3.0/3.5)
b. Steady State reactor power	_____ KW (200/250/275)
c. Reactivity Worth of both Transient rods	_____ (\$) 2.50/2.75/3.00
d. Pool water conductivity	_____ micromhs/cm (1/3/5)

Category B: Normal/Emergency Operating Procedures and Radiological Controls

QUESTION B.07 [1.0 point]

You are currently the licensed operator at UCI reactor. Which ONE of the following will violate 10 CFR Part 55.53 "Conditions of licenses"?

- a. Last licensed renewal was 60 months ago.
- b. Last requalification operating test was 18 months ago.
- c. Last quarter you were the licensed operator for 5 hours.
- d. Last requalification written examination was 18 months ago.

QUESTION B.08 [1.0 point]

According to the UCI Emergency Plan, who is the first person that should be contacted if there is a vague threat of disorder?

- a. UCI Police
- b. Facility Director
- c. Senior Reactor Operator
- d. Reactor Operator

QUESTION B.09 [1.0 point]

The dose rate from a mixed beta-gamma point source reads 100 mrem/hour at one (1) foot and reads 0.1 mrem/hour at ten (10) feet. What percentage of the source consists of beta radiation?

- a. 30%
- b. 50%
- c. 70%
- d. 90%

Category B: Normal/Emergency Operating Procedures and Radiological Controls

QUESTION B.10 [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 reactor operation, you compare reading of radiation monitors.
- b. During the startup, you verify the reactor interlock system by performing simultaneous manual withdrawal of two control rods.
- c. During the startup, you verify a 1 kW interlock for pulse mode operation.
- d. Adjust the Wide Range Linear Monitor set point with recent data collected on the calibration.

QUESTION B.11 [1.0 point]

Which ONE of the following experiments is not allowed to be installed in the reactor or experiment facilities under ANY condition? The experiment:

- a. contains corrosive materials.
- b. contains 15 milligrams of TNT material.
- c. has a secured experiment worth of \$2.0.
- d. has a single, movable experiment worth of \$1.0.

QUESTION B.12 [1.0 point]

In accordance with 10CFR20.1301, individual members of the public are limited to a TEDE in one year of:

- a. 50 mrem.
- b. 100 mrem.
- c. 500 mrem.
- d. 1250 mrem.

Category B: Normal/Emergency Operating Procedures and Radiological Controls

QUESTION B.13 [2.0 points, 0.5 each]

Identify each of the following as either a Safety Limit (SL) a Limiting Safety System Setting (LSSS) or a Limiting Condition for Operation (LCO).

- a. The temperature in a stainless steel-clad TRIGA LEU fuel element shall not exceed 1000°C under any conditions of operation.
- b. The reactor power level shall not exceed 250 kW during steady state operation.
- c. The standard instrumented fuel temperatures which shall be in the B2, B4, C5, C6, or C7 shall not be greater than 425°C.
- d. The scram time for any control rods shall be lesser than 1 second.

QUESTION B.14 [1.0 point]

To ensure the health and safety of the public, 10CFR50 allows the operator to deviate from Technical Specifications. What is the minimum level of authorization needed to deviate from Technical Specifications?

- a. UCI Reactor Operations Committee
- b. UCI Reactor Director
- c. UCI Licensed Senior Reactor Operator.
- d. UCI Licensed Reactor Operator.

QUESTION B.15 [1.0 point]

Which ONE of the following statements correctly describes the relationship between the Safety Limit (SL) and the Limiting Safety System Setting (LSSS)?

- a. The SL is a maximum operationally limiting value that prevents exceeding the LSSS during normal operations.
- b. The SL is a parameter that assures the integrity of the fuel cladding. The LSSS initiates protective actions to preclude reaching the SL.
- c. The SL is a maximum setpoint for instrumentation response. The LSSS is the minimum number of channels required to be operable.
- d. The LSSS is a parameter that assures the integrity of the fuel cladding. The SL initiates protective action to preclude reaching the LSSS.

Category B: Normal/Emergency Operating Procedures and Radiological Controls

QUESTION B.16 [1.0 point]

All applicants for an RO or SRO license must submit NRC Form 396 and 398 to the U.S. NRC before taking the examinations. This requirement is specified in 10 CFR:

- a. Part 19
- b. Part 20
- c. Part 50
- d. Part 55

QUESTION B.17 [1.0 point]

According to UCI procedures and Technical Specifications, which ONE of the following is NOT considered an UNSCHEDULED SHUTDOWN?

- a. During a pulse operation, a reactor scram is within one seconds after pressing a "fire" button.
- b. Suddenly loss of the electrical power and caused all the safety rods to scram.
- c. The operator was not watching the reactor period and caused all the control rods to scram
- d. The operator inadvertently presses on a scram bar during power increase and caused all the control rods to scram.

QUESTION B.18 [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 because 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

Category B: Normal/Emergency Operating Procedures and Radiological Controls

QUESTION B.19 [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}

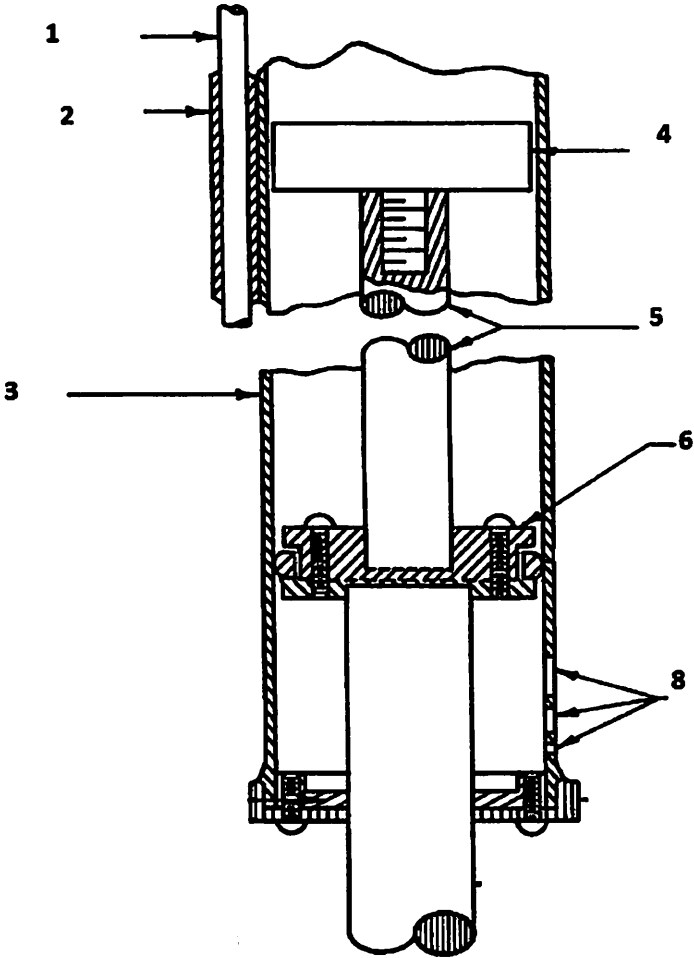
(***** END OF CATEGORY B *****)

Category C: Facility and Radiation Monitoring Systems

QUESTION C.01 [1.0 point]

The following diagram depicts the rack and pinion drive for standard rod. Which ONE of the following numbers correctly describes the Armature?

- a. 1
- b. 4
- c. 6
- d. 5



Category C: Facility and Radiation Monitoring Systems

QUESTION C.02 [1.0 point]

Which ONE of the control rods is in the F-ring?

- a. SHIM
- b. REG
- c. ATR
- d. FTR

QUESTION C.03 [1.0 point]

If a presence of ____ found in the reactor pool, it is a potential of fuel cladding failure.

- a. Br-81
- b. Co-60
- c. Ar-41
- d. N-16

QUESTION C.04 [1.0 point]

The reactivity worth of a new experiment shall be verified at a power level _____, before reactor operation at higher power with the experiment.

- a. less than 2 watts
- b. 5 watts
- c. 10 watts
- d. higher than 10 watts

Category C: Facility and Radiation Monitoring Systems

QUESTION C.05 [2.0 points, 0.5 each]

Identify whether each of the following Reactor Safety Channels shall be effective in the Steady State (SS) mode, the Pulse mode (PULSE), or both modes (BOTH).

- a. Preset Timer
- b. Pool Water Temperature
- c. Reactor Power Level
- d. Fuel Element Temperature

QUESTION C.06 [1.0 point]

The main purpose of the fuel followers installed in the control rods is to:

- a. decrease the fast neutron flux in the core.
- b. enhance their control characteristics.
- c. increase the core excess reactivity in the reactor core.
- d. increase the effectiveness for reactor pulsing.

QUESTION C.07 [1.0 point]

Which ONE of the following channels will display the Peak Power (nv) and Energy (nvt) data?

- a. Wide Range Monitor
- b. Wide Range Linear Power Monitor
- c. Power Range Monitor
- d. Dual-pen strip chart recorder

Category C: Facility and Radiation Monitoring Systems

QUESTION C.08 [1.0 point]

The Safety control rod is partially withdrawn from the core. At this point, the conductivity meter indicates 5 micromhos/cm. As a result:

- a. the control rod cannot be withdrawn any further.
- b. the control rod cannot be inserted any further.
- c. the reactor will scram.
- d. the reactor is normal.

QUESTION C.09 [2.0 points, 0.5 each]

Reactor is in operation. Match the input signals listed in column A with their AUTOMATIC responses listed in column B. (Items in column B may be used more than once or not at all.)

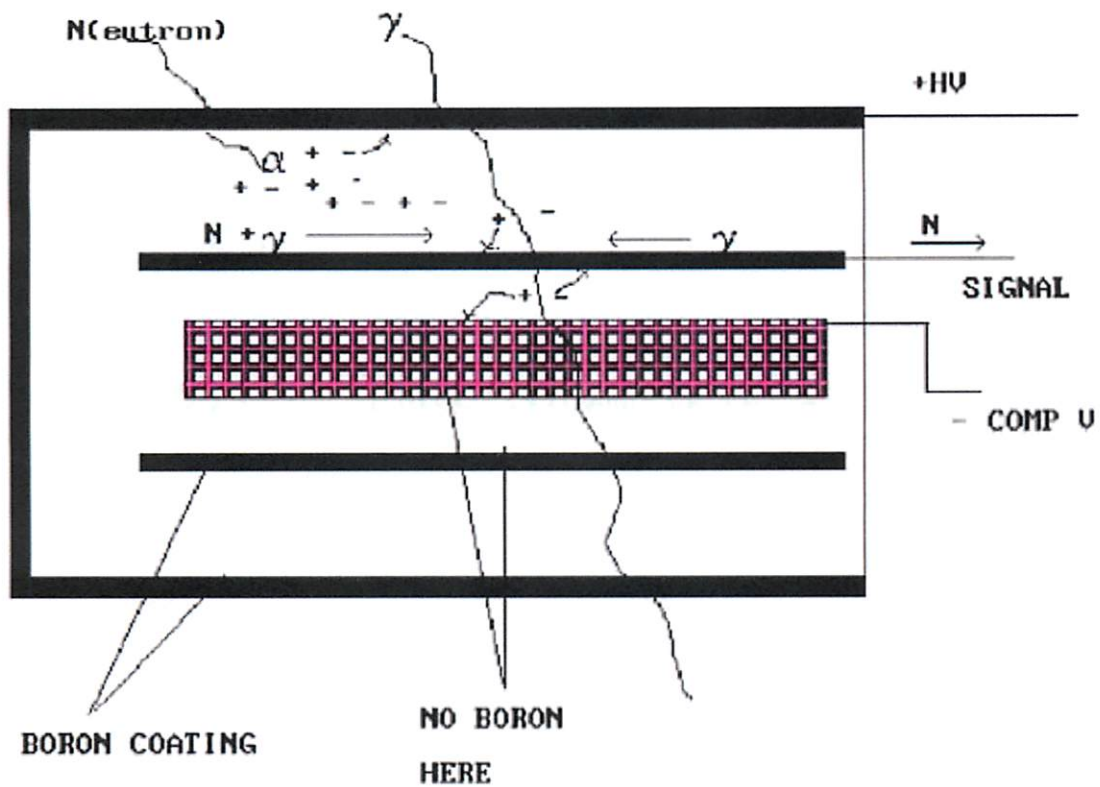
<u>Column A</u>	<u>Column B</u>
a. Pool water temperature = 35 °F	1. Nothing happen
b. Withdraw SHIM Rod in Pulse Mode	2. Alarm ONLY
c. Wide Range Linear Channel = 100% power	3. Interlock
d. Wide Range Monitor Detector HV failure	4. Scram (with or without Alarm)

Category C: Facility and Radiation Monitoring Systems

QUESTION C.12 [1.0 point]

The Figure below depicts:

- a. The Compensated Ion Chamber.
- b. The Uncompensated Ion Chamber.
- c. The Gamma Ion Chamber.
- d. The Fission Chamber.



Category C: Facility and Radiation Monitoring Systems

QUESTION C.13 [1.0 point]

Which ONE of the following is NOT true regarding the configuration of UCI TRIGA-LEU fuel elements?

- a. The total uranium content shall be nominally 8.5 % by weight, enriched to less than 20% U-235.
- b. The cladding shall be 304 stainless steel, nominally 0.020 inches thick.
- c. The hydrogen to zirconium atom ratio in the zirconium hydride shall be a nominal 1.00 hydrogen atoms to 1.64 zirconium atom.
- d. An upper fitting with an engraved unique serial number shall be designed to fit a latching tool for fuel movement.

QUESTION C.14 [1.0 point]

Reactor is subcritical with the following conditions:

The SHIM rods and drives are "DOWN"

The Carriage of the Transient rod is UP

Reactor is in the Steady State Mode

If you apply "AIR" to the Transient rod system, the reactor will:

- a. scram.
- b. inhibit (interlock).
- c. change to Pulse Mode.
- d. increase to critical.

QUESTION C.15 [1.0 point]

A neutron flux will activate isotopes in air. The primary isotope we worry about in the pneumatic transfer system is:

- a. Kr^{80} ($Kr^{79} (n, \gamma) Kr^{80}$).
- b. N^{16} ($O^{16} (n,p) N^{16}$).
- c. H^2 ($H^1 (n, \gamma) H^2$).
- d. Ar^{41} ($Ar^{40} (n, \gamma) Ar^{41}$).

Category C: Facility and Radiation Monitoring Systems

QUESTION C.16 [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

QUESTION C.17 [1.0 point]

If any significant buildup of radioactivity from the reactor pool, the conductivity of the pool water will be:

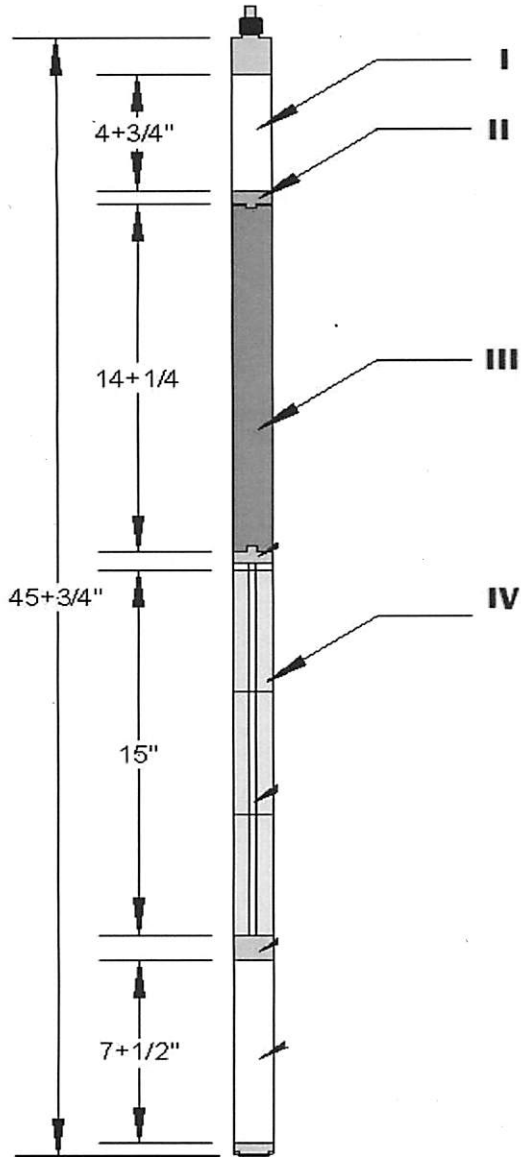
- a. increase.
- b. decrease.
- c. the same.
- d. no relationship between radioactivity and conductivity in the pool water.

Category C: Facility and Radiation Monitoring Systems

QUESTION C.18 [1.0 point, 0.25 each]

The following diagram depicts the FUEL FOLLOWED control rod. Match each distractor with an appropriate label listed in the diagram.

- a. Fuel
- b. Stainless steel plug
- c. Graphite
- d. Borated Graphite



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

Category A: Reactor Theory, Thermodynamics, and Facility Operating Characteristics

A.01

Answer: a, DECREASE b, INCREASE c, INCREASE
d, DECREASE

Reference: DOE Fundamentals Handbook, NPRT, Vol. 2, Module 4, EO 3.6, p.28

A.02

Answer: b

Reference: DOE Fundamentals Handbook, NPRT, Vol.1, Module 2, EO 3.1, p. 29

A.03

Answer: b

Reference: Reactivity added = 0.140 % $\Delta k/k = 0.0014 \Delta k/k$
 $\tau = (\beta - \rho) / \lambda_{\text{eff}} \rho = \frac{0.007 - 0.0014}{(0.1)(0.0014)} = 40 \text{ seconds}$

A.04

Answer: b

Reference: Chart of the Nuclides

A.05

Answer: a

Reference: Burn, R., Introduction to Nuclear Reactor Operations, © 1988, Section 3.2

A.06

Answer: b

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

A.07

Answer: c

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

A.08

Answer: a

Reference: $P = P_0 e^{\lambda T} \rightarrow \ln(4) = \text{time} \times \lambda \rightarrow \text{time} = \ln(4) / \lambda = \ln(4) \times 10 \text{ sec} = 1.386 \times 10 \approx 13.8 \text{ sec}.$

A.09

Answer: c

Reference: Reactor is increasing, then constant when reactor period reaches to infinitive.

A.10

Answer: b

Reference: $CR = S/(1-K) \rightarrow CR = 1000/(1 - 0.8) = 5000 \text{ N/sec}$

A.11

Answer: b

Reference: Burn, R., *Introduction to Nuclear Reactor Operations*, © 1982, Sec 3.3.3, page 3-21.

$\Delta \rho = \text{keff}_1 - \text{keff}_2 / (\text{keff}_1 \times \text{keff}_2) = 0.95 - 0.8 / (0.8 \times 0.95) = 0.197 \Delta k/k$

Category A: Reactor Theory, Thermodynamics, and Facility Operating Characteristics

A.12

Answer: a

Reference: $P = P_0 e^{t/T}$
 $t = \ln(P/P_0) * T = \ln(10) * 52 = 119.7 \text{ seconds} \approx 120 \text{ seconds} = 2 \text{ minutes}$

A.13

Answer: a

Reference: Burn, R., Introduction of Nuclear Reactor Operations, © 1988, Sec 3.3.1

A.14

Answer: c

Reference: Introduction to Nuclear Operation, Reed Burn, 1988, Sec 8.1

A.15

Answer: d

Reference: Burn, R., *Introduction of Nuclear Reactor Operations*, © 1988, Sec 2.5.3

A.16

Answer: b

Reference: Total work = \$4.65
TS margin = total worth - (p_{excess} + Highest control worth)
\$4.65 - (\$0.90 + \$2.25) = \$1.50

A.17

Answer: a

Reference: $P = P_0 e^{t/T} \rightarrow T = t/\ln(P/P_0)$
 $T = 10/\ln(100/10)$; $T = 4.34 \text{ sec.}$

A.18

Answer: c

Reference: DOE Fundamentals Handbook, NPRT, Vol. 2, Module 3, EO 2.3, p.25

A.19

Answer: c

Reference: Burn, R., *Introduction of Nuclear Reactor Operations*, © 1982, Sec 3.2.1

A.20

Answer: b

Reference: Burn, R., Introduction to Nuclear Reactor Operations, © 1982, § 5.3, p. 5.6
For third generation = $n + K*n + K^2 * n = 1000 + 800 + 640 = 2440$ neutrons

Category B: Normal/Emergency Operating Procedures and Radiological Controls

B.01

Answer: d
Reference: UCI TS 6.5.b.

B.02

Answer: b
Reference: $A = A_0 \cdot e^{-\lambda t}$
 $0.5C_i = 1 C_i \cdot e^{-\lambda(t)}$
 $\lambda = \ln(0.5) / (\text{half-life})$
 $\lambda = -0.693 / 2\text{year} = -0.3466$
 $\ln(0.2/2) = -0.3466 \cdot (t) \rightarrow -2.30 / -0.3466 = t$
solve for t: 6.6 years

B.03

Answer: c
Reference: $DR_1 \cdot (D_1)^2 = DR_2 \cdot (D_2)^2$;
 $500 \text{ mrem} (5)^2 = 5 \text{ mrem} (d)^2$
 $D = 50 \text{ ft}$

B.04

Answer: b
Reference: Standard Health Physics Definition

B.05

Answer: c
Reference: UCI TS 3.7.1.a.

B.06

Answer: a. = 3; b. = 250; c. = 3; d. = 3 (0.25 each)
Reference: TS 3.1.3, TS 3.1.1, and TS 3.3.3

B.07

Answer: b
Reference: 10 CFR Part 55.53
• 55.53(i) – the licensee shall have a biennial medical examination.
• 55.53(h), 55.59(c) – annual operating tests
• 55.53(e) – the licensee shall actively perform the functions of a licensed operator for a minimum of 4 hours per calendar quarter.
• 55.53(h), 55.59(c)(1) – "The requalification program must be conducted for a continuous period not to exceed 2 years"
License renewal : 6 years

B.08

Answer: a
Reference: UCI Emergency Plan Section 7.1.1

Category B: Normal/Emergency Operating Procedures and Radiological Controls

B.09

Answer: d
Reference: 10CFR20 - At 10 feet, there is no beta radiation.
Calculate gamma at 1 ft.
 $DR_1 \cdot (D_1)^2 = DR_2 \cdot (D_2)^2$
 $0.1 \cdot (10)^2 = DR_2 \cdot (1)^2$
gamma at 1 foot = 10 mrem/hour.
Therefore, beta at 1 foot = 90 mrem/hour or 90%.

B.10

Answer: a. = CHECK; b. = TEST; c. = TEST; d. = CAL (0.25 each)
Reference: TS Definitions

B.11

Answer: d
Reference: TS 3.8

B.12

Answer: b
Reference: 10CFR20

B.13

Answer: a. = SL; b. = LCO; c. = LSSS; d. = LCO (0.5 each)
Reference: TS 2.1, TS 2.2, TS 3.1, TS 3.2, and TS 3.3

B.14

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

B.15

Answer: b
Reference: TS 2.1 and 2.2, Objective

B.16

Answer: d
Reference: 10CFR55

B.17

Answer: a
Reference: NRC Standard Question

B.18

Answer: d
Reference: NRC Standard Question

B.19

Answer: b
Reference: Chart of the Nuclides

Category C: Facility and Radiation Monitoring Systems

C.01

Answer: b
Reference: UCI SAR , Figure 4-9

C.02

Answer: d
Reference: UCI SAR Figure 4-13

C.03

Answer: a
Reference: Chart of Nuclides

C.04

Answer: a
Reference: UCI SAR 10.1.2

C.05

Answer: a, Pulse b, Both c, Steady State d, both (0.5 each)
Reference: UCI TS 3.2.3, Table 2.

C.06

Answer: c
Reference: SAR 1.8

C.07

Answer: c
Reference: UCI Instruction Manual for Operators, Section 6.2

C.08

Answer: d
Reference: UCI TS 3.3.3

C.09

Answer: a(4) b(3) c(1) d(4) (0.5 each)
Reference: UCI SAR 7.2

C.10

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

Category C: Facility and Radiation Monitoring Systems

C.11

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

C.12

Answer: a
Reference: NRC Standard Questions

C.13

Answer: c
Reference: UCI TS 5.3.3

C.14

Answer: b
Reference: UCI TS 3.2.3

C.15

Answer: d
Reference: UCI Training Manual 10.3.2

C.16

Answer: d
Reference: UCI SOP, Section 4.3

C.17

Answer: a
Reference: NRC Standard Questions

C.18

Answer: a (IV) b (II) c (I) d (III) (0.25 each)
Reference: UCI SAR Figure 5-6

SUBJECT: EXAMINATION REPORT NO. 50-326/OL-19-01, UNIVERSITY OF CALIFORNIA – IRVINE DATED JULY 5, 2019

DISTRIBUTION:

PUBLIC

RidsNrrDipPrlb Resource

RidsNrrDipProb Resource

Facility File (ZTaru)

ADAMS Accession No. ML19176A409

NRR-079

OFFICE	NRR/DLP/PROB/CE	NRR/DLP/PROB/OLA	NRR/DLP/PROB/BC
NAME	JNguyen	ZTaru	AMendiola
DATE	06/18/2019	06/21/2017	07/5/2019

OFFICIAL RECORD COPY