February 13, 2013

Dr. Tatjana Jevremovic, Director
University of Utah Nuclear Research Reactor
50 South Central Drive
University of Utah
Salt Lake City, UT 84112

SUBJECT: EXAMINATION REPORT NO. 50-407/OL-13-01, UNIVERSITY OF UTAH

Dear Dr. Jevremovic:

During the week of January 21, 2013, the Nuclear Regulatory Commission (NRC) administered operator licensing examinations at your University of Utah TRIGA reactor. The examination was conducted according to NUREG-1478, "Operator Licensing Examiner Standards for Research and Test Reactors," Revision 2. Examination questions and preliminary findings were discussed at the conclusion of the examination with those members of your staff identified in the enclosed report.

In accordance with Title 10, Section 2.390 of the Code of Federal Regulations, 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 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 via internet e-mail John.Nguyen@nrc.gov.

Sincerely,

/RA/

Gregory T. Bowman, Chief
Research and Test Reactors Oversight Branch
Division of Policy and Rulemaking
Office of Nuclear Reactor Regulation

Docket No. 50-407

Enclosures: 1. Examination Report No. 50-407/OL-13-01
2. Written Exam

cc: Dr. Dong-Ok Choe, Reactor Supervisor
cc: w/o enclosures: See next page

February 13, 2013

Dr. Tatjana Jevremovic, Director
University of Utah Nuclear Research Reactor
50 South Central Drive
University of Utah
Salt Lake City, UT 84112

SUBJECT: EXAMINATION REPORT NO. 50-407/OL-13-01,
UNIVERSITY OF UTAH NUCLEAR TRIGA REACTOR

Dear Dr. Jevremovic:

During the week of January 21, 2013, the Nuclear Regulatory Commission (NRC) administered operator licensing examinations at your University of Utah TRIGA reactor. The examination was conducted according to NUREG-1478, "Operator Licensing Examiner Standards for Research and Test Reactors," Revision 2. Examination questions and preliminary findings were discussed at the conclusion of the examination with those members of your staff identified in the enclosed report.

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cc: Dr. Dong-Ok Choe, Reactor Supervisor, UUTR
cc: w/o enclosures: See next page

DISTRIBUTION w/ encls:
PUBLIC PROB r/f RidsNrrDprProb RidsNrrDprPrlb Facility File (CRevelle)

ADAMS Accession No: ML13042A431

OFFICE	PROB:CE		IOLB:LA	E	PROB:BC
NAME	JNguyen		CRevelle		GBowman
DATE	01/ 30 /2013		02/ 11 /2013		02/13 /2013

OFFICIAL RECORD COPY

UNIVERSITY OF UTAH Docket No. 50-407

cc:

Mayor of Salt Lake City
451 South State
Room 306
Salt Lake City, UT 84111

Dr. Thomas Parks
Vice President for Research
201 S. Presidents Circle, Room 210
University of Utah
Salt Lake City, UT 84112-9011

Ms. Karen Langley
Director, University of Utah Radiological Health
100 OSH, University of Utah
Salt Lake City, UT 84112

Dr. Cynthia Furse
Associate Vice President for Research
210 Park, University of Utah
Salt Lake City, UT 84112

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

Director, Division of Radiation Control
Dept. Of Environmental quality
168 North 1959 West
P.O. Box 144850
Salt Lake City, UT 84114-4850

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

REPORT NO.: 50-407/OL-13-01

FACILITY DOCKET NO.: 50-407

FACILITY LICENSE NO.: R-126

FACILITY: UNIVERSITY OF UTAH NUCLEAR RESEARCH REACTOR

EXAMINATION DATES: January 23-24, 2013

SUBMITTED BY: **/RA/** 02/01/2013
John T. Nguyen, Chief Examiner Date

SUMMARY:

During the week of January 21, 2013, the NRC administered operator licensing examinations to two senior reactor operator licensing candidates. All candidates passed all portions of the examination.

REPORT DETAILS

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

2. Results:

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

3. Exit Meeting:
John T. Nguyen, Chief Examiner, NRC
Dr. Tatjana Jevremovic, Reactor Director, UUTR
Dr. Dong-Ok Choe, Reactor Supervisor, UUTR

The NRC examiner thanked the facility staff for their cooperation during the examination. The examiner discussed with the facility management regarding the training program and the generic weaknesses during their operating tests. The facility licensee had no comments on the written examination. The examiner noted that the candidates were well prepared for the examination.

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

FACILITY: Utah University

REACTOR TYPE: TRIGA

DATE ADMINISTERED: 01/23/2013

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
18.00	33.3	_____	_____	A. REACTOR THEORY, THERMODYNAMICS AND FACILITY OPERATING CHARACTERISTICS
18.00	33.3	_____	_____	B. NORMAL AND EMERGENCY OPERATING PROCEDURES AND RADIOLOGICAL CONTROLS
18.00	33.3	_____	_____	C. FACILITY AND RADIATION MONITORING SYSTEMS
54.00		_____ FINAL GRADE	_____ %	TOTALS

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

_____
Candidate's Signature

ENCLOSURE 1

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 ___

(***** 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 ___

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 ___ (0.25 each)

B18 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 ___ (0.25 each)

C05 a b c d ___

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 ___

(***** 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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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 lbm

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

UNIVERSITY of UTAH RESEARCH REACTOR

Operator Licensing Examination

Week of January 21, 2013

ENCLOSURE 2

QUESTION A.1 [1.0 points]
Two common FISSION PRODUCTS that have especially large neutron capture cross sections and play a significant role in reactor physics are:

a. Xe-135 and B-10

b. Xe-135 and Cs-137

c. Xe-135 and Sm-149

d. B-10 and Sm-149

QUESTION A.2 [1.0 point]
Which of the following is the definition for reactivity (ρ)?

a. The measure of a reactor's departure from criticality

b. The time required for power to change by a factor of "e"

c. The fraction of all fission neutrons that are born as delayed neutrons

d. The faction of number of neutrons of current generation and number of neutrons of the previous generation

QUESTION A.3 [1.0 point]
Five minutes following shutdown, reactor power is 3×10^6 counts per minute (cpm). Which ONE of the following is the count rate (cpm) three minutes later?

a. 2×10^6

b. 8×10^5

c. 5×10^5

d. 3×10^5

QUESTION A.4 [1.0 point]
Reactor is at full power. The operator immediately scrams all control rods into the core. This IMMEDIATE insertion of all control rods will cause:
Given:
T: reactor period, ℓ^*: Prompt neutron lifetime; ρ: reactivity insertion; β: beta fraction

a. The delayed period to be equal to POSITIVE 80 seconds

b. A number of prompt neutrons equals to a number of delayed neutrons

c. The immediate period to be a function of the prompt neutron lifetime ($T=\ell^*/\rho$)

d. A sudden change of power that equals to the initial power multiplied by $\beta(1-\rho)/(\beta-\rho)$

QUESTION A.5 [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., 50 ev, 100 kev) have more likely leakage from the reactor core

d. Neutrons of specific energy levels (e.g., 50 ev, 100 kev) are more likely to be absorbed than neutrons at other energy levels

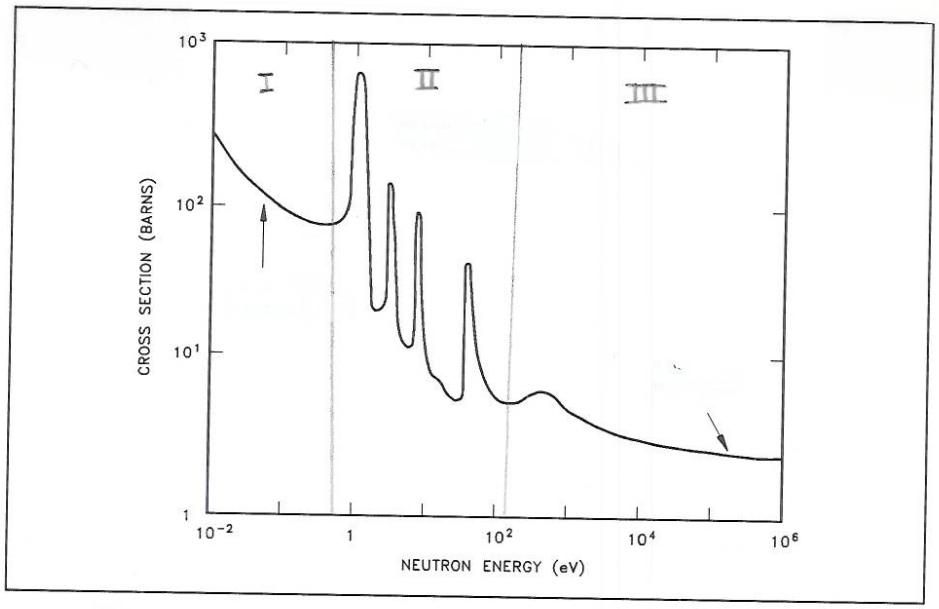


Figure 1 Typical Neutron Absorption Cross Section vs. Neutron Energy

QUESTION A.6 [1.0 point]
Given a source strength of 200 neutrons per second (N/sec) and a multiplication factor of 0.9, which ONE of the following is the expected stable neutron count rate?

a. 180 N/sec

b. 1800 N/sec

c. 2000 N/sec

d. 4000 N/sec

QUESTION A.7 [1.0 point]
Given the following Core Reactivity Data during startup:

Control Rod	Total Rod Worth ($)	Rod Worth removed at 5 watts critical ($)	Rod excess at 5 watts critical ($)
Rod #1	1.50	1.50	0.00
Rod # 2	1.80	1.50	0.30
Rod # 3	2.20	2.00	0.20
Rod # 4	3.50	2.50	1.00
Total Worth	9.00	7.50	1.50

Assume all rods are scrammable. The **SHUTDOWN MARGIN** in accordance with the UUTR Technical Specifications for this core is:

a. $1.5

b. $4.0

c. $5.5

d. $6.0

QUESTION A.8 [1.0 point]
The reactor is critical at 5 watts. Which ONE of the following correctly describes the reactor behavior when a reactivity worth of 0.01 delta K/K is IMMEDIATELY inserted to the reactor core?

a. Subcritical

b. Critical

c. Supercritical

d. Prompt critical

QUESTION A.9 [1.0 point]
Which ONE of the following correctly describes the SIX- FACTOR FORMULA?

a. $K_\infty = K_{eff}$ * the reproduction factor (η)

b. $K_\infty = K_{eff}$ * the total non-leakage probability ($\mathcal{L}_f \times \mathcal{L}_{th}$)

c. $K_{eff} = K_\infty$ * the total non-leakage probability ($\mathcal{L}_f \times \mathcal{L}_{th}$)

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

QUESTION A.10 [1.0 point]
Which ONE of the following correctly describes the effect of reactor reactivity when the fuel temperature increases?

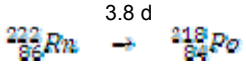
a. There is no reactivity effect when fuel temperature increases

b. The increase in fuel temperature will begin to create a positive reactivity effect

c. The increase in fuel temperature will begin to create a negative reactivity effect

d. As the fuel heats up the void in fuel increases, thereby, creating a positive reactivity effect

QUESTION A.11 [1.0 point]
The following shows part of a decay chain for the radioactive element Radon (Rn). This decay chain is a good example of ___ decay.



a. Alpha

b. Beta

c. Gamma

d. Neutron

QUESTION A.12 [1.0 point]
Given a reactor period of 22 seconds, approximately how long will it take for power to triple?

a. 10 seconds

b. 24 seconds

c. 36 seconds

d. 66 seconds

QUESTION A.13 [1.0 point]
Which ONE of the following elements will slow down fast neutrons most quickly, i.e. produces the greatest energy loss per collision?

a. Uranium-238

b. Oxygen-16

c. Boron-10

d. Hydrogen-1

QUESTION A.14 [1.0 point]
Which **ONE** of the following conditions will **DECREASE** the shutdown margin of a reactor?

a. Increase moderator temperature (Assume negative temperature coefficient)

b. Insertion of a negative reactivity worth experiment

c. Burnout of a burnable poison

d. Fuel depletion

QUESTION A.15 [1.0 point]
Which ONE of the following is the **most correct reason** for having an installed neutron source within the core?

An installed neutron source is very important during startup because without of a neutron source...

a. the chain reaction in the reactor core would NOT start

b. the startup channel would NEVER indicate neutron population

c. the compensating voltage on the source range detector doesn't work

d. the reactor could result in a sudden increase in power if the control rods were pulled out far enough

QUESTION A.16 [1.0 point]
Which ONE of the following is the principle source of heat in the reactor after a shutdown from extended operation at 100 kW?

a. Decay of fission products

b. Spontaneous fission of U^{238}

c. Production of delayed neutrons

d. Production of prompt gamma rays

QUESTION A.17 [1.0 point]
During the time following a reactor scram, reactor power decreases on a negative 80 second period. Which ONE of the following is the correspondence of the half-life of the longest-lived delayed neutron precursors?

a. 80 seconds

b. 55 seconds

c. 40 seconds

d. 20 seconds

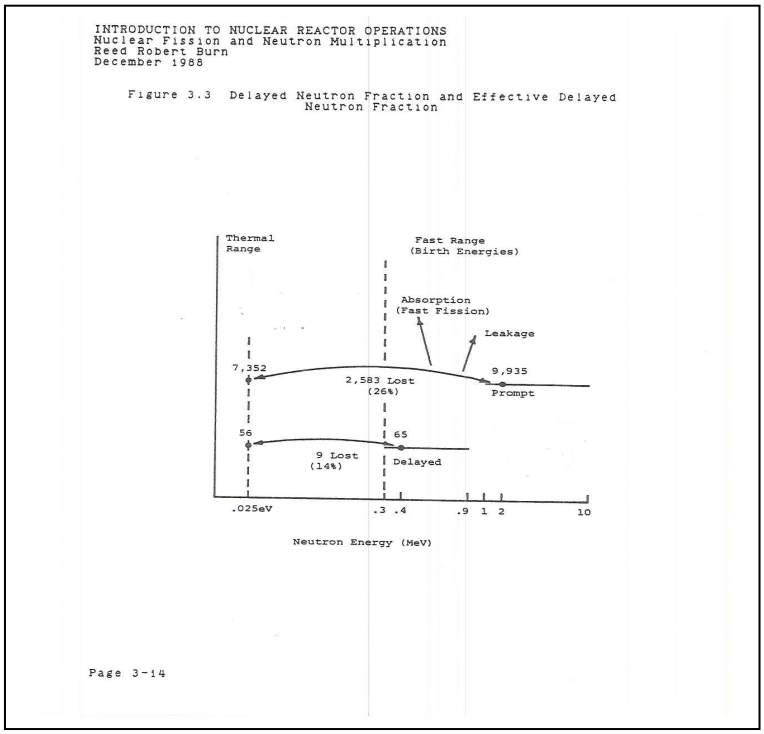
QUESTION A.18 [1.0 point]
Use Figure 3.3 attached. Calculate the effective delayed neutron fraction (β-effective). At birth energies, there are 65 delayed neutrons and 9935 prompt neutrons. In the process of slowing down, there are only 56 delayed neutrons and 7352 prompt neutrons at the thermal range. The resultant β-effective of Figure 3.3 is:

a. 0.00654

b. 0.00756

c. 0.00762

d. 0.00348



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

QUESTION B.1 [1.0 point]
The following measurements are made from a beta-gamma point source:
- 1 R/hr at one foot
- 0.5 mR/hr at ten feet

What are the relative fractions of betas and gammas emitted at one foot?

a. (950/50) = 19

b. (1000/50) = 20

c. (995/5) = 199

d. (1000/5) = 200

QUESTION B.2 [1.0 point]
The UUT reactor has been shutdown due to a fuel element leak. Which ONE of the following radioactive GASES poses the most significant hazard during the research for the leaking fuel element? (Assume the fuel element is leaking during the search)

a. Ar-41

b. I-131

c. Cs-137

d. N-16

QUESTION B.3 [1.0 point]
Per UUTR Technical Specification, what is the MINIMUM level of management who may direct relocation of any in-core experiment with reactivity worth greater than one dollar?

a. Senior Reactor Operator

b. Reactor Supervisor

c. Reactor Facility Director

d. The Reactor Operations Committee

QUESTION B.4 [1.0 point]
During an Emergency, the RS-OEC may authorize personnel voluntary whole body exposure up to 75 rem dose equivalent per individual for life saving actions. This individual is authorized to receive up to 75 rem dose equivalent per:

a. annual basis

b. each emergency

c. twice in a lifetime

d. once in a lifetime

QUESTION B.5 [1.0 point]
An area in which radiation levels could result in an individual receiving a dose equivalent in excess of 100 mRem/hr is defined as:

a. Radiation area

b. Restricted Area

c. High Radiation Area

d. Very High Radiation Area

QUESTION B.6 [1.0 point]
A radioactive source reads 10 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 10 Rem/hr to 10 mRem/hr?

a. 10 hours

b. 15 hours

c. 20 hours

d. 25 hours

QUESTION B.7 [1.0 point]
The operator licensing candidate requires submitting the NRC Form 396, Certification of Medical Examination by Facility Licensee, to the NRC Chief Examiner before the start date of the examination. This requirement can be found in:

a. 10 CFR Part 26

b. 10 CFR Part 50.59

c. 10 CFR Part 55

d. 10 CFR Part 73

QUESTION B.8 [1.0 point]
Per UUTR Administrative Procedure, what is the MINIMUM level of management who can make temporary changes to procedures that do not change their original intent?

a. Senior Reactor Operator

b. Reactor Supervisor

c. Reactor Facility Director

d. The Reactor Operations Committee

QUESTION B.9 [1.0 point]
Per UUTR Technical Specifications, the reactor tank water radioactivity shall be measured _____.

a. weekly

b. monthly

c. quarterly

d. annually

QUESTION B.10 [1.0 point]
Which ONE of the following would be an initiating condition for a Notification of Unusual Event?

a. Reactor staff injury

b. Minor fire in the control room

c. Significant contamination of the MEB facility

d. Radiological effluents from the Reactor Laboratory exceed 15 mrem whole-body dose equivalent accumulated in 24 hours

QUESTION B.11 [1.0 point]
Which ONE of the following conditions requires the NRC APPROVAL for changes?

a. Revise the TRIGA Startup Checklist

b Revise the requalification operator licensing examination

c Major changes in the Semi-Annual Control Rod Calibrations

d Delete a requirement of the designated SRO on-call described in Section 6.1.3 of the UUTR Technical Specification

QUESTION B.12 [1.0 point]
The radiation from an unshielded source is 1 rem/hr. When a 60 mm thickness of lead sheet is inserted; the radiation level reduces to 125 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.13 [1.0 point]
A small radioactive source is to be stored in the reactor building. The source is estimated to contain 10 curies and emit 100% of 110-Kev gamma. Assuming no shielding used, how far is a distant that reads 100 mrem/hr?

a. 8 feet

b. 24 feet

c. 75 feet

d. 257 feet

QUESTION B.14 [1.0 point]
Which **ONE** of the following types of experiments shall **NOT** be irradiated at UUTR?

a. Any experiment contains corrosive materials

b. Any experiment contains explosive materials

c. The experiment has the sum of the reactivity worth of $1.50

d. The unsecured experiment has a reactivity worth of NEGATIVE $0.50

QUESTION B.15 [1.0 point]
Which **ONE** of the following is the correct statement when the Area Radiation Monitor (ARM) in the reactor ceiling exceeds the preset level of 10 mR/hr?

a. The ventilation system is MANUALLY secured and the reactor is permitted to operate up to 48 hours

b. The ventilation system is AUTOMATICALLY secured and the reactor is permitted to operate up to 48 hours

c. The ventilation system is MANUALLY secured and the reactor is permitted to operate up to 24 hours

d. The ventilation system is AUTOMATICALLY secured and the reactor shall not be operated

QUESTION B.16 [1.0 point]
Which one of the following is the definition of Total Effective Dose Equivalent (TEDE) specified in 10 CFR Part 20?

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, 0.25 each]
Per UUTR Technical Specifications, match each event listed in column A with its associated time required for a written report to the U.S. NRC listed in column B. (Items in column B may be used more than once)

Column A	Column B
a. Total radioactivity liquid waste discharged	1. 14 days
b. A violation of a safety limit	2. 30 days
c. Indicate a substantial variation from prior analysis after an amendment of power upgrade	3. Annually
d. Permanent changes in Level 1of the facility organization	

QUESTION B.18 [1.0 point]
Which type of following radiation will travel through air with the shortest distance?

a. neutron

b. alpha

c. beta

d. gamma

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

QUESTION C.1 [1.0 point]
Two instrumented fuel elements that monitor the fuel temperature in the core are located at:

a. B ring ONLY

b. B and C rings

c. C and D rings

d. E and F rings

QUESTION C.2 [1.0 point]
To reduce neutron leakage, which ONE of the following materials is inserted in the top and bottom of the active fuel portion of each fuel element?

a. Aluminum

b. Boron

c. Cadmium

d. Graphite

QUESTION C.3 [1.0 point]
Per SOP UNEP-006, the water filters located on the TRIGA reactor pool refrigeration/ purification system will be replaced when :

a. the flow rate of the refrigeration/ purification system is higher than 3 gpm

b. the flow rate the refrigeration/ purification system is lower than 3 gpm

c. the conductivity of the reactor tank water is less than 5 μmhos/cm

d. the pH of the reactor tank water is between 6 and 7

QUESTION C.4 [1.0 point, 0.25 each]
Match the inputs listed in column A with their responses listed in column B. (Items in column B may be used more than once or not at all). Assume the reactor is in operation.

Column A	Column B
a. Linear power level =100 kW	1. Indicate only
b. Percent power level=104 %	2. Interlocks
c. Pool water conductivity = 1 μmho/cm	3. Scram
d. Withdrawal of Shim and Safety rods simultaneously	

QUESTION C.5 [1.0 point]
If the Linear Power Channel output is about 7% higher than the calculated thermal power calibration, the reactor operator needs to adjust the Linear Power Channel output by:

a. adjusting the linear channel gain

b. adjusting the CIC detector high voltage

c. physically adjusting the height of the detectors in the support assembly

d. move the graphite reflector to change the neutron flux near the detectors

QUESTION C.6 [1.0 point]
The reactor is in operation. Which ONE of the following will result in a reactor scram?

a. The reactor period channel exceeds 7 sec

b. The water level is at 1 ft from the top of the reactor tank

c. The reactor tank water temperature meter reaches 30 °C

d. The reactor console loses the electrical power but the UPS is still operational

QUESTION C.7 [1.0 point]
Which ONE of the following materials is used as the neutron absorber in the Shim-Safety rods?

a. Hafnium

b. Cadmium

c. Samarium

d. Boron Carbide

QUESTION C.8 [1.0 point]
During a reactor operation, you discover the Continuous Air Monitor (CAM) pump failure. Other monitors are operating. Which ONE of the following is the correct action in accordance with UUTR Technical Specifications?

a. Continue to operate and you don't have to report to the supervisor because the pump failure does NOT affect the operations of the CAM

b. Report the result to the supervisor and continue to operate because the reactor can be operable for 48 hours with the operable ARM system

c. Immediately shutdown the reactor and report the result to the supervisor because its failure considers a reportable occurrence

d Shutdown the reactor, immediately report the result to the U.S. NRC because it is a reportable occurrence.

QUESTION C.9 [1.0 point]
The UUT reactor uses the Compensated Ion Chamber (CIC) for:

a. Startup Channel

b. Percent Power Channel

c. Log Power Channel

d. Linear Power Channel

QUESTION C.10 [1.0 point]
Use the following diagram of an instrumented fuel element. Which ONE of the following is the correct match for the position locator (Column A) to the correct component (Column B)?

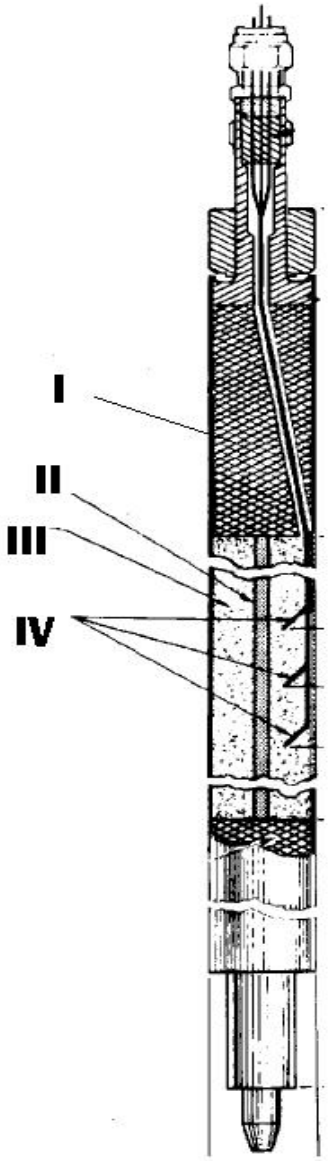
Column A	Column B
I	A. Zirconium Hydride-Uranium
II	B. Stainless steel
III	C. Samarium Burnable Poison
IV	D. Graphite Reflector
	E. Zirconium Rod
	F. Spacer
	G. Thermocouples

a. I-C, II-F, III-A, IV-C

b. I-D, II-A, III-E, IV-C

c. I-D, II-E, III-A, IV-G

d. I-C, II-B, III-E, IV-G



QUESTION C.11 [1.0 point]
During reactor operation, a leak develops in the SECONDARY to PRIMARY heat exchanger. Which ONE of the following correctly explains the reactor pool level?

a. Pool level will increase because the Primary pressure is HIGHER than the Secondary pressure

b. Pool Level will increase because the Primary pressure is LOWER than the Secondary pressure

c. Pool Level will be the same because the Primary pressure is EQUAL to the Secondary pressure

d. Pool Level will decrease because the Primary pressure is HIGHER than Secondary pressure

QUESTION C.12 [1.0 point]
You perform a fuel element inspection. In measuring the transverse bend, you find the bend of one fuel element exceeds the original bend by 0.120 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 UUT Tech Spec requires the elongation measurement only

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

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

QUESTION C.13 [1.0 point]
A bracket, fitted with an adjustment screw, is mounted on top of the magnet drawtube. A micro switch is arranged so that its actuating lever is operated by the adjustment screw on the bracket. The switch will reverse position according to whether the magnet drawtube is at or above its completely depressed position. This micro switch is:

a. the magnet down switch

b. the magnet up switch

c. the rod down switch

d. the rod up switch

QUESTION C.14 [1.0 point]
Which ONE of the following best describes on how the compensated Ion Chamber (CIC) and the Fission Chamber (FC) 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 FC is coated with U-235 for fission 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 FC 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 FC is coated with U-235 for fission reaction.

d. The CIC has only one chamber coated with U-235 for fission reaction, whereas the FC has two chambers, both can sense gamma rays but only one is coated with U-235 for fission reaction.

QUESTION C.15 [1.0 point]
A neutron flux will activate isotopes in air. The primary isotope we worry about when working with the rabbit system is:

a. H^2

b. N^{16}

c. Ar^{41}

d. I^{131}

QUESTION C.16 [1.0 point]
For calibration of the control rod, the operator determines the rod reactivity by measuring the rate of decrease in power level by scram of the calibrated rod from the desired height. This technique is called:

a. Rod Drop Method

b. Positive Period Method

c. Thermal Power Calibration Method

d. Positive Period-Differential Worth Method

QUESTION C.17 [1.0 point]
Which **ONE** of the following Experimental Facilities provides the **HIGHEST** neutron flux?

a. Central Irradiation Facility (CIF)

b. Pneumatic Transfer System (PTS)

c. Dry Tube Thermal Irradiator

d. Beam Port

QUESTION C.18 [1.0 point]
Which **ONE** of the following is the main function of the demineralizer in the primary purification system?

a. Absorb delayed neutrons, thus increase life of the reactor tank

b. Absorb Ar-41, thus reduce the effluent released to environment

c. Absorb O-16, thus reduce the N-16 dose rate at the reactor tank surface

d. Remove both positive and negative ions to maintain low conductivity in the tank water

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

A.1
Answer c
Reference: Burn, R., *Introduction to Nuclear Reactor Operations,* © 1988, Sec 8.1

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

A.3
Answer: d
Reference: $P=P_o e^{t/\tau}$ x $=3 \times 10^6 * e^{180/-80}$ $x = 3 \times 10^6 * 0.105 = 3.15 \times 10^5$

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

A.5
Answer d
Reference: DOE Fundamentals Handbook *Nuclear Physics and Reactor Theory Vol. 2*

A.6
Answer: c
Reference: $CR = S/(1-K) \rightarrow CR = 200/(1 - .9) = 2000$

A.7
Answer: b
Reference: Tech Spec SDM = $\sum$rod worth removed at critical – most reactivity control rod worth= \$7.5 -\$3.5 = \$4.0
or
Tech Spec SDM = total rod worth –($\sum$(rod excesses) + most reactivity control rod worth)= \$9.0 –(\$1.5+\$3.5) = \$4.0

A.8
Answer: d
Reference: Burn, R., *Introduction of Nuclear Reactor Operations*, © 1988, Sec 4.2
0.01 delta-K/K >0.007, so reactor is prompt critical

A.9
Answer: c
Reference: DOE Handbook Vol 2, Rx Theory (Nuclear Parameters), E.O. 1.1 a&b, pg. 9

A.10
Answer: c
Reference: DOE Fundamentals Handbook *Nuclear Physics and Reactor Theory Vol. 2*

A.11
Answer a
Reference: Chart of the Nuclides

A.12
Answer: b
Reference: $P=P_o e^{t/\tau}$ $3=1* e^{t/22}$ t = 22 sec*ln(3) = 24.2 sec

A.13
Answer: d
Reference: DOE Handbook Vol. 1 Section 3.0

A.14
Answer: c
Reference: increasing the core excess results a decrease in shutdown margin

A.15
Answer: d
Reference: NRC Standard Question

A.16
Answer: a
Reference: Burn, R., *Introduction to Nuclear Reactor Operations,* © 1982, page 4-33

A.17
Answer: b
Reference: Group 1 is the longest-lived delayed neutron precursor for thermal fission in U-235, with a half-life of 55.72 sec. Lamarsh, J. "Introduction to Nuclear Engineering" p. 88

A.18
Answer: b
Reference: β-effective =56/(56+7352) =0.00756
Burn, R., *Introduction of Nuclear Reactor Operations*, © 1988, Figure 3.3

B.1
Answer: a
Reference: Assume beta cannot travel to 10 feet in air, therefore 0.5 mr is gamma.
Gamma dose at 1 ft is: $(DR1)(R1^2) = (DR2)(R2^2) \rightarrow DR2 = (DR1)(R1^2) / R2^2 = 0.5$ mr x $(10 \text{ ft})^2 / (1 \text{ ft})^2 = 50$ mr/hr
Therefore, beta contribution at 1 ft is 1000 - 50 = 950 mr/hr.
Beta contribution/Gamma contribution = 950/50 = 19

B.2
Answer: b
Reference: Standard NRC question

B.3
Answer: b
Reference: Technical Specifications 6.1.3

B.4
Answer: d
Reference: Emergency Plan, Section 3.5

B.5
Answer: c
Reference: 10 CFR 20.1003

B.6
Answer: b
Reference: $DR = DR_\circ * e^{-\lambda t}$
1.0 rem/hr =10 rem/hr* $e^{-\lambda(5hr)}$
Ln(1.0/10) = -λ*5 --> λ=0.4605; solve for t: Ln(.01/10)=-0.4605 (t) → t=15 hours
or
Reduce from 10 Rem to 1 Rem: 5 hours
From 1 Rem to 0.1 Rem: 5 hours
From 0.1 Rem to 0.01 Rem: 5 hours
Total: 15 hours

B.7
Answer: c
Reference: 10 CFR 55.21

B.8
Answer: a
Reference: Administrative Procedure

B.9
Answer: b
Reference: TS 4.3

B.10
Answer: d
Reference: EP 4.1 and 4.2

B.11
Answer: d
Reference: TS 6.1.3 and 10 CFR 50.59

B.12
Answer: b
Reference: $DR = DR_{\circ} * e^{-\mu X}$
Find μ : $125 = 1000 * e^{-\mu * 60}$; μ = 0.03466
If insertion of an HVL (thickness of lead), the original intensity will be reduced by half.
Find X: $1 = 2 * e^{-0.03466 * X}$; X= 20 mm
Find HVL by shortcut:
1000mR- 500 mR is the 1st HVL
500 mR – 250 mR is the 2nd HVL
500mR-125 mR is the 3rd HVL
So HVL=60mm/3 = 20 mm

B.13
Answer: a

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

Dose rate at 1 ft = 6CEN = 6 x 10Ci x 0.110 Mev x 1 =6.6 Rem/hr
Distant at 100 mrem/hr = R= sqrt(6600 mR/100 mR) = 8.12 ft

B.14
Answer: c
Reference: TS 3.8

B.15
Answer: d
Reference: SAR 7.7.1

B.16
Answer: c
Reference: 10 CFR 20.

B.17
Answer: a(3) b(1) c(2) d(2)
Reference: TS 6.7

B.18
Answer: b
Reference: Basic Health Physic

C.1
Answer: c
Reference: SAR, Figure 4.5-1 Core configuration of 100 kW UUTR

C.2
Answer: d
Reference: SAR 4.2.1.1

C.3
Answer: b
Reference: SAR 5.1, Form UNEP-006R3

C.4
Answer: a(3) b(1) c(1) d(2)
Reference: TSs 3.2.3 and 3.3

C.5
Answer: a
Reference: Form UNEP-013R4, Adjustment of Power Monitoring Channels and ADMIN SOP

C.6
Answer: d
Reference: TS 3.2.3

C.7
Answer: d
Reference: TS 5.3.2

C.8
Answer: b
Reference: TS 3.7.1

C.9
Answer: d
Reference: SAR 7.2.3.1

C.10
Answer: c
Reference: SAR, Figure 7.2-1

C.11
Answer: b
Reference: SAR 5.2.2

C.12
Answer: c
Reference: TS 3.1.6

C.13
Answer: a
Reference: SAR 7.3.2

C.14
Answer: a
Reference: Information during a walkthrough

C.15
Answer: c
Reference: NRC Standard Question

C.16
Answer: a
Reference: Administrative Procedure

C.17
Answer: a
Reference: Highest flux due to its location (center of the reactor core)

C.18
Answer: d
Reference: SAR 5.2.3