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

June 3, 2026

Dr. Edward Goodell, Director
Utah Nuclear Engineering Program
University of Utah
110 Central Campus Drive, Room 2000
Salt Lake City, UT 84112

SUBJECT: EXAMINATION REPORT NO. 50-407/OL-26-01, UNIVERSITY OF UTAH

Dear Dr. Goodell:

During the week of May 4, 2026, the U.S. Nuclear Regulatory Commission (NRC) administered an operator licensing examination at your University of Utah TRIGA Nuclear 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 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 component of NRC's Agencywide Documents Access and Management System (ADAMS). ADAMS is accessible from the NRC website 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 Amy Beasten at (301) 415-8341, or via email at Amy.Beasten@nrc.gov.

Sincerely,

Signed by Brown, Tony
on 06/03/26

Tony Brown, Chief
Non-Power Production and Utilization Facility
Oversight Branch
Division of Advanced Reactors and Non-Power
Production and Utilization Facilities
Office of Nuclear Reactor Regulation

Docket No. 50-407

Enclosures:
1. Examination Report No. 50-407/OL-26-01
2. Facility Comments and NRC Resolution
3. Written Examination

cc: w/ enclosures to GovDelivery Subscribers

SUBJECT: EXAMINATION REPORT NO. 50-407/OL-26-01, UNIVERSITY OF UTAH
DATED: JUNE 3, 2026

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

REPORT NO.: OL-26-01

FACILITY DOCKET NO.: 50-407

FACILITY LICENSE NO.: R-126

FACILITY: University of Utah TRIGA Nuclear Reactor

EXAMINATION DATE(S): Week of May 4, 2026

SUBMITTED BY: Amy E. Beasten, PhD, Chief Examiner — May 22, 2026 (Date)

SUMMARY:
During the week of May 4, 2026, the NRC administered operator licensing examinations to six Reactor Operator (RO) candidates and two Senior Reactor Operator - Instant (SRO-I) candidates. One RO candidate failed Category B of the written examination but passed the operations test. One RO candidate failed Categories A and B of the written examination but was an overall written examination pass, and passed the operating test. One SRO-I candidate failed Category C of the written examination but passed the operating test. All remaining candidates passed all applicable portions of the examinations and tests.

REPORT DETAILS

1. Examiners: Amy E. Beasten, PhD, Chief Examiner, NRC
Michele C. DeSouza, Chief Examiner, NRC

2. Results:

	RO PASS/FAIL	SRO PASS/FAIL	TOTAL PASS/FAIL
Written	4/2	1/1	5/3
Operating Tests	6/0	2/0	8/0
Overall	4/2	1/1	5/3

3. Exit Meeting:
Amy E. Beasten, PhD, Chief Examiner, NRC
Michele C. DeSouza, Chief Examiner, NRC
Dr. Edward Goodell, Reactor Facility Director, UUTR
Andrew Allison, Reactor Supervisor, UUTR

Prior to administration, adjustments to the written exam were accepted based on facility comments. These comments provided corrections and additional clarity to questions/answers and identified where changes were appropriate based on current facility conditions.

Upon completion of all operator licensing examinations, the NRC examiner met with facility staff representatives to discuss the results. The NRC examiners discussed some apparent weaknesses among the expected level of knowledge for RO and SRO candidates. Examiner observations included: weakness in Administrative Topics, including staffing requirements and fuel handling; weaknesses regarding nuclear instrumentation, how signals are produced, the indications provided in the control room, and general overreliance on digital readouts. The NRC examiners also noted some gaps in basic operational theory, such as how to estimate and understand critical rod positions. At the conclusion of the meeting, the NRC examiner thanked the facility for their support in the administration of the examination.

FACILITY COMMENTS AND NRC RESOLUTION

QUESTION C.07 [1.00 point]
In accordance with the UUTR Safety Analysis Report, which ONE of the following statements best describes what happens if a loss of console power to the reactor were to occur during full power operations?

a. The reactor will scram automatically, and an uninterruptible power supply will provide power to the radiation monitors.

b. The reactor will scram automatically, and an uninterruptible power supply will provide power to the radiation monitors and the nuclear instrumentation.

c. The reactor will remain fully operational until the uninterruptible power supply runs out of power.

d. The reactor will remain operating, but console indications will be lost.

Answer: a.
Reference: UUTR Safety Analysis Report 8.2

Facility Comment C.07
UUTR Facility Staff requests to modify OL 26-01 written examination question C.07 to have both answer (a.) and (b.) as acceptable answers based upon the following justification:

As previously discussed with examiners, answer (a.) was an acceptable answer due to SAR section 8.2 Emergency Electrical Power Systems referencing UPS to radiation monitors.

Facility staff would like to have answer (b.) added as an additional acceptable answer referencing SAR section 13.2.8 Loss of Normal Electrical Power containing the following statement, "A backup power system present at the UUTR mainly provides conditioned power to the instrumentation." UUTR staff believe this statement could be interpreted as the UPS providing power to nuclear instrumentation and should therefore be an acceptable answer as well for the examination.

NRC Resolution C.07
The NRC determined that the submitted justification for 2 correct answers is not supported. The NRC further reviewed the facility documentation, including Event Notification 58271, dated May 08, 2026. Based on the facility documentation, EN 58271, and discussions with the facility prior to exam administration, the NRC has determined there is no clear single answer to this question and has deemed the question invalid and as a result deleted it.

University of Utah

Operator Licensing Examination

Week of May 4, 2026

Enclosure 3

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

FACILITY:	University of Utah
REACTOR TYPE:	TRIGA
DATE ADMINISTERED:	May 6, 2026
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 and a 70% overall are 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	**33.0**	________	________	**A. REACTOR THEORY, THERMODYNAMICS, AND FACILITY OPERATING CHARACTERISTICS**
20.00	**33.0**	________	________	**B. NORMAL AND EMERGENCY OPERATING PROCEDURES AND RADIOLOGICAL CONTROLS**
20.00	**33.0**	________	________	**C. FACILITY AND RADIATION MONITORING SYSTEMS**
60.00		________	________%	**TOTALS**
		FINAL GRADE		

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

____
Candidate's Signature

NRC RULES AND GUIDELINES FOR LICENSE EXAMINATIONS

During the administration of this examination the following rules apply:

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

2. 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 <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. Answers written on the line will be taken as the final answer. 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 and a 70 percent overall.

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

Candidate Name:___________________________

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

A N S W E R S H E E T

Multiple Choice (Circle your choice, or write on the line)
If you change your answer, write your final selection on the line. Answers written on the line will be taken as the final answer.

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 _____________ (0.50 each)

A11 a b c d ___

A12 a b c d ___

A13 a _____________ b _____________ c _____________ d _____________ (0.25 each)

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 *****)

Candidate Name:____________________________

Category B: Normal/Emergency Operating Procedures and Radiological Controls

A N S W E R   S H E E T

Multiple Choice (Circle your choice, or write on the line)
If you change your answer, write your final selection on the line. Answers written on the line will be taken as the final answer.

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 ______________ (0.25 each)

B09 a b c d ___

B10 a b c d ___

B11 a b c d ___

B12 a b c d ___

B13 a b c d ___

B14 a b c d ___

B15 a b c d ___

B16 a b c d ___

B17 a b c d ___

B18 a b c d ___

B19 a b c d ___

B20 a b c d ___

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

Candidate Name:___________________________

Category C: Facility and Radiation Monitoring Systems

A N S W E R   S H E E T

Multiple Choice (Circle your choice, or write on the line)
If you change your answer, write your final selection on the line. Answers written on the line will be taken as the final answer.

C01 a b c d ___

C02 a b c d ___

C03 a b c d ___

C04 a b c d ___

C05 a b c d ___

C06 a b c d ___

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 ___

C20 a b c d ___

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

EQUATION SHEET

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

1 kg = 2.21 lb

1 Horsepower = 2.54 x 10^3 BTU/hr

1 Mw = 3.41 x 10^6 BTU/hr

1 BTU = 778 ft-lb

°F = 9/5 °C + 32

1 gal (H_2O) ≈ 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 [1.00 point]
A supercritical reactor has a k_{eff} of 1.074. How much reactivity is added to change the k_{eff} to 0.983?

a. + 0.086 Δk/k

b. – 0.086 Δk/k

c. + 0.931 Δk/k

d. – 0.931 Δk/k

QUESTION A.02 [1.00 point]
Which ONE of the following best describes the reason that, following a reactor scram from full licensed power, indicated reactor power does not immediately decay to zero?

a. In-core nuclear instrumentation lags the prompt drop.

b. Core neutron population is sustained by the delayed neutron precursors.

c. Core neutron population is sustained by spontaneous fission of U-235.

d. Core neutron population is sustained by neutrons from the fission product poisons.

QUESTION A.03 [1.00 point]
All of the following conditions will require movement of control rods to maintain constant reactor power EXCEPT:

a. Primary coolant conductivity increase.

b. U-235 burnup.

c. Xe-135 buildup.

d. Tank water temperature decrease.

QUESTION A.04 [1.00 point]
Which ONE of the following statements best describes the importance of a negative temperature coefficient of reactivity?

a. As fuel temperature increases, the concentration of fission product poisons in the fuel matrix increases, adding negative reactivity through increased neutron absorption.

b. As fuel temperature increases, moderator temperature increases rapidly through conduction heat transfer, adding negative reactivity.

c. An increase in reactor power causes an increase in fuel temperature which results in a negative reactivity addition, causing the power increase to slow or stop.

d. As fuel temperature increases, U-235 in the fuel is consumed, causing Pu-239 to form which becomes additional sources of fission causing control rods to be withdrawn farther, adding negative reactivity.

QUESTION A.05 [1.00 point]
During the initial rise to power, the nuclear instruments show that when K_{eff} is 0.87, the count rate is 1320 cps. Once reactivity has been added, what count rate would correspond with a K_{eff} of 0.92?

a. 1625 cps

b. 2001 cps

c. 2145 cps

d. 3250 cps

QUESTION A.06 [1.00 point]
Which ONE of the following best describes the values of K_{eff} and ρ during the power increment when the reactor is increasing power from 10 kW to 100 kW in a prompt criticality?

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

b. $K_{eff} > 1$ and $0 < \rho < \beta_{eff}$

c. $K_{eff} > 1$ and $\rho > 1$

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

QUESTION A.07 [1.00 point]
All of the following statements are possible effects of control rod shadowing EXCEPT:

a. Decrease in indicated reactor power.

b. Increase in fuel temperature.

c. Increase in time needed for in-core irradiation of a fixed experiment.

d. Decrease in bulk pool water temperature.

QUESTION A.08 [1.00 point]
Which ONE of the following best describes the difference between prompt and delayed neutrons?

a. Prompt neutrons are produced immediately and directly from the fission event and delayed neutrons are produced immediately following the first beta decay of fission fragments.

b. Prompt neutrons are produced from spontaneous fission of U-235 in the fuel, and delayed neutrons are the result of fission in U-238.

c. Prompt neutrons ensure there is a sufficient neutron population to overcome the effects of fission product poisoning following a shutdown and delayed neutrons are responsible for lengthening the neutron generation time to ensure the reactor does not go prompt critical.

d. Prompt neutrons are responsible for the ability to control the rate at which power can rise in the reactor and delayed neutrons are responsible for the rate at which a reactor can be shut down.

QUESTION A.09 [1.00 point]
All of the following factors in the six-factor formula are affected by the enrichment of U-235 in the fuel EXCEPT:

a. Reproduction Factor

b. Thermal Utilization Factor

c. Resonance Escape Probability

d. Thermal Non-Leakage Probability

QUESTION A.10 [2.00 point, 0.50 each]
Match the terms in Column A with the result in Column B to complete the following statements. Answers in Column B may be used once, more than once, or not at all:

As moderator temperature decreases, [Column A] [Column B].

Column A	**Column B**
a. Thermal Utilization Factor	1. Decreases
b. Reproduction Factor	2. Increases
c. Resonance Escape Probability	3. Stays the same
d. Fast Fission Factor	

QUESTION A.11 [1.00 point]
Approximately how long will it take reactor power to increase from 2W to 60kW, if reactor period is 70 seconds?

a. 6.7 minutes

b. 8.5 minutes

c. 9.3 minutes

d. 12 minutes

QUESTION A.12 [1.00 point]
While bringing the reactor critical, which ONE of the following describes how a subcritical reactor responds to equal insertions of positive reactivity?

a. Each reactivity insertion results in a larger increase in neutron flux resulting in a shorter time to stabilize.

b. Each reactivity insertion results in a smaller increase in neutron flux resulting in a shorter time to stabilize.

c. Each reactivity insertion results in a larger increase in neutron flux resulting in a longer time to stabilize.

d. Each reactivity insertion results in a smaller increase in neutron flux resulting in a longer time to stabilize.

QUESTION A.13 [1.00 point, 0.25 each]
Match the neutron interaction in Column A with the reaction type (symbol) in Column B. Options in Column B may be used once, more than once, or not at all.

Column A	**Column B**
a. Elastic scattering	1. (n, γ)
b. Inelastic scattering	2. (n, p)
c. Charged particle interaction	3. (n, n')
d. Radiative capture	4. (n, n)

QUESTION A.14 [1.00 point]
Which ONE of the following statements best describes the moderator-to-fuel ratio?

a. Decreasing the moderator-to-fuel ratio will increase the resonance escape probability.

b. Increasing the moderator-to-fuel ratio will increase the thermal utilization factor

c. Increasing the moderator temperature will decrease the moderator-to-fuel ratio.

d. Increasing the moderator temperature will decrease the moderator-to-fuel ratio.

QUESTION A.15 [1.00 point]
What is the remaining percentage of power following the prompt drop in the reactor power when a rod worth of 0.85 ΔK/K is rapidly inserted into a critical reactor? Assume β_{eff} = 0.0065

a. - 1.15%

b. 0.65 %

c. 1.40%

d. 1.98%

QUESTION A.16 [1.00 point]
Which ONE of the following statements best describes the mean free path?

a. The average distance a neutron travels before being absorbed.

b. The average distance a neutron travels between collisions.

c. The probability of a neutron interacting with a nucleus per centimeter of travel.

d. The probability of a neutron being absorbed per centimeter of travel.

QUESTION A.17 [1.00 point]
Which ONE of the following isotopes has the largest microscopic absorption cross-section for thermal neutrons?

a. Boron-10

b. Uranium-235

c. Xenon-135

d. Samarium-149

QUESTION A.18 [1.00 point]
All of the following statements regarding moderator properties are true EXCEPT:

a. A good moderator has a large absorption cross-section and a small scattering cross-section.

b. A good moderator has a small absorption cross-section and a large scattering cross-section.

c. A good moderator has a large energy loss per collision.

d. A good moderator slows neutrons to reduce the amount of neutron leakage from the core.

QUESTION A.19 [1.00 point]
Which ONE of the following is defined as the balance between production of neutrons and their absorption and leakage in the core?

a. Utilization Factor.

b. Reproduction Factor.

c. Infinite Multiplication Factor.

d. Effective Multiplication Factor.

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

Category B: Normal/Emergency Operating Procedures and Radiological Controls

QUESTION B.01 [1.00 point]
In accordance with the UNEF Emergency Plan, which ONE of the following statements best describes the Site Boundary?

a. Rooms 1206 MEB and 1205(A-K) MEB.

b. The area which includes the reactor room and the control room.

c. The area encompassed by the building extending 250 feet from the center of the pool.

d. The area encompassed by the building extending 500 feet from the center of the pool.

QUESTION B.02 [1.00 point]
The radiation from an unshielded source is 175 mrem/hr. A 15-mm thick lead sheet is inserted and the radiation level drops to 150 mrem/hr. What is the half-value-layer (HVL) of lead?

a. 15.5 mm

b. 33.8 mm

c. 47.6 mm

d. 67.3 mm

QUESTION B.03 [1.00 point]
In accordance with the UUTR Technical Specifications, all of the following conditions are permissible during reactor operations EXCEPT:

a. Reactor power indicates 95kW on all power monitoring channels.

b. Reactor tank water is 5 μmhos/cm.

c. Reactor period is 7 seconds.

d. Reactor tank water level is 15” below the top of the UUTR tank.

QUESTION B.04 [1.00 point]
In accordance with UNEP-002, Biennial Fuel/Tank/Control Rod/Reflector Element Inspection, which ONE of the following statements regarding fuel handling is TRUE?

a. Damper is disabled.

b. A licensed reactor operator is not required to be present at the console if fuel is being moved in the storage racks.

c. The regulating rod is withdrawn to 100%.

d. The central thimble is plugged with lead.

QUESTION B.05 [1.00 point]
In accordance with 10 CFR Part 20, which ONE of the following statements best describes the Total Effective Dose Equivalent?

a. The derived limit for the amount of radioactive material taken into the body of an adult worker by inhalation or ingestion in a year.

b. The sum of the effective dose equivalent for external exposures and the committed effective dose equivalent for internal exposures.

c. The sum of the products of the weighting factors applicable to each of the body organs or tissues that are irradiated and the committed dose equivalent to these organs or tissues.

d. The sum of the products of the dose equivalent to the organ or tissue and the weighting factors applicable to each of the body organs or tissues that are irradiated

QUESTION B.06 [1.00 point, 0.25 each]
In accordance with the UUTR Technical Specifications, match the surveillance activity in Column A with the required frequency in Column B. Options in Column B may be used once, more than once, or not at all.

Column A	**Column B**
a. Radiation monitoring system channel calibration	1. Monthly
b. Reactor tank water level monitor channel check	2. Semi-annual
c. Control rod reactivity worth determination	3. Annual
d. Fuel element temperature channel test	4. Biennial

QUESTION B.07 [1.00 point]
An experiment reading 225 mrem/hr was removed from the reactor. Three hours later, it reads 75 mrem/h. What is the half-life of the experiment?

a. 0.98 hr

b. 1.89 hr

c. 2.02 hr

d. 3.33 hr

QUESTION B.08 [1.00 point, 0.25 each]
In accordance with the UNEF Emergency Plan, match the event in Column A with the classification in Column B. Options in Column B may be used once, more than once, or not at all.

Column A	**Column B**
a. Earthquake during operation.	1. Non-Reactor Safety Related Event
b. Receipt of bomb threat against the MEB.	2. Notification of Unusual Event
c. Injured person with contamination.	3. Alert
d. Fire lasting more than 15 minutes.	

QUESTION B.09 [1.00 point]
In accordance with UUTR-12, Semi-Annual Thermal Power Calibration, all of the following conditions must be met EXCPET:

a. The reactor must not have been operated for the previous 10 days to allow time for the fuel to cool.

b. Primary cooling system is off.

c. Reactor power must be maintained for a minimum of two hours.

d. Adjustments to the power monitoring channels may be made if recorded power and calculated power deviate by more than 5%.

QUESTION B.10 [1.00 point]
In accordance with the UNEF Emergency Plan, in the event of an unanticipated high-level radiation alarm while removing experiments from the reactor tank, which ONE of the following actions should the Reactor Operator take?

a. Scram and secure the reactor.

b. Secure ventilation.

c. Perform a radiation survey in the reactor room and post the area as a high radiation area.

d. Return the sample to the tank unless authorization was received to operate within a high radiation area.

QUESTION B.11 [1.00 point]
In accordance with the UUTR Technical Specifications, which ONE of the following values describes the facility Safety Limit?

a. 500 °C for a stainless steel-clad, high hydride fuel element in the B ring.

b. 800 °C for an aluminum clad, low hydride fuel element in the B ring.

c. 1000 °C for a stainless steel-clad, high hydride element in any ring.

d. 1000 °C for an aluminum clad, low hydride element in the E or F ring.

QUESTION B.12 [1.00 point]
An irradiated sample has a dose rate of 2.0 rem/hr as indicated at a distance of 4 meters from the sample. How far from the irradiated sample should the High Radiation Area posting be?

a. 8.3 m

b. 13.7 m

c. 17.9 m

d. 18.2 m

QUESTION B.13 [1.00 point]
In accordance with UUTR-01, Prestart, Operation, and Termination Procedure, all of the following equipment MUST be ON before reactor operations can commence EXCEPT:

a. UPS and UPS computers

b. Cleanup pump

c. Primary cooling

d. Ventilation damper control enabled

QUESTION B.14 [1.00 point]
In accordance with the UNEF Emergency Plan, all of the following actions should be taken by the Reactor Operator in the event of a loss of primary water in the reactor tank EXCEPT:

a. Immediately connect the water hose on the west wall of the reactor room and flood the tank, regardless of water level.

b. Ensure the cooling pumps are secured.

c. Close any valves to stop further loss if a siphon is occurring.

d. Evacuate the facility if tank level is less than 10 feet above the core.

QUESTION B.15 [1.00 point]
In accordance with the UUTR Technical Specifications, all of the following experiments are permissible at the UUTR EXCEPT:

a. Two unsecured experiments with reactivity worths of $0.95 and $-0.15.

b. An experiment containing 15 mg TNT is irradiated in a container rated to 45 mg detonation pressure.

c. An experiment containing a small quantity of hydrochloric acid (HCl) is doubly encapsulated.

d. An experiment containing 10mg TRISO fuel.

QUESTION B.16 [1.00 point]
What is the dose rate at 1 foot, given 85% of the decay of a 7 Curie source results in emission of a 230 keV gamma?

a. 8.21 R/hr

b. 10.3 R/hr

c. 12.9 R/hr

d. 15.7 R/hr

QUESTION B. 17 [1.00 point]
In accordance with 10 CFR 50.59, all of the following changes would require a 50.59 evaluation EXCEPT:

a. Administratively changing the linear power scram setpoint to 95 kW.

b. Replacing the power monitor with a fission chamber.

c. Moving the instrumented fuel element from the B-ring to the F-ring.

d. Revising UUTR-01, Prestart, Operation, and Termination Procedure to adjust spelling, grammar, and formatting.

QUESTION B.18 [1.00 point]
In accordance with the UNEF Emergency Plan, all of the following are responsibilities of the Onsite Emergency Coordinator (OEC) EXCEPT:

a. Perform off-site dose projections.

b. Terminate an emergency.

c. Authorizing radiation exposures to emergency team members in excess of normal occupational limits.

d. Making protective action decisions.

QUESTION B.19 [1.00 point]
In accordance with the UUTR Technical Specifications, which ONE of the following operational events would require the presence of a Senior Reactor Operator?

a. Normal reactor shutdown.

b. Steady-state operations lasting more than one hour.

c. Relocation of any in-core experiment worth $1.00 or more.

d. Stuck or dropped control rods.

QUESTION B.20 [1.00 point]
In accordance with the UUTR Technical Specifications, the RSC has all of the following responsibilities EXCEPT:

a. Review all new procedures.

b. Review proposed changes to the Technical Specifications.

c. Review and approve changes to requalification program requirements.

d. Review new experiments.

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

Category C: Facility and Radiation Monitoring Systems

QUESTION C.01 [1.00 point]
In accordance with the UUTR Safety Analysis Report, which ONE of the following statements best describes the control rod drives?

a. Acme-screw type motor

b. Rack-and-pinion motor

c. Worm gear

d. Stepper motor

QUESTION C.02 [1.00 point]
In accordance with the UUTR Safety Analysis Report, pool temperature is limited to ________ in order to ___________________________.

a. 25 °C; prevent thermal stress on core components and the tank liner.

b. 35 °C; prevent the safety limit from being reached.

c. 35 °C; prevent degradation of the resin bed purifying system.

d. 40 °C; prevent boiling, formation of voids, and damage to core components.

QUESTION C.03 [1.00 point]
In accordance with the UUTR Technical Specifications, which ONE of the following statements concerning radiation monitoring operability is true?

a. The reactor can be operable for 24 hours if the area radiation monitor is inoperable provided portable monitoring equipment is used.

b. The reactor can be operable for 24 hours if neither the continuous air monitor nor the area radiation monitor are operable.

c. The reactor can be operable for 48 hours without the continuous air monitor if the area radiation monitor is operable.

d. The reactor can be operable for 48 hours without the area radiation monitor if the continuous air monitor is operable.

Category C: Facility and Radiation Monitoring Systems

QUESTION C.04 [1.00 point]
In accordance with the UUTR Safety Analysis Report, which ONE of the following statements best describes how the fission chamber produces a detectable signal at very low power levels?

a. The detector has two chambers, one which is sensitive to gammas and neutrons, and the other, which is sensitive to only gammas, allows the gamma signal to be subtracted.

b. Neutrons are distinguished from gammas using a pulse height discriminator.

c. A current signal, similar to an ion chamber, is used since there is no need to discriminate between neutrons and gammas at such a low power.

d. Neutrons at this power are too low energy to enter the chamber, so individual gammas are counted and converted to a signal.

QUESTION C.05 [1.00 point]
In accordance with the UUTR 50.59 Continuous Air Monitor Upgrade with TA CAM-33, which ONE of the following statements best describes the where Continuous Air Monitor samples?

a. The reactor stack.

b. Reactor room near the top of the reactor tank.

c. Reactor room exhaust air after the HEPA filter in the ventilation system.

d. Reactor room exhaust air prior to the HEPA filter in the ventilation system.

QUESTION C.06 [1.00 point]
Which ONE of the following reactions best describes how the neutron startup source functions at the UUTR?

a. $^{252}Cf \rightarrow$ Fission Products + 3-4 neutrons

b. $^{241}Am \rightarrow {}^{237}Np + \alpha$
$\alpha + Be \rightarrow {}^{12}C + n$

c. $^{239}Pu \rightarrow {}^{235}U + \alpha$
$\alpha + Be \rightarrow {}^{12}C + n$

d. $^{124}Sb \rightarrow {}^{124}Te + \gamma$
$\gamma + Be \rightarrow {}^{8}Be + n$

~~**QUESTION C.07 [1.00 point]**~~ ~~**Question deleted**~~
~~In accordance with the UUTR Safety Analysis Report, which ONE of the following statements best describes what happens if a loss of console power to the reactor were to occur during full power operations?~~

~~a. The reactor will scram automatically, and an uninterruptible power supply will provide power to the radiation monitors.~~

~~b. The reactor will scram automatically, and an uninterruptible power supply will provide power to the radiation monitors and the nuclear instrumentation.~~

~~c. The reactor will remain fully operational until the uninterruptible power supply runs out of power.~~

~~d. The reactor will remain operating, but console indications will be lost.~~

QUESTION C.08 [1.00 point]
In accordance with the UUTR Safety Analysis Report, which ONE of the following statements best describes the flow of air through the facility ventilation system in Limited Intake Mode?

a. The supply fan from the main ventilation system slows to reduce the volume of air introduced into the reactor room, and air continues to exhaust at the same volume through the stack.

b. The supply damper closes and air is exhausted through the HEPA filters and then through the stack.

c. The supply fan from the main ventilation systems slows to reduce the volume of air introduced into the reactor room and the exhaust damper shuts to prevent uncontrolled release or radiation.

d. The supply damper closes and the exhaust fan stops so that all air is coming into the reactor room is limited to ingress and egress.

QUESTION C.09 [1.00 point]
In accordance with the UUTR Technical Specifications, which ONE of the following actions would be considered a channel CALIBRATION?

a. Comparison of current wide range linear monitor indications with wide range linear monitor indications at the same power levels during previous reactor operations.

b. Adjustment of the wide range linear monitor indications while at power to correct for instrument drift.

c. Adjustment of the wide range linear monitor indications following performance of the thermal power calibration to ensure the monitor indicates correctly.

d. Comparison of wide range linear monitor indications with fission chamber indications of reactor power.

QUESTION C.10 [1.00 point]
In accordance with the UUTR Safety Analysis Report, which ONE of the following statements best describes how the exhaust from the pneumatic transfer system is released?

a. The exhaust is recycled so it can be used again.

b. The exhaust is vented directly outside the building since it is helium instead of compressed air so the risk of producing any radioisotopes is negligible.

c. The exhaust is vented from the counting laboratory into the reactor room where it mixes with the reactor room air before being released through the stack.

d. The exhaust passes through a pre-filter and a HEPA filter before continuing up the stack.

QUESTION C.11 [1.00 point]
In accordance with the UUTR Safety Analysis Report, a gaseous effluent commonly produced from reactor operation is _______ which is ________________.

a. F-19; produced from the irradiation of water.

b. I-135; produced as a byproduct of fission.

c. N-16; produced from the irradiation of water.

d. Rn-222; a naturally occurring isotope.

QUESTION C.12 [1.00 point]
Which ONE of the following statements best describes the Log/Lin power channel?

a. It is an uncompensated ion chamber lined with boron that detects neutrons and gammas.

b. It is a compensated ion chamber that has a chamber lined with boron which detects neutrons and gammas, and an unlined chamber which can only detect gammas. The combined signal compensates for gammas to provide a neutron-only signal.

c. It is an ion chamber lined with BF_3 which detects neutrons and gammas.

d. It is an unlined uncompensated ion chamber which can detect neutrons and gammas.

QUESTION C.13 [1.00 point]
In accordance with the UUTR Safety Analysis Report, confinement is maintained at a ____________ pressure which ________________________________.

a. negative; reduces the amount of radioactivity released into the environment and controls the release of radioactive effluents through the stack.

b. negative; ensures radioactivity release during abnormal and emergency operation leaves confinement so staff and emergency response can safely respond to the event.

c. positive; reduces the amount of radioactivity released into the environment and controls the release of radioactive effluents through the stack.

d. positive; ensures radioactivity release during abnormal and emergency operation leaves confinement so staff and emergency response can safely respond to the event.

QUESTION C.14 [1.00 point]
In accordance with the UUTR Technical Specifications, which ONE of the following statements, which ONE of the following statements best describes the basis for the reactivity limits on experiments?

a. It ensures that the insertion or removal of the total worth of any single experiment will not cause reactor power to exceed the licensed power limit.

b. It ensures that the removal of the total worth of any single experiment, or of all experiments, will not exceed the safety limits.

c. It ensures that the failure of any single experiment will not cause damage to the reactor components.

d. It ensures that the failure of any single experiment will not cause a release of airborne radioactivity to the reactor bay that would result in exceeding the total dose limits to an individual as specified in 10 CFR Part 20.

QUESTION C.15 [1.00 point]
In accordance with the UUTR Safety Analysis Report, which ONE of the following statements best describes the reactor fuel?

a. UZrH containing 20 wt% uranium enriched to 8.5% in U-238, clad in stainless steel or aluminum

b. UZrH containing 20 wt% uranium enriched to 8.5% in U-235, clad in stainless steel or aluminum.

c. UZrH containing 8.5 wt% uranium enriched to 20% in U-235, clad in stainless steel or aluminum.

d. UZrH containing 8.5 wt% uranium enriched to 20% in U-238, clad in stainless steel or aluminum.

QUESTION C.16 [1.00 point]
In accordance with the UUTR Technical Specifications, which ONE of the following statements best describes the basis for the maximum available excess reactivity based on reference core configurations?

a. This prevents power excursion events should an installed experiment fail.

b. This ensures that rod movement is controlled to prevent an uncontrolled change in reactor power.

c. This provides the capability to operate the reactor at full power with experiments in place.

d. This is the value that ensures the reactor can be shut down from any operating condition even if the most reactive control rod remains fully withdrawn.

QUESTION C.17 [1.00 point]
Which ONE of the following best describes the reason for the high sensitivity of a Geiger-Müller detector?

a. Any incident radiation event causing primary ionization results in ionization of the entire detector.

b. It is coated with special nuclear material that causes high ionizations at low concentrations.

c. The lower voltage applied to the detector helps to amplify all incident events.

d. It has a large tube, so the target area is bigger for all incident events.

QUESTION C.18 [1.00 point]
In accordance with the UUTR Safety Analysis Report, which ONE of the following statements best describes the control rod limit switches?

a. Rod UP, Rod DOWN, Magnet DOWN

b. Rod UP, Magnet UP, Rod DOWN

c. Magnet UP, Rod Down, Magnet DOWN

d. Magnet UP, Magnet DOWN, Rod UP

QUESTION C.19 [1.00 point]
In accordance with the UUTR 50.59, Replacement of Secondary Cooling System and Modification of Purification System, which ONE of the following statements best describes how cross-contamination of the primary and secondary water is prevented?

a. Primary system flow rate is maintained higher than secondary.

b. The secondary system is only in service when the reactor is shut down.

c. The secondary loop is a closed loop from the reactor bay heat exchanger to a second heat exchanger located in the Merrill Engineering Building's machinery room, enabling isolation of reactor water in the primary loop to remain in the reactor facility.

d. A double-walled heat exchanger is used to prevent cross-contamination of the secondary system.

QUESTION C.20 [1.00 point]
In accordance with the UUTR Safety Analysis Report, which ONE of the following statements best describes the dashpot action of the control rods?

a. Control rods are decelerated over the final 2 inches of downward travel using water to dampen the shock on the rods following a reactor scram.

b. Control rods are decelerated over the final 2 inches of travel using water to provide time for the motor to reconnect with each rod following a reactor scram.

c. Control rod motion is slowed in the middle 2 inches of full range of travel to ensure proper reactivity removal and insertion rates.

d. Control rods are decelerated over the final 2 inches of upward travel using air to dampen to precent mechanical stress to the drive and motor.

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

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

A.01
Answer: b.
Reference: $\Delta\rho = (k_{eff2}-k_{eff1})/(k_{eff1}*k_{eff2})$
$\Delta\rho = (0.983-1.074) / (1.074*0.983)$
$\Delta\rho = (-0.091) / 1.056$
$\Delta\rho = -0.086\ \Delta k/k$

A.02
Answer: b.
Reference: DOE Fundamentals Handbook, Volume 1, Module 2, p 23-24.

A.03
Answer: a.
Reference: Burn, *Introduction to Nuclear Reactor Operators,* Volume 2, p. 7-17

A.04
Answer: c.
Reference: DOE Fundamentals Handbook, Volume 2, Module 3, p. 28

A.05
Answer: c.
Reference: $CR_1 * (1 – K_{eff1}) = CR_2 * (1 – K_{eff2})$
$1320 * (1 – 0.87) = CR_2 * (1 – 0.92)$
$171.6 = CR_2 * 0.08$
$CR_2 = 2145$

A.06
Answer: a.
Reference: Burns, *Introduction to Nuclear Reactor Operators*, Volume 2, p. 3-21

A.07
Answer: d.
Reference: Burn, *Introduction to Nuclear Reactor Operations*, p. 7-12

A.08
Answer: a.
Reference: DOE Fundamentals Handbook, Vol. 1, p. 29

A.09
Answer: d.
Reference: DOE Fundamentals Handbook, Volume 2, Module 3, p. 16

A.10
Answer: a. 1 (Decreases); b. 3 (Stays the same); c. 2 (Increases); d. 3 (Stays the same)
Reference: DOE Fundamentals Handbook, Volume 1, Module 1, p. 3-16

A.11
Answer: d.
Reference: $P(t) = P(0)e^{t/T}$
$60kW = 0.002kW*e^{t/70}$
$60kW / 0.002kW = e^{t/70}$
$\ln(30000) = \ln(e^{t/70})$
$10.31 = t/70$
t = 721.6 s = 12 minutes

A.12
Answer: c.
Reference: Burn, R., Introduction to Nuclear Reactor Operation, Section 5.3, p. 5-12

A.13
Answer: a. 4; b. 3; c. 2; d. 1
Reference: Burn, *Introduction to Nuclear Reactor Operations*, Section 2.4.5, 2-28

A.14
Answer: c. or d.
Reference: DOE Fundamentals Handbook, Volume 2, Module 3, p. 24-25

A.15
Answer: c.
Reference: $\frac{P_1}{P_0} = \frac{\beta_{eff} \cdot (1 - p)}{\beta_{eff} - p}$
$P_1/P_0 = (0.0065 \times (1+0.85)) / (0.0065+0.85)$
$P_1/P_0 = 0.014$
$P_1/P_0 = 1.4\%$

A.16
Answer: b.
Reference: Burn, Introduction to Nuclear Reactor Theory, p. 2-43

A.17
Answer: c.
Reference: Burn, Introduction to Nuclear Reactor Operations, Section 8.1

A.18
Answer: a.
Reference: DOE Fundamentals Handbook, Volume 1, Module 2, p 23-24

A.19
Answer: d.
Reference: DOE Fundamentals Handbook, Volume 2, Module 3, p. 15

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

Category B: Normal/Emergency Operating Procedures and Radiological Controls

B.01
Answer: c.
Reference: UNEF Emergency Plan, Section 2

B.02
Answer: d.
Reference: $DR = DR_0 * e^{-\mu X}$
Find μ:
$150 = 175 * e^{-\mu * 15}$
$0.857 = e^{-\mu * 15}$
$\ln(0.857) = \ln(e^{-\mu * 15})$
$-0.154 = -\mu * 15$
$\mu = 0.0103$

If insertion of an HVL (thickness of lead), the original intensity will be reduced by half.
Find X:

$1 = 2 * e^{-0.0103 * X}$
$0.5 = e^{-0.0103 * X}$
$\ln(0.5) = \ln(e^{-0.0103 * X})$
$-0.693 = -0.0103 * X$
X= 67.3 mm

B.03
Answer: b.
Reference: UUTR Technical Specifications 3.1.1, 3.3, 3.2.3

B.04
Answer: b.
Reference: UUTR-002, Biennial Fuel/Tank/Control Rod/Reflector Element Inspection

B.05
Answer: b.
Reference: 10 CFR 20.1003

B.06
Answer: a. 3 (Annual); b. 1 (Monthly); c. 2 (Semi-annual); d. 3 (Annual)
Reference: UUTR Technical Specifications 4.1, 4.2, 4.3, 4.7

B.07
Answer: b.
Reference: $DR = DR_0 e^{-\lambda t}$, $T_{\frac{1}{2}} = \frac{0.693}{\lambda}$
$DR = DR_0\, e^{-.693(t)/T1/2}$
$75 = 225\, e^{-(.693)(3)/T1/2}$
$0.333 = e^{-(.693)(3)/T1/2}$
$\ln(0.333) = \ln(e^{-(.693)(3)/T1/2})$
$-1.099 = -2.079 / T_{1/2}$
$T_{1/2} = -2.079 / -1.099$
$T_{1/2} = 1.89$ hr

Category B: Normal/Emergency Operating Procedures and Radiological Controls

B.08
Answer: a. 2 (NOUE); b. 1 (Non reactor event); c. 1 (Non reactor event); d. 2 (NOUE)
Reference: UNEF Emergency Plan 4.1 and 4.2

B.09
Answer: a.
Reference: UUTR-12, Semi-Annual Thermal Power Calibration

B.10
Answer: d.
Reference: UNEF Emergency Plan 11.8, High Radiation Alarm

B.11
Answer: c.
Reference: UUTR Technical Specifications 2.1

B.12
Answer: c.
Reference: $DR_1 * (D_1)^2 = DR_2 * (D_2)^2$
2000 mrem/hr $(4)^2 = 100$ mrem/hr $(d)^2$
$32{,}000$ mrem/hr $= 100\ (d)^2$
$320 = d^2$
$D = 17.9$ m

B.13
Answer: c.
Reference: UUTR-01, Prestart, Operation, and Termination Procedure

B.14
Answer: a.
Reference: UNEF Emergency Plan, 11.10 Loss of Primary Water in the Reactor Tank

B.15
Answer: d.
Reference: UUTR Technical Specifications 3.8.1, 3.8.2, 3.8.3

B.16
Answer: a.
Reference: 6 Cen = R/hr at 1 ft
(6 * 7 Ci) x (0.85 * 0.230)
8.211 R/hr at 1 ft

B.17
Answer: d.
Reference: 10 CFR 50.59

B.18
Answer: a.
Reference: UNEF Emergency Plan 3.1.1

B.19
Answer: c.
Reference: UUTR Technical Specification 6.1.3

B.20
Answer: c.
Reference: UUTR Technical Specification 6.2.3

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

Category C: Facility and Radiation Monitoring Systems

C.01
Answer: b.
Reference: UUTR SAR 4.2.2

C.02
Answer: c.
Reference: UUTR SAR 5.1

C.03
Answer: c.
Reference: UUTR Technical Specifications 3.7.1

C.04
Answer: b.
Reference: UUTR SAR 7.2.3.1

C.05
Answer: b.
Reference: UUTR 50.59 Continuous Air Monitor Upgrade with TA CAM-33

C.06
Answer: c.
Reference: UUTR SAR 4.2.4
DOE Fundamentals Handbook, Vol. 1, Module 2, p.3

~~**C.07**~~
~~Answer: a.~~
~~Reference: UUTR SAR 8.2~~
Question deleted, no clear single correct answer

C.08
Answer: b.
Reference: UUTR SAR 9.1.4.2

C.09
Answer: c.
Reference: UUTR Technical Specification 1.3

C.10
Answer: d.
Reference: UUTR SAR 10.2.1.2

C.11
Answer: c.
Reference: UUTR SAR 11.1.1

C.12
Answer: a.
Reference: UUTR SAR 7.2.3.1
UUTR 50.59 Replacement of UUTR Control Console with a new Thermo-Fisher Gamma-Metrics (TFGM) Console

<u>Category C: Facility and Radiation Monitoring Systems</u>

C.13
Answer: a.
Reference: UUTR SAR 9.1

C.14
Answer: b.
Reference: UUTR Technical Specification 3.8.1

C.15
Answer: c.
Reference: UUTR SAR 4.2.1.1

C.16
Answer: c.
Reference: UUTR Technical Specifications 3.1.3

C.17
Answer: a.
Reference: Standard NRC question

C.18
Answer: c.
Reference: UUTR SAR 7.3.1

C.19
Answer: d.
Reference: UUTR 50.59, Replacement of Secondary Cooling System and Modification of Purification System

C.20
Answer: a.
Reference: UUTR SAR 7.3.1

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