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

December 18, 2019

Matthew Lund
Interim Director
Utah Nuclear Engineering Program
Joseph Merrill Engineering Building
50 S. Central Campus Drive, Room 1206
Salt Lake City, UT 84112

SUBJECT: EXAMINATION REPORT NO. 50-407/OL-20-01, UNIVERSITY OF UTAH

Dear Mr. Lund:

During the week of November 18, 2019, the U.S. Nuclear Regulatory Commission (NRC) administered an operator licensing examination at your University of Utah 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 Ms. Michele DeSouza at (301) 415-0747 or via internet e-mail Michele.DeSouza@nrc.gov or Mr. William Schuster at (301) 415-1590 or via internet email William.Schuster@nrc.gov.

Sincerely,

Anthony J. Mendiola, 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-20-01
2. Written Examination

cc: w/o enclosures: See next page

University of Utah Docket No. 50-407

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

Dr. Andrew S. Weyrich
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University of Utah
201 S President's Circle, Room 210
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75 S 2000 E, Room 322
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Dr. Diane Pataki
Associate Vice President for Research
University of Utah
201 President's Circle, Room 210
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Test, Research and Training
Reactor Newsletter
Attention: Ms. Amber Johnson
Dept of Materials Science and Engineering
University of Maryland
4418 Stadium Drive
College Park, MD 20742-2115

Director, Division of Radiation Control
Dept. of Environmental Quality
195 North 1950 West
P.O. Box 14485
Salt Lake City, UT 84114-4850

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

REPORT NO.: 50-407/OL-20-01

FACILITY DOCKET NO.: 50-407

FACILITY LICENSE NO.: R-126

FACILITY: University of Utah

EXAMINATION DATES: November 18-20, 2019

SUBMITTED BY: Michele DeSouza 11/26/2019
Michele DeSouza, Chief Examiner Date

SUMMARY:
During the week of November 18, 2019, the NRC administered an operator licensing examination to three Reactor Operator (RO), one Senior Reactor Operator Instant (SRO-I) and one Senior Reactor Operator Upgrade (SRO-U). The candidates passed all applicable portions of the examinations.

REPORT DETAILS

1. Examiner: Michele DeSouza, Chief Examiner, NRC
William C Schuster IV, Chief Examiner, NRC

2. Results:

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

3. Exit Meeting:
Michele C. DeSouza, Chief Examiner, NRC
William C Schuster IV, Chief Examiner, NRC
Matthew Lund, University of Utah Reactor Supervisor

Prior to administration of the written examination, based on facility comments, adjustments were accepted. Upon completion of the examination, the NRC Examiners met with facility staff representative to discuss the results. A facility weakness was identified as the documentation of the changes to the nuclear instrumentation and components was not available to candidates. The examiners encouraged the licensee to document the nuclear instrumentation and component changes promptly. The processing of facility examination results is imperative due to lack of Utah licensed personnel. At the conclusion of the meeting, the NRC examiner thanked the facility for their support in the administration of the examination.

U.S.NRC
UNITED STATES NUCLEAR REGULATORY COMMISSION
Protecting People and the Environment

UNIVERSITY OF UTAH

Operator Licensing Examination

Week of November 18, 2019

ENCLOSURE 2

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

FACILITY: UUTR

REACTOR TYPE: TRIGA

DATE ADMINISTERED: 11/19/2019

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.

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

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

____
Candidate's Signature

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 ___

A02 a b c d ___

A03 a b c d ___

A04 a ___ b ___ c ___ d ___ (0.25 each)

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 ___

B07 a b c d ___

B08 a b c d ___

B09 a b c d ___

B10 a b c d ___

B11 a b c d ___

B12 a b c d ___

B13 a b c d ___

B14 a b c d ___

B15 a b c d ___

B16 a b c d ___

B17 a b c d ___

B18 a b c d ___

B19 a b c d ___

B20 a ___ b ___ c ___ d ___ (0.25 each)

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

Category C – Facility and Radiation 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 ___ (0.5 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 ___ (0.33 each)

C18 a b c d ___

C19 a b c d ___

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

NRC RULES AND GUIDELINES FOR LICENSE EXAMINATIONS

During the administration of this examination the following rules apply:

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

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

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

4. Use black ink or dark pencil <u>only</u> to facilitate legible reproductions.

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

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

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

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

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

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

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

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

EQUATION SHEET

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

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

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

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

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

$$\ell^* = 1\times10^{-4}\sec$$

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

1 Horsepower = 2.54 x 10^3 BTU/hr

1 BTU = 778 ft-lb

1 gal (H_2O) ≈ 8 lb

c_P = 1.0 BTU/hr/lb/°F

1 kg = 2.21 lb

1 Mw = 3.41 x 10^6 BTU/hr

°F = 9/5 °C + 32

°C = 5/9 (°F - 32)

c_p = 1 cal/sec/gm/°C

Category A: Theory, Thermodynamics & Facility Operating Characteristics

Question A.01 [1.0 point]
A reactor is subcritical with a K_{eff} of 0.927. If you add 7.875% Δk/k into the core, the reactor will be: (Calculations should use three significant digits)

a. Subcritical

b. Critical

c. Supercritical

d. Prompt Critical

Question A.02 [1.0 point]
Which ONE of the following is the time period in which the MAXIMUM amount of Xe-135 will be present in the core?

a. 1 to 2 hours after a power increase from 50% to 100%

b. 7 to 11 hours after a scram from 100% power

c. 1 to 2 hours after a start up to 100%power

d. 7 to 11 hours after a scram from 50% power

Question A.03 [1.0 point]
An experimenter makes an error loading a sample. Injection of the sample results in a 100 millisecond period. If the scram setpoint is 125 kW and the scram delay time is 0.1 seconds, Which ONE of the following is the peak power of the reactor at shutdown?

a. 125 kW

b. 250 kW

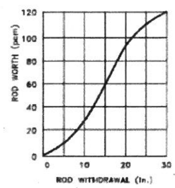
c. 340 kW

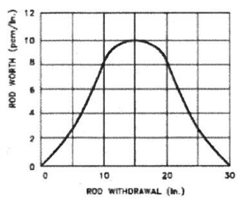
d. 430 kW

Category A: Theory, Thermodynamics & Facility Operating Characteristics

Question A.04 [1.0 point, 0.25 points each]
Identify if the descriptions or graphs in Column A describe or depict integral control rod worth or differential rod worth in Column B? (Answers may be used once, more than once, or not at all)

Column A	Column B
a. total reactivity worth of the control rod at that height	1. Differential Rod Worth
b. reactivity change per unit movement of a control rod	2. Integral Rod Worth

c. 

d. 

Question A.05 [1.0 point]
WHICH ONE of the following describes the MAJOR contributions to the production and depletion of xenon in the reactor?

a. Produced directly from fission and depletes by neutron absorption only.

b. Produced from radioactive decay of iodine and depletes by neutron absorption only.

c. Produced directly from fission and depletes by radioactive decay and neutron absorption.

d. Produced from radioactive decay of iodine and depletes by radioactive decay and neutron absorption

Question A.06 [1.0 point]
The reactor is critical at 100 watts. A control rod is withdrawn to insert a positive reactivity of 0.126% $\Delta k/k$. Which ONE of the following will be the stable reactor period as a result of the reactivity insertion? Given Beta effective = 0.0078

a. 13 seconds

b. 46 seconds

c. 52 seconds

d. 80 seconds

Question A.07 [1.0 point]
Which ONE of the following is the MAIN reason for operating the reactor with thermal neutrons instead of fast neutrons?

a. The atomic weight of thermal neutrons is larger than fast neutrons, so thermal neutrons are easier to slow down and be captured by the fuel

b. The neutron lifetime of thermal neutrons is longer than fast neutrons, so the fuel has enough time to capture thermal neutrons

c. The fission cross section of the fuel is much higher for thermal energy neutrons than fast neutrons

d. Fast neutrons give off higher radiation than thermal neutrons and the reactor needs to reduce the radiation limit by using thermal neutrons

Question A.08 [1.0 point]
Which ONE of the following isotopes has the **LEAST** thermal neutron cross section?

a. Cadmium-113

b. Samarium-149

c. Xenon-135

d. Uranium-235

Question A.09 [1.0 point]
Which ONE of the following is the definition of the number of neutrons passing through a square centimeter per second is the definition of which ONE of the following?

a. Neutron Population (np)

b. Neutron Impact Potential (nip)

c. Neutron Flux (nv)

d. Neutron Density (nd)

Category A: Theory, Thermodynamics & Facility Operating Characteristics

Question A.10 [1.0 point]
Which of the following atoms will cause a neutron to lose the most energy during an elastic scattering reaction?

a. O^{16}

b. C^{12}

c. U^{235}

d. H^{1}

Question A.11 [2.0 points, 0.4 each]
Given a mother isotope of $({}_{35}Br^{87})^{*}$, identify each of the daughter isotopes as a result of α, β^{+}, β^{-}, γ, or n, decay (Answers may be used once, more than once or not at all)

a. ${}_{33}As^{83}$

b. ${}_{34}Se^{87}$

c. ${}_{35}Br^{86}$

d. ${}_{35}Br^{87}$

e. ${}_{36}Kr^{87}$

Question A.12 [1.0 point]
Which one of the following conditions would <u>INCREASE</u> the shutdown margin of a reactor?

a. Inserting an experiment adding positive reactivity.

b. Lowering moderator temperature if the moderator temperature coefficient is negative.

c. Depletion of a burnable poison.

d. Depletion of uranium fuel.

Question A.13 [1.0 point]
Which ONE of the following is the stable reactor period which will result in a power rise from 1% to 100% power in 120 seconds?

a. 10 seconds

b. 13 seconds

c. 26 seconds

d. 80 seconds

Question A.14 [1.0 point]
The reactor is **SHUTDOWN** by 5 %Δk/k with the count rate of 100 counts per second (cps). The control rods are withdrawn until the count rate is doubled. What is the value of K_{eff} when the count rate is doubled?

a. 0.952

b. 0.976

c. 0.998

d. 1.002

Question A.15 [1.0 point]
Which ONE of the following conditions will DECREASE the Core Excess of a reactor?

a. Fuel depletion

b. Burnout of a burnable poison

c. Insertion of a positive reactivity worth experiment

d. Lowering moderator temperature (assume a negative temperature coefficient)

Question A.16 [1.0 point]
Given a reactor period of 32 seconds, approximately how long will it take for power to triple?

a. 22 seconds

b. 35 seconds

c. 46 seconds

d. 64 seconds

Question A.17 [1.0 point]
Following a positive reactivity addition to a shutdown reactor, the neutron power will increase even though k-effective is less than 1. The MAIN reason is due to:

a. Production of fast neutrons

b. Negative temperature coefficient in the moderator

c. Subcritical multiplication process

d. Void temperature coefficient in the moderator

Question A.18 [1.0 point]
Which ONE of the following isotopes will absorb more neutrons when it interacts with neutrons?

a. Hydrogen-1

b. Argon-40

c. Boron-10

d. Uranium-235

Question A.19 [1.0 point]
Which ONE of the following describes the term PROMPT DROP?

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

b. A reactor has attained criticality on prompt neutrons alone

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

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

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

Category B: Normal/Emergency Procedures and Radiological Controls

Question B.01 [1.0 point]
Which ONE of the following events does NOT require the presence of the Reactor Supervisor in the facility?

a. Fuel relocations within the core region

b. Initial start-up and approach to power of the day

c. Insertion of experiment worth of $0.50

d. Restart following an unplanned shutdown

Question B.02 [1.0 point]
How long will it take a 1 Curie source, with a half-life of 1 year, to decay to 0.01 Curie?

a. 4.6 years

b. 6.6 years

c. 10.6 years

d. 16.6 years

Question B.03 [1.0 point]
A Reactor Operator (RO) works in a High Radiation Area (HRA), with a dose rate of 100 mR/hr, for eight hours a day. Which ONE of the following is the MAXIMUM number of days in which the RO may perform his duties WITHOUT exceeding 10CFR20 limits?

a. 5 days

b. 6 days

c. 7 days

d. 12 days

Question B.04 [1.0 point]
An irradiated sample provides a dose rate of 0.5 rem/hr at 2 feet. Approximately how far from the sample reads 5 mrem/hr?

a. 6 feet

b. 9 feet

c. 14 feet

d. 20 feet

Question B.05 [1.0 point]
Which ONE of the following modifications would be considered a license amendment request under "50.59"? The facility plans to:

a. Replace an identical control rod drive.

b. Change a control rod calibration with new technique.

c. Measure a control rod drop time with new technique.

d. New experiment containing uranium-235 liquid.

Question B.06 [1.0 point]
"The reactor area shall contain a minimum free volume of 5.65×10^8 cm^3." This is an example of:

a. Design Features

b. Surveillance Requirements

c. Limiting Conditions for Operation (LCO)

d. Limiting Safety System Setting (LSSS)

Question B.07 [1.0 point]
Assuming there is no leak from outside of the demineralizer tank, you use a survey instrument to measure the dose rate from it. Compare the reading of the window probe with the window CLOSED and the reading with the window OPEN will:

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

b. remain the same, because the Quality Factors for Gamma and Beta radiation are the same

c. increase, because the Quality Factors for Beta and Alpha is greater than for Gamma

d. remain the same, because the survey instrument would not be detecting Beta and Alpha radiation from the demineralizer tank

Question B.08 [1.0 point]
Which ONE of the following accidents is considered to be the Maximum Hypothetical Accident for the UUTR?

a. During fuel element movement in air, the fuel element is dropped on the reactor bay; resulting in the release of gaseous fission product to the atmosphere.

b. An earthquake occurs and causes a loss of pool water; resulting in the release of high level of radiation.

c. A major earthquake occurs, resulting in the release of the contaminated reactor pool water to the surrounding water table.

d. During fuel movement in reactor pool, an element is dropped underwater and damaged severely enough to breach the cladding and release part of fission product to the atmosphere.

Question B.09 [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.

Question B.10 [1.0 point]
Which ONE of the following is the definition of the Total Effective Dose Equivalent (TEDE)?

a. The sum of the 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.11 [1.0 point]
Which ONE of the following is the correct definition of a CHANNEL CHECK?

a. The combination of sensor, line, amplifier, and output device which are connected for the purpose of measuring the value of a parameter.

b. The introduction of a signal into the channel for verification that it is operable.

c. A qualitative verification of acceptable performance by observation of channel behavior.

d. An adjustment of the channel such that its output corresponds with acceptable accuracy to known values of the parameter which the channel measures.

Question B.12 [1.0 point]
Which ONE of the following is the definition for "Annual Limit on Intake (ALI)"?

a. Projected dose commitment values to individuals that warrant protective action following a release of radioactive material.

b. The concentration of a radio-nuclide in air which, if inhaled by an adult worker for a year, results in a total effective dose equivalent of 100 millirem.

c. The effluent concentration of a radio-nuclide in air which, if inhaled continuously over a year, would result in a total effective dose equivalent of 50 millirem for noble gases.

d. 10CFR20 derived limit, based on a Committed Effective Dose Equivalent of 5 Rems whole body or 50 Rems to any individual organ, for the amount of radioactive material inhaled or ingested in a year by an adult worker.

Question B.13 [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 1/32 inches. For this measurement, you will:

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

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

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

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

Question B.14 [1.0 point]
Which ONE of the following is an example of a Byproduct Material?

a. Pu-239

b. U-238

c. U-235

d. Co-60

Question B.15 [1.0 point]
Per UUTR emergency classifications, which ONE of the following is the classification of a personnel exposure in excess of 10 CFR 20 limits?

a. Alert

b. Notification of Unusual Event

c. Non-Reactor Safety-related Event

d. Site Area Emergency

Question B.16 [1.0 point]
Which ONE of the following parts in 10CFR requires all applicants for an RO and SRO license to submit NRC Form 396 and NRC Form 398 to the US NRC before taking a licensing examination?

a. Part 19

b. Part 20

c. Part 50

d. Part 55

Question B.17 [1.0 point]
The below items are listed as a reportable occurrence EXCEPT:

a. The reactor power level exceeds 110 kW.

b. The reactor tank water temperature exceeds 40 °C.

c. A reactor is in operation when the Continues Air Monitor (CAM) is just broken.

d. The available excess reactivity on the reference core configuration is $1.30.

Question B.18 [1.0 point]
10 CFR 50.59 would require UUTR submit a request to the NRC for which ONE of the following modifications?

a. Revise the UUTR startup checklist

b. Add more responsibilities to facility staff requirements on the fuel movement procedure

c. Revise a frequency of requalification written examination from biennial to annual

d. Reduce a minimum number of Reactor Safety Committee members listed in Technical Specification from five to three

Question B.19 [1.0 point]
You are currently the licensed operator at UUTR. Which ONE of the following will violate 10CFR55.53 (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 12 months ago

Question B.20 [1.0 point, 0.25 each]
Match each of the Technical Specification limits in Column A with its corresponding value in Column B. (Answers in Column B may be used once, more than once, or not at all)

Column A	Column B
a. Worth of a single secured experiment	1. $0.30
b. Non-secured experiment	2. $0.50
c. Shutdown Margin	3. $1.00
d. Total worth of ALL experiments	4. $1.20

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

Category C: Facility and Radiation Monitoring Systems

Question C.01 [1.0 point]
Over the course of reviewing logs, you notice the reactor tank water level dropped by 0.5 cm due to evaporation. In reference to performing UNEP 008 to add water to the tank, approximately how many gallons of water evaporated?

a. 6 gallons

b. 12 gallons

c. 23 gallons

d. 35 gallons

Question C.02 [1.0 point]
Which ONE of the following is the neutron startup source?

a. Americium-Beryllium

b. Californium

c. Polonium-Beryllium

d. Plutonium-Beryllium

Question C.03 [1.0 point]
Which ONE of the following systems is NOT connected to an uninterruptible power supply (UPS) or battery backup?

a. Security system

b. Fuel temperature monitoring channels

c. Primary Pump

d. Radiation monitors

Category C: Facility and Radiation Monitoring Systems

Question C.04 [2.0 point, 0.5 each]
Match the input signals listed in Column A with the responses listed in Column B. (Answers may be used once, more than once, or not at all)

Column A	Column B
a. Loss of electrical power at reactor console	1. Normal Operation
b. Linear power level = 90 kW	2. Alarm ONLY
c. Neutron Count Rate < 2 CPS	3. Interlock
d. Fuel element temperature = 130 °C	4. Scram (with or without Alarm)

Question C.05 [1.0 point]
The UUTR Regulating Rod is located in the ______:

a. C-ring

b. D-ring

c. E-ring

d. F-ring

Question C.06 [1.0 point]
Which ONE of the following substances is MAINLY used as the neutron absorber in the UUTR control rods?

a. Boron Carbide

b. Cadmium

c. Erbium

d. Hafnium

Question C.07 [1.0 point]
Which ONE of the following provides a reactor SCRAM?

a. High Bulk Pool Temperature

b. High Pool Conductivity

c. High Reactor Tank Water Level

d. High Radiation alarm

Category C: Facility and Radiation Monitoring Systems

Question C.08 [1.0 point]
On the control panel the indicating lights for the SHIM rod are as follows: the CONT light is ON, the UP light is OFF and the DOWN light is ON. What is the condition of the Shim Rod?

a. The rod drive and the rod are both at the top of travel.

b. The rod drive and the rod are both at the bottom of travel.

c. The rod drive is at the top of travel, but the rod is at the bottom.

d. The rod drive and the rod are both between the bottom and top of travel.

Question C.09 [1.0 point]
Which ONE of the following best describes how the Uncompensated Ion Chamber (UIC) operates?

a. The UIC has only one chamber coated with Boron-10 for (n,a) reaction.

b. The UIC has only one chamber coated with U-235 for fission reaction.

c. The UIC has two chambers, both can sense gamma rays but only one is coated with Boron-10 for (n,a) reaction.

d. The UIC has two chambers, one is coated with U-235 for fission reaction and the other is coated with Boron-10 for (n,a) reaction.

Question C.10 [1.0 point]
In the primary purification system, which ONE of the following is the main function of the demineralizer?

a. Absorb H-3 to maintain purity of the pool water

b. Remove soluble impurity to maintain low conductivity in the pool water

c. Reduce N-16 formation to reduce the dose rate at the reactor pool

d. Absorb thermal neutrons to increase life of the reactor pool

Question C.11 [1.0 point]
Which ONE of the following experiments is allowed to be irradiated at the UUTR?

a. Sample with an absolute reactivity worth of $1.30

b. Sample of 30 milligrams TNT equivalent in container meeting design pressure requirements

c. Singly encapsulated sample containing corrosive materials

d. Sample with an absolute reactivity worth of $0.30

Category C: Facility and Radiation Monitoring Systems

Question C.12 [1.0 point]
Burnup of the initial content of uranium-235 in the U-ZrH fuel is not allowed to exceed __________. The fuel burnup calculation is required to be performed ______________.

a. 25%; Annually

b. 25%; Biennially

c. 50%; Annually

d. 50%; Biennially

Question C.13 [1.0 point]
If the ventilation system fails, which ONE of the following correctly describes operation of the reactor?

a. Reactor can be operated for 48 hours without the ventilation system but with the operable ARM and CAM.

b. Reactor can be operable for 24 hours without the ventilation system but with the operable ARM and CAM.

c. Reactor can be operable for 12 hours without the ventilation system but with the operable ARM and CAM.

d. Reactor is immediately secured and shall not be operated until the ventilation is fully operable.

Question C.14 [1.0 point]
The Stack Continuous Air Monitor samples exhaust air for which ONE of the following?

a. Argon-41

b. Cobalt-60

c. Krypton-85

d. Cesium-137

Category C: Facility and Radiation Monitoring Systems

Question C.15 [1.0 point]
Which ONE of the following is NOT true regarding the configuration of UUTR TRIGA-LEU fuel elements?

a. Maximum of 30 weight percent enriched to less than 20% uranium-235

b. Hydrogen-to-zirconium atom ratio (in the ZrHx): between 1.0 and 1.6

c. 304 stainless steel or aluminum cladding

d. No burnable poisons

Question C.16 [1.0 point]
Which ONE of the following materials is used in the Thermal Irradiator?

a. Polyethylene

b. Heavy Water

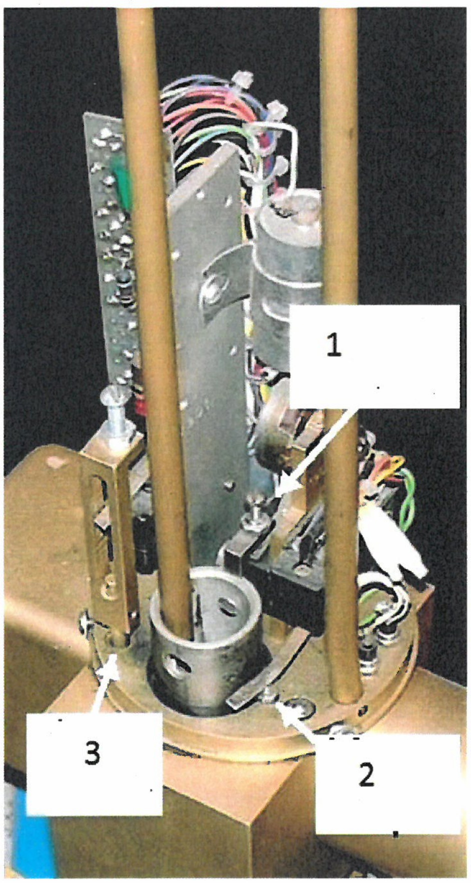
c. Cadmium

d. Graphite

Category C: Facility and Radiation Monitoring Systems

Question C.17 [1.0 point, 0.33 each]
Use the following diagram of the control rod and match the Limit Switch (LS) components listed in Column B to the appropriate labels in Column A? (Answers are used only once)

Column A	Column B
a. Magnet Down LS	1
b. Magnet UP LS	2
c. Rod Down LS	3



Question C.18 [1.0 point]
The following channels are linked to a safety function EXCEPT________.

a. Source Count Rate

b. Log Percent Power

c. Linear Power

d. Percent Power

Category C: Facility and Radiation Monitoring Systems

Question C.19 [1.0 point]
The purposes of the cleanup loop in the primary coolant system are to minimize:

a. corrosion of the fuel elements and need for cooling the pool

b. corrosion of the control rods and growth of algae in the pool

c. corrosion of the fuel elements and activation of dissolved materials in the pool

d. corrosion of the control rods and generation of tritium ($_1H^3$) in the pool

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

Category A: Theory, Thermodynamics & Facility Operating Characteristics

A.01
Answer: b
Reference: SDM = (1- keff)/keff = (1-0.927)/0.927 = 0.07875 Δk/k. So if you add the same amount of SDM, the reactor is critical.
Another method: you can find the new value of Keff when adding 0.07875 Δk/k to reactor.
Δρ = (k2 –k1)/ k1*k2
0.07875 = (k2- 0.927)/(0.927* k2), solve for k2
K2 = 1, hence the reactor is critical

A.02
Answer: b
Reference: Burn, R., *Introduction of Nuclear Reactor Operations*, © 1982, Sec 8.4, page 8-9.

A.03
Answer: c
Reference: $P = P_0 e^{t/\tau}$, P = 125 kwatt × $e^{0.1/0.1}$ = 125 × e = 339.79

A.04
Answer: a. 2; b. 1; c. 2; d. 1
Reference: DOE Fundamentals Handbook, NPRT, Vol. 2, Module 3, EO 5.4, EO 5.5, EO 5.6, pp 51-53

A.05
Answer: d
Reference: Burn, R., Introduction of Nuclear Reactor Operations, © 1988

A.06
Answer: c
Reference: Reactivity added = 0.126%Δk/k=0.00126Δk/k; T=β-ρ/λeffρ;
(0.0078-0.00126)/(0.1)(0.00126) = 51.9 seconds

A.07
Answer: c
Reference: Burn, R., Introduction to Nuclear Reactor Operations, 1982, Figure 2.6, page 2-39

A.08
Answer: d
Reference: Burn, R., Introduction to Nuclear Reactor Operations, © 1988, Table 2.5, page 2-59

A.09
Answer: c
Reference: Burn, R., Introduction to Nuclear Reactor Operations, © 1982

A.10
Answer: d
Reference: Burn, R., Introduction to Nuclear Reactor Operations, © 1982

A.11
Answer: a. α; b. β^+; c. n; d. γ; e. β^-
Reference: NRC Standard Question, Chart of Nuclides

A.12
Answer d
Reference: DOE Fundamentals Handbook, Nuclear Physics and Reactor Theory Volume 2, Module 4, Enabling Objective 3.6 p. 28

A.13
Answer: c
Reference: $P = P_0 e^{t/T}$ —> $T = t/Ln(P/P_0)$
t= 120/Ln(100); t = 26 sec

A.14
Answer: b
Reference: Keff1=1/1- ρ1
Keff1 =1/(1-(-.05)) —>Keff1= 0.952,
Count1*(1-Keff1) = Count2*(1-Keff2)
Count1*(1-0.952) = Count2*(1-Keff2)
100*(1-0.952) = 200(1- Keff2); Keff2 = 0.976

A.15
Answer: a
Reference: Decreasing the reactivity worth in the core will decrease the core excess

A.16
Answer: b
Reference: $P=P_oe^{t/\tau}$ $3=1^* e^{t/32}$ t = 32 sec*ln(3) = 35.2 sec

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

A.18
Answer: c
Reference: Burn, *Introduction to Nuclear Reactor Operations*, Section 2.5.1, Pages 2-38-43

A.19
Answer: c
Reference: Burn, R., Introduction to Nuclear Reactor Operations, 1982, page 4-21

Category B: Normal/Emergency Procedures and Radiological Controls

B.01
Answer: c
Reference: UUTR Technical Specification 6.1.3

B.02
Answer: b
Reference: $A=A_o e^{-\lambda t}$ $0.01Ci=1Ci^{e-\lambda t}$; ln(0.01/1) = -0.693(t) -4.60/-0.693; 6.6 years

B.03
Answer: b
Reference: 10CFR20.1201(a)(1) [5000 mR x (1 hr/100mR) x (day/8 hr)] = 6.25 days

B.04
Answer: d
Reference: $500mrem(2)^2=5mrem(d)^2$ D=20 feet

B.05
Answer: d
Reference: 10 CFR 50.59

B.06
Answer: a
Reference: UUTR Technical Specification 5.1

B.07
Answer: d
Reference: Basic radiological techniques; Beta and Alpha radiation don't make it through the demineralizer tank

B.08
Answer: a
Reference: UUTR SAR 13.1

B.09
Answer: b
Reference: UUTR Technical Specification 2.1.2 and 2.2.1

B.10
Answer: c
Reference: 10CFR20.1003

B.11
Answer: c
Reference: UUTR Technical Specifications, Definitions

B.12
Answer: d
Reference: 10CFR20.1003

<u>Category B: Normal/Emergency Procedures and Radiological Controls</u>

B.13
Answer: a
Reference: UUTR Technical Specification 3.1.6

B.14
Answer: d
Reference: 10CFR20.1003; byproduct material is any radioactive material, except special nuclear material, made radioactive by the process of producing or using special nuclear material

B.15
Answer: b or c (NRC identified during administration of exam multiple answers accepted)
Reference: UUTR Emergency Preparedness Plan 4.0

B.16
Answer: d
Reference: 10CFR55

B.17
Answer: c
Reference: UUTR Technical Specification 3.1, 3.3, and 3.7

B.18
Answer: d
Reference: 10CFR50.59; Change to Technical Specification 6.2.1

B.19
Answer: b
Reference: 10CFR55.53; 55.53(i)- licensee shall have a biennial medical exam, 55.53(h) 55.59(c) – annual operating tests; 55.53(e) 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) requalification program must be conducted for a continuous period not to exceed 2 years; License renewal – 6 years

B.20
Answer: a. 3; b. 3; c. 2; d. 4
Reference: UUTR Technical Specification 3.1 and 3.5

Category C: Facility and Radiation Monitoring Systems

C.01
Answer: a
Reference: UUTR SOP UNEP 008; 0.5 cm * 11.6 gallons/cm = 5.8 gallons or ~6 gallons.

C.02
Answer: d
Reference: UUTR SAR 1.3.3

C.03
Answer: c
Reference: UUTR SAR 8.2

C.04
Answer: a. 4; b. 1; c. 3; d. 1
Reference: UUTR Technical Specification 3.2.3

C.05
Answer: b
Reference: UUTR SAR, Figure 1.3-4, Top view of the UUTR core

C.06
Answer: a
Reference: UUTR Technical Specification 5.3.2, Control Rods

C.07
Answer: d
Reference: UUTR SAR 7.7.1

C.08
Answer: b
Reference: NRC Standard Question

C.09
Answer: a
Reference: NRC Standard Question

C.10
Answer: b
Reference: NRC Standard Question

C.11
Answer: d
Reference: UUTR Technical Specification 3.8

C.12
Answer: d
Reference: UUTR Technical Specification 4.1

C.13
Answer: d
Reference: UUTR Technical Specification 3.5

Category C: Facility and Radiation Monitoring Systems

C.14
Answer: a
Reference: UUTR SAR 7.7.2

C.15
Answer: a
Reference: UUTR Technical Specification 5.3.3

C.16
Answer: b
Reference: UUTR SAR 10.2.1.1

C.17
Answer: a. 1; b. 2; c. 3
Reference: UUTR SAR Figure 7.3-2

C.18
Answer: b
Reference: UUTR SAR 3.1.3

C.19
Answer: c
Reference: UUTR SAR 5.2.3

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