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

April 13, 2018

Matthew Lund, Reactor Supervisor
University of Utah Nuclear Engineering Program
50 S. Central Campus Dr.
Salt Lake City, UT 84112

SUBJECT: EXAMINATION REPORT NO. 50-407/OL-18-01, UNIVERSITY OF UTAH

Dear Mr. Lund:

During the week of February 26, 2017, 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.

Sincerely,

/RA/

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

Docket No. 50-407

Enclosures: 1. Examination Report No. 50-407/OL-18-01
2. Written Examination

cc: w/o enclosures: See next page

SUBJECT: EXAMINATION REPORT NO. 50-407/OL-18-01, UNIVERSITY OF UTAH DATED APRIL 13, 2018

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ADAMS ACCESSION No. ML18094A795 **NRR-079**

OFFICE	NRR/DLP/PROB/CE	NRR/DLP/PROB	NRR/DLP/PROB/BC
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DATE	03/19/2018	04/05/2018	04/13/2018

OFFICIAL RECORD COPY

cc:

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

REPORT NO.: 50-407/OL-18-01

FACILITY DOCKET NO.: 50-407

FACILITY LICENSE NO.: R-126

FACILITY: University of Utah

EXAMINATION DATES: February 26 – March 1, 2018

SUBMITTED BY: ____________________________ __________
Michele DeSouza, Chief Examiner Date

SUMMARY:
During the week of February 26, 2018, the NRC administered an operator licensing examination to four Reactor Operator (RO), one written retake Category B, and one written retake Category C candidates. The candidates passed all applicable portions of the examinations.

REPORT DETAILS

1. Examiner: Michele DeSouza, Chief Examiner, NRC

2. Results:

	RO PASS/FAIL	SRO PASS/FAIL	TOTAL PASS/FAIL
Written	6/0	0/0	6/0
Operating Tests	4/0	0/0	4/0
Overall	6/0	0/0	6/0

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

Per discussion with the facility, prior to administration of the written examination, adjustments were accepted. Upon completion of the examination, the NRC Examiner met with facility staff representative to discuss the results. Based on candidate responses, the processing of facility examination results is imperative due to lack of Utah personnel in staffing and positions. At the conclusion of the meeting, the NRC examiner thanked the facility for their support in the administration of the examination.

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

FACILITY:	UUTR
REACTOR TYPE:	TRIGA
DATE ADMINISTERED:	03/01/2018
CANDIDATE:	_______________

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

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

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

____
Candidate's Signature

ENCLOSURE 2

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

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 ___   (0.25 each)

A02   a   b   c   d   ___

A03   a   b   c   d   ___

A04   a   b   c   d   ___

A05   a   b   c   d   ___

A06   a   b   c   d   ___

A07   a   b   c   d   ___

A08   a   b   c   d   ___

A09   a   b   c   d   ___

A10   a   b   c   d   ___

A11   a   b   c   d   ___

A12   a   b   c   d   ___

A13   a   b   c   d   ___

A14   a   b   c   d   ___

A15   a   b   c   d   ___

A16   a   b   c   d   ___

A17   a   b   c   d   ___

A18   a   b   c   d   ___

A19   a   b   c   d   ___

A20   a   b   c   d   ___

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

Category B – Normal/Emergency Operating Procedures and Radiological Controls

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 ___

B18 a b c d ___

B19 a b c d ___

B20 a b c d ___

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

Category C – Facility and Radiation 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 ___ (0.5 each)

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 ___

(***** 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

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

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

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

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

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

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

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

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

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

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

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

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

$$M = \frac{1 - K_{eff_1}}{1 - K_{eff_2}}$$

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

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

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

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

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

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

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

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

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

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

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

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)

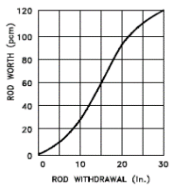
c_P = 1.0 BTU/hr/lb/°F

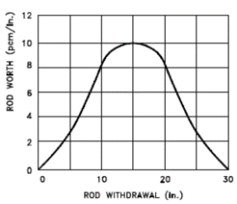
c_p = 1 cal/sec/gm/°C

Category A: Theory, Thermodynamics & Facility Operating Characteristics

Question A.01 [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?

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.02 [1.0 point]
A reactor contains a neutron source that produces 15,000 neutrons/second. The reactor has a k_{eff} = 0.88. What is the stable total neutron production rate in the reactor?

a. 100,000 neutrons/sec

b. 115,074 neutrons/sec

c. 125,000 neutrons/sec

d. 135,135 neutrons/sec

Question A.03 [1.0 point]
Xenon-135 (Xe^{135}) is produced in the reactor by two methods. One is directly from fission; the other is indirectly from the decay of:

a. Xe^{136}

b. Sm^{136}

c. Cs^{135}

d. I^{135}

Question A.04 [1.0 point]
Given a source strength of 200 neutrons per second (N/sec) and a multiplication factor of 0.6, which ONE of the following is the expected stable neutron count rate?

a. 150 N/sec

b. 250 N/sec

c. 400 N/sec

d. 500 N/sec

Question A.05 [1.0 point]
Which ONE of the following best describes the alpha decay (α) of a nuclide?

a. The number of protons decreases by 2, and the number of neutrons decreases by 2.

b. The number of protons decreases by 2, and the number of neutrons decrease by 4.

c. The number of protons decreases by 4, and the number of neutrons decrease by 2.

d. The number of protons decreases by 4, and the number of neutrons decreases by 4.

Question A.06 [1.0 point]
Reactor period is defined as:

a. The time required for the reactor power to double

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

c. The time required for the reactor power to be reduced to one-half the initial level

d. The number of factors of ten that reactor power changes in one minute

Question A.07 [1.0 point]
In a subcritical reactor, K_{eff} is increased from 0.885 to 0.943. Which one of the following is the amount of reactivity that was added to the core?

a. 4.68 %Δk/k

b. 5.58 %Δk/k

c. 6.94 %Δk/k

d. 7.45 %Δk/k

Category A: Theory, Thermodynamics & Facility Operating Characteristics

Question A.08 [1.0 point]
The reactor is subcritical with the count rate of 100 counts per second (cps) and K_{eff} of 0.950. The control rods are withdrawn until the count rate is doubled. What is the new value of K_{eff}?

a. 1.020

b. 0.998

c. 0.975

d. 0.952

Question A.09 [1.0 point]
Which ONE of the following is the stable reactor period which will result in a power rise from 50% to 100% power in 50 seconds?

a. 14 seconds

b. 36 seconds

c. 72 seconds

d. 144 seconds

Question A.10 [1.0 point]
The first pulse has a reactivity worth of **$1.10** which results in a peak power of **500 MW**. If the second pulse has a peak power of **5000 MW**, the corresponding reactivity worth is:
Given: β_{eff}=0.0075

a. $1.32

b. $1.40

c. $1.62

d. $2.02

Question A.11 [1.0 point]
What is the result of the Doppler Effect in the fuel temperature coefficient?

a. Stationary nuclei absorb more neutrons

b. Vibrating nuclei absorb less neutrons

c. Raising the temperature causes the nuclei to vibrate more rapidly effectively broadening the energy range of neutrons that may be resonantly absorbed.

d. An apparent broadening of the nuclei's resonances due to a temperature increase.

Question A.12 [1.0 point]
Which of the following is an example of a **FERTILE** material?

a. Th-232

b. U-233

c. U-235

d. Pu-239

Question A.13 [1.0 point]
Which ONE of the reactions below describes a method of production and removal of Xenon?

a. ${}_{52}Te^{134} \rightarrow \gamma + {}_{53}I^{134} \rightarrow p + {}_{54}Xe^{135} \rightarrow \beta^{-} + {}_{55}Cs^{135} \rightarrow \beta^{-} + {}_{56}Ba^{135}$

b. ${}_{52}Te^{135} \rightarrow \gamma + {}_{53}I^{135} \rightarrow \beta^{-} + {}_{54}Xe^{135} \rightarrow {}_{0}n^{1} + {}_{54}Xe^{136} \rightarrow \beta^{-} + {}_{56}Ba^{135}$

c. ${}_{52}Te^{135} \rightarrow \beta^{-} + {}_{53}I^{135} \rightarrow \beta^{-} + {}_{54}Xe^{135} \rightarrow \beta^{-} + {}_{55}Cs^{135} \rightarrow \beta^{-} + {}_{56}Ba^{135}$

d. ${}_{52}Te^{134} \rightarrow \beta^{-} + {}_{53}I^{135} \rightarrow \beta^{-} + {}_{54}Xe^{135} \rightarrow \gamma + {}_{55}Cs^{135} \rightarrow \beta^{+} + {}_{56}Ba^{135}$

Question A.14 [1.0 point]
What is the result between a neutron and a target nucleus in elastic scattering?

a. Energy is transferred into nuclear excitation, and then emitted via gamma emissions.

b. The target nucleus gains the amount of kinetic energy that the neutron loses.

c. The neutron is absorbed by the target nucleus and then emitted with lower kinetic energy.

d. The neutron conserves its initial kinetic energy if the target nucleus is large.

Question A.15 [1.0 point]
What is the difference between prompt and delayed neutrons?

a. Prompt neutrons are released virtually instantaneously, and delayed neutrons are a very small fraction of the total number of neutrons and do not have an important role in the control of the reactor.

b. Prompt neutrons are released during fast fission, while delayed neutrons are released during thermal fissions.

c. Prompt neutrons are released within 10^{-13} seconds, whereas delayed neutrons are emitted following the beta decay of a fission fragment.

d. Prompt neutrons are 99% of the neutron produced in fission and are therefore the dominating factor in determining the reactor period, whereas delayed neutrons account for less than 1% of the neutron population and have little effect on the reactor period.

Question A.16 [1.0 point]
What is the effect of U-238 on the reactor neutron life cycle when a neutron energy is below 1 MeV?

a. The number of fissions due to U-238 decrease.

b. The number of fissions due to U-238 remains the same.

c. The number of fissions due to U-238 increase.

d. The number of fissions due to U-235 increase.

Question A.17 [1.0 point]
Which ONE of the following conditions will INCREASE the shutdown margin of a reactor?

a. Lowering moderator temperature (assume negative temperature coefficient)

b. Insertion of a positive reactivity worth experiment

c. Burnout of a burnable poison

d. Fuel depletion

Question A.18 [1.0 point]
Which ONE of the following physical characteristics of the TRIGA fuel is the main contributor for the prompt negative temperature coefficient?

a. As the fuel heats up, the resonance absorption peaks broaden and increases the likelihood of absorption in U-238 and/or Pu-240

b. As the fuel heats up, a rapid increase in moderator temperature occurs through conduction and convection heat transfer mechanisms, which adds negative reactivity

c. As the fuel heats up, the oscillating hydrogen in the ZrH lattice imparts energy to a thermal neutron, thereby increasing its mean free path and probability of escape

d. As the fuel heats up, fission product poisons (e.g., Xenon), increase in concentration within the fuel matrix and add negative reactivity via neutron absorption

Question A.19 [1.0 point]
A reactor is slightly supercritical with the following values for each of the factors in the six-factor formula:

Fast Fission Factor = 1.03	Fast non-leakage probability = 0.84
Resonance Escape Probability = 0.96	Thermal non-leakage probability = 0.88
Thermal Utilization Factor = 0.70	Reproduction Factor = 1.96

A control rod is inserted to bring the reactor back to critical. Assuming all other factors remain unchanged, the new value for the Thermal Utilization Factor is:

a. 0.698

b. 0.702

c. 0.704

d. 0.708

Question A.20 [1.0 point]
What is the reason the stable negative period following a scram is always the same value (- 80 seconds) regardless of initial power level?

a. The nuclear instrument reads the constant count rate from a neutron source.

b. The rate of power change is dependent on a mean lifetime of the short lived delayed neutron precursors.

c. The delayed neutrons are born at same rate as prompt neutrons after shutdown resulting in a constant neutron count rate.

d. The rate of power change is dependent on a mean lifetime of the longest lived delayed neutron precursors.

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

Category B: Normal/Emergency Procedures and Radiological Controls

Question B.01 [1.0 point]
Which ONE of the following changes requires NRC Approval?

a. Revision of the operator licensing requalification examination

b. Revision of Standard Operating Procedure #1

c. Changes in the format of the Utah Experiment Authorization Form

d. Delete an administrative control requirement listed in the Utah Technical Specification 6.0

Question B.02 [1.0 point]
Who may authorize reentry into the Utah Nuclear Engineering Facility after an emergency evacuation?

a. Reactor Operator

b. Senior Reactor Operator

c. Radiation Safety Officer

d. Operations Emergency Coordinator

Question B.03 [1.0 point]
A radioactive source reads 80 mRem/hr on contact. Thirty minutes later, the same source reads 40 mrem/hr. How long is the time for the source to decay from a reading of 80 mrem/hr to 5 mrem/hr?

a. 1.5 hours

b. 2 hours

c. 3 hours

d. 5 hours

Question B.04 [1.0 point]
Which ONE of the following regulations requires submitting NRC Form 396, Certification of Medical Examination by Facility Licensee, as part of an application for an operator license?

a. 10 CFR 19

b. 10 CFR 20

c. 10 CFR 50

d. 10 CFR 55

Category B: Normal/Emergency Procedures and Radiological Controls

Question B.05 [1.0 point]
Which ONE of the following is the renewal requirement for an existing license?

a. Every six months

b. Every year

c. Biennually

d. Every six years

Question B.06 [1.0 point]
Which ONE of the following is the surveillance reporting requirement of Ar^{41} discharge?

a. Every 3 months

b. Twice a year

c. Once a year

d. Every other year

Question B.07 [1.0 point]
Which ONE of the following below items is NOT a reportable occurrence?

a. Reactor power level exceeds 110 kW

b. Reactor tank water temperature exceeds 40^{o}C

c. Available excess reactivity on the reference core configuration is $1.30

d. Reactor is in operation when the Continuous Air Monitor (CAM) is just broken

Question B.08 [1.0 point]
Which ONE of the following radioactive GASES might be an indication of a fuel element leak?

a. N^{16}

b. Ar^{41}

c. Xe^{135}

d. Cs^{137}

Question B.09 [1.0 point]
A radioactive source is to be stored in the reactor bay with no shielding. The source reads 2 R/hr at 1 foot. How far from the source does a barrier need to be placed for it to be considered a “Radiation Area”?

a. 372 m

b. 610 cm

c. 110 cm

d. 30 cm

Question B.10 [1.0 point]
The reactor is operating at 10 mrem/hr at the pool radiation area monitor. You are conducting the facility walk-thru portion of your NRC licensing exam with the NRC examiner. How long can the NRC examiner stay before their 10 CFR 20 total ANNUAL effective dose limit is exceeded?

a. 10 hours

b. 5 hours

c. 2 hours

d. 1 hour

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 are performing a periodic radiation survey of an area where general radiation readings are approximately 1 mrem/hr. However, you find an old experimental facility in an accessible area not posted for radiological safety reading 25 mrem/hr at 30 cm. How would this area be posted in accordance with the requirements of 10 CFR 20?

a. Radiation Area on contact with the experimental facility

b. Radiation Area @ 30 cm from the experimental facility

c. High Radiation Area on contact with the experimental facility

d. High Radiation Area @ 30 cm from the experimental facility

Question B.14 [1.0 point]
Utah Emergency Preparedness Plan allows a one-time MAXIMUM exposure limit of __________ to save a life.

a. 5 rem

b. 10 rem

c. 25 rem

d. 75 rem

Question B.15 [1.0 point]
Per Utah Emergency Classifications, which ONE of the following is a “failure of an experiment that results in the release of radioactivity”?

a. Alert

b. Notification of Unusual Event

c. Safety Event – (non-reactor related)

d. Normal Operation

Question B.16 [1.0 point]
The CURIE content of a radioactive source is a measure of

a. number of radioactive atoms in the source.

b. number of nuclear disintegrations per unit time.

c. amount of energy emitted per unit time by the source

d. amount of damage to soft body tissue per unit time.

Question B.17 [1.0 point]
What is the MINIMUM level of management who shall be present at the facility during a recovery from an unplanned or unscheduled shutdown?

a. Reactor Operator

b. Senior Reactor Operator

c. Reactor Supervisor

d. Reactor Safety Committee Member

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

a. Utilize a new Xenon poisoning method of measurement

b. Change of primary coolant pressure gauge with a like model

c. Use new Resistance Temperature Detectors (RTD) to perform reactor power calibration

d. Replace the Fission Chamber with an uncompensated ion chamber

Question B.19 [1.0 point]
You use a survey instrument with a window probe to measure the beta-gamma dose rate from an irradiated experiment. The dose rate with the window closed is 160 mrem/hour and 200 mrem/hour with the window open. Which ONE of the following is the gamma dose rate?

a. 40 mrem/hour

b. 140 mrem/hour

c. 160 mrem/hour

d. 360 mrem/hour

Question B.20 [1.0 point]
Which ONE of the following are the Utah Technical Specification limits for irradiated fuel storage?

a. k-eff <0.95

b. k-eff <0.90

c. k-eff <0.85

d. k-eff <0.80

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

Category C: Facility and Radiation Monitoring Systems

Question C.01 [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 more than once or not at all)

Column A	Column B
a. Linear Power Channel = 100 kW	1. Interlock
b. Pool Water Temperature = 35°C	2. Alarm ONLY
c. Simultaneously insert SHIM and REG	3. Normal Operation
d. Loss of electrical power at reactor console	4. Scram (with or without Alarm)

Question C.02 [1.0 point]
Which ONE of the following best describes how the Uncompensated Ion Chamber (UIC) and Compensated Ion Chamber (CIC) operate?

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

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

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

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

Question C.03 [1.0 point]
Which ONE of the following provides a reactor SCRAM?

a. Low Pool pH

b. Log High Power Level

c. High Fuel Temperature

d. Low Pool Conductivity

Category C: Facility and Radiation Monitoring Systems

Question C.04 [1.0 point]
What is the nominal Hydrogen-Zirconium atom ratio in the TRIGA LEU fuel elements?

a. 8 Hydrogen atoms to 20 Zirconium atoms

b. 8.5 Hydrogen atoms to 25 Zirconium atoms

c. 1 Hydrogen atom to 1.6 Zirconium atoms

d. 1.5 Hydrogen atoms to 1 Zirconium atoms

Question C.05 [1.0 point]
The following channels are linked to a safety function EXCEPT________.

a. Percent Power

b. Source Count Rate

c. Linear Power

d. Log Percent Power

Question C.06 [1.0 point]
Which ONE of the following is used to reduce the shock to the control rods during a scram?

a. Spring on the push rod

b. Electro-mechanical brake initiates when the rod down switch energizes

c. Servo-controller engages the control rod braking system, forcing water out

d. Connecting rod piston drives water out of a dashpot as the rod nears the bottom of travel

Question C.07 [1.0 point]
Which ONE of the following is supplied power following the loss of electrical power?

a. Phones

b. Detector HV

c. Overhead Lights

d. Control Rod Drives

Category C: Facility and Radiation Monitoring Systems

Question C.08 [1.0 point]
How much did the water level, from the top of the tank, increase if you added 29 gallons to the reactor tank?

a. 2.0 cm

b. 2.5 cm

c. 3.0 cm

d. 3.5 cm

Question C.09 [1.0 point]
Which ONE of the following is the neutron startup source?

a. Plutonium-Beryllium

b. Americium-Lithium

c. Antimony-Beryllium

d. Americium-Beryllium

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

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

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

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

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

Question C.11 [1.0 point]
Which ONE of the following occurs after receiving a signal requiring an isolation of the reactor room?

a. Supply damper must be manually closed and opened at the damper

b. Supply damper automatically closes, and opens by a button the operator pushes

c. Supply damper automatically closes and opens

d. Supply damper must be manually closed and automatically opened at the damper

Category C: Facility and Radiation Monitoring Systems

Question C.12 [1.0 point]
Which ONE of the following systems is connected to a separate uninterrupted power supply?

a. Control Rods

b. Area Radiation Monitor

c. Pneumatic Transfer System

d. Primary Coolant pumps

Question C.13 [1.0 point]
Which ONE of the following is the purge gas used in the Pneumatic Transfer System?

a. CO_2

b. He

c. N

d. Ar

Question C.14 [1.0 point]
Which ONE of the following best describes the function of the graphite inserts in the top and bottom of the fuel element?

a. Reduce neutron leakage

b. Absorb fission product gases

c. Seal fuel cladding if it ruptures

d. Protect thermocouples when safety limit is exceeded

Question C.15 [1.0 point]
Which ONE of the following signatures is NOT required on the Utah experiment authorization form?

a. Reactor Supervisor

b. Reactor Committee

c. Radiological Health

d. Nuclear Regulatory Commission

Question C.16 [1.0 point]
While performing a fuel element inspection, you determine the traverse bend of a fuel element exceeds its original by 0.05. What are your actions?

a. Continue the fuel inspection because this bend is within T.S. limits.

b. Continue the fuel inspection because the Utah T.S. does NOT require any measurement of fuel elements.

c. Stop the fuel inspection, immediately report results to reactor supervisor because it is a damaged fuel element.

d. Stop the fuel inspection, immediately report the results to the NRC because it is a reportable occurrence.

Question C.17 [1.0 point]
How frequent is the calculation of fuel burnup of the Uranium-235 in the UZrH fuel required to be performed?

a. Quarterly

b. Semi-Annually

c. Annually

d. Biennially

Question C.18 [1.0 point]
The Stack Continuous Air monitors for which ONE of the following?

a. Argon-41 release

b. Cobalt-60 emission

c. Krypton-85 release

d. Cesium-137 emission

Question C.19 [1.0 point]
Which ONE of the following correctly describes the reactor operation when the ventilation system fails?

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

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

c. Reactor can be operable for 48 hours without the ventilation system but with the operable ARM.

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

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

Category A: Theory, Thermodynamics & Facility Operating Characteristics

A.01
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.02
Answer: c
N = (S) (M)
M = 1 / (1-k_{eff}) = 1 / (1-0.88) = 8.3333
N = (15,000)(8.3333) = 125,000 neutrons/second
Reference: DOE Fundamentals Handbook, NPRT, Vol. 2, Module 4, EO 1.2, p 4

A.03
Answer: d
Reference: Burn, R., Introduction to Nuclear Reactor Operations, Section 8.1 - 8.4

A.04
Answer: d
Reference: CR=S/(1-k)→200/(1-0.6) = 500 N/sec

A.05
Answer a
Reference: Chart of the Nuclides, KAPL. Seventeenth Edition

A.06
Answer: b
Reference: DOE Fundamentals Handbook, NPRT, Vol. 2, Module 4, EO 2.1, p.17

A.07
Answer: c
Reference: Burn, R., Introduction to Nuclear Reactor Operations, Section 3.3.4
Δρ = (Keff1-Keff2)/(Keff1*Keff2) = (0.943-0.885)/((0.943*0.885)
0.0694Δk/k = 6.94%Δk/k

A.08
Answer: c
Reference: Count1*(1-Keff1) = Count2*(1-Keff2) 100*(1-0.950) = 200*(1-Keff2)
100*(1-0.95) = 200(1- Keff2); Keff2 = 0.975

A.09
Answer: c
Reference: $P = P_0e^{t/T}$, T = t / (ln(P/P_0) = 50 / (ln(2)) = 72.15 seconds

A.10
Answer: a
$\rho1=(\rho\$1)(\beta_{eff})=(\$1.10)(.0075)=(.00825)$
$[(\rho2-\beta_{eff})\text{^}2]/Peak2 = [(\rho1-\beta_{eff})\text{^}2]/Peak1$
$Peak2/Peak1*[(\rho1- \beta_{eff})\text{^}2]=[(\rho2-\beta_{eff})\text{^}2]$
$(5000/500)*[(.00825-.0075)\text{^}2]= [(\rho2-\beta_{eff})\text{^}2]$
$[(.000005625)\text{^}½]+\beta_{eff} =\rho2=.009872$
$\rho\$2=(\rho2/\beta_{eff})=(.009872/.0075)= \$1.316 \approx \$1.32$
Reference: Burn, R., Introduction to Nuclear Reactor Operations, 1988. § 4.6, p. 4-16

A.11
Answer: c
Reference: DOE Fundamentals Handbook, NPRT, Vol. 2, Module 3, EO 2.7,p. 26

A.12
Answer: a
Reference: DOE Fundamentals Handbook, NPRT, Vol., Module 1, EO 4.7,p. 51

A.13
Answer: c
Reference: DOE Fundamentals Handbook, NPRT, Vol. 2, Module 3, EO 4.1, p.35
KAPL, “Chart of the Nuclides”, 17th Ed.

A.14
Answer: b
Reference: DOE Fundamentals Handbook, NPRT, Vol., Module 1, EO 3.1, p.43

A.15
Answer: c
Reference: DOE Fundamentals Handbook, NPRT, Vol., Module 2, EO 3.1, p. 29

A.16
Answer: a
Reference: DOE Fundamentals Handbook, NPRT, Vol. 1, Module 1, EO 4.3, p.52

A.17
Answer: d
Reference: Decreasing the reactivity worth in the core will increase the shutdown margin

A.18
Answer: c
Reference: TRIGA Fuel Design

A.19
Answer: a
Reference: 1.03 x 0.96 x 0.84 x 0.88 x 1.96 x 0.70 = 1.00
1 / (1.03 x 0.96 x 0.84 x 0.88 x 1.96) = 0.698

A.20
Answer: d
Reference: Burn, R., Introduction of Nuclear Reactor Operations, © 1988, Sec 4.5

Category B: Normal/Emergency Procedures and Radiological Controls

B.01
Answer: d
Reference: Utah Technical Specifications 6.4, 10 CFR 50.59

B.02
Answer: d
Reference: Utah UTR Emergency Preparedness Plan 3.4

B.03
Answer: b
Reference: $DR = DR_{\circ} * e^{-\lambda t} = 40$ mrem/hr $= 80$ mrem/hr* $e^{-\lambda(0.5hr)}$
Ln(40/80) = -λ*0.5hr = λ=1.3863
Solve for t: Ln(5/80)=-1.3863 (t) = t=2 hours
Short cut:
80 mrem to 40 mrem : 30 mins; 40 mrem to 20 mrem : 60 mins
20 mrem to 10 mrem : 90 mins; 10 mrem to 5 mrem : 120 mins
Total: 120 mins or 2 hrs

B.04
Answer: d
Reference: 10 CFR 55.21

B.05
Answer: d
Reference: 10 CFR 55.55

B.06
Answer: c
Reference: Utah Technical Specifications 4.5

B.07
Answer: d
Reference: Utah Technical Specifications 3.1, 3.3 and 3.7

B.08
Answer: c
Reference: NRC Standard question

B.09
Answer: b
Reference: $\frac{DR_1}{x_1^2} = \frac{DR_2}{x_2^2}; x_2^2 = \frac{2000\ mrem}{8\ mrem} 1\ ft^2 \left(\frac{(30.48\ cm)^2}{1\ ft^2}\right) = x = 609.6\ cm$

B.10
Answer: a
Reference: 10 CFR 20 100 mrem limit; TD = DR x T; 100 mrem = 10 mrem/hr x T = 10 hours

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

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

B.13
Answer: b
Reference: 10 CFR 20

B.14
Answer: d
Reference: Utah UTR Emergency Plan 3.5

B.15
Answer: b
Reference: Utah UTR Emergency Plan 4.2.4

B.16
Answer: b
Reference: Standard Health Physics Definition

B.17
Answer: c
Reference: Utah Technical Specifications 6.1.3

B.18
Answer: d
Reference: 10CFR50.59

B.19
Answer: c
Reference: NRC Standard Instrumentation Question

B.20
Answer: b
Reference: Utah Technical Specifications 5.42

Category C: Facility and Radiation Monitoring Systems

C.01
Answer: a. 4. b. 4. c. 3. d. 4.
Reference: Utah Technical Specifications 3.2

C.02
Answer: c
Reference: NRC Standard Question

C.03
Answer: c
Reference: Utah UTR SAR 7.2.1

C.04
Answer: c
Reference: Utah Technical Specifications 5.3.3

C.05
Answer: d
Reference: Utah UTR SAR 3.1.3

C.06
Answer: d
Reference: NRC Standard Question

C.07
Answer: b
Reference: Utah UTR SAR 8.2

C.08
Answer: b
Reference: Utah SOP UNEP 008; 29 gallons/11.6 gallons/cm = 2.5 cm

C.09
Answer: a
Reference: Utah SAR 1.3.3

C.10
Answer: a
Reference: NRC Standard Question

C.11
Answer: b
Reference: Utah SAR 11.1.5.10

C.12
Answer: b
Reference: Utah 6.3

C.13
Answer: b
Reference: Utah SAR 4.5.2.1

C.14
Answer: a
Reference: Utah SAR 4.2.1

C.15
Answer: d
Reference: Utah Experiment Authorization Form

C.16
Answer: a
Reference: Utah Technical Specifications 3.1.6

C.17
Answer: d
Reference: Utah Technical Specifications 4.1

C.18
Answer: a
Reference: Utah SAR 7.7.2

C.19
Answer: a.
Reference: Utah Technical Specifications 3.5