November 30, 2017

Paul Whaley, Associate Director
Nuclear Engineering Teaching Lab
University of Texas at Austin
NETL-PRC Bldg 159
10100 Burnet Rd
Austin, TX 78758

SUBJECT: EXAMINATION REPORT NO. 50-602/OL-17-02, UNIVERSITY OF TEXAS AT AUSTIN

Dear Dr. Whaley:

During the week of September 28, 2017, the U.S. Nuclear Regulatory Commission (NRC) administered operator licensing examinations at your University of Texas at Austin TRIGA 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 at the conclusion of the examination with those members of your staff identified in the enclosed report.

In accordance with Title 10, Section 2.390 of the *Code of Federal Regulations*, a copy of this letter and the enclosures will be available electronically for public inspection in the NRC Public Document Room or from the Publicly Available Records (PARS) component of NRC's Agencywide Documents Access and Management System (ADAMS). ADAMS is accessible from the NRC Web site at http://www.nrc.gov/reading-rm/adams.html (the Public Electronic Reading Room).

The NRC is forwarding the individual grades to you in a separate letter which will not be released publicly. If you have any questions concerning this examination, please contact Paulette Torres at (301) 415-5656, or via e-mail at Paulette.Torres@nrc.gov.

Sincerely,

/RA/

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

Docket No. 50-602

Enclosures:
1. Examination Report
2. Facility Comments with NRC Resolution
3. Written examination with facility comments incorporated

cc: Larry Hall, Reactor Manager
cc w/o enclosures: See next page

SUBJECT: EXAMINATION REPORT NO. 50-602/OL-17-02, UNIVERSITY OF TEXAS AT AUSTIN DATED NOVEMBER 30, 2017.

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cc:

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Austin, TX 78711

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

REPORT NO.: 50-602/OL-17-02

FACILITY DOCKET NO.: 50-602

FACILITY LICENSE NO.: R-129

FACILITY: University of Texas at Austin TRIGA Reactor

EXAMINATION DATES: September 28-29, 2017

SUBMITTED BY: /RA/ 11/9/17
Paulette Torres, Chief Examiner Date

SUMMARY:

During the week of September 28, 2017, the NRC administered operator licensing examinations to two Reactor Operators (RO) license candidates. Both candidates failed the written exam/all applicable portions of the examinations.

REPORT DETAILS

1. Examiner: Paulette Torres, Examiner, NRC

2. Results:

	RO PASS/FAIL	SRO PASS/FAIL	TOTAL PASS/FAIL
Written	0/2	N/A	0/2
Operating Tests	1/1	N/A	1/1
Overall	0/2	N/A	0/2

3. Exit Meeting:
Paulette Torres, Chief Examiner, NRC
Larry Hall, Reactor Manager, University of Texas at Austin

The facility licensee agreed to e-mail their comments on the written examination that were incorporated in the examination report (see Enclosure 2).

4. Prior to the completion of the NRC's operator licensing examination review process, one of the candidates examined was terminated by the facility. The NRC has determined that this candidate failed both the written and operating portions of the examination. Due to facility's termination of this candidate, a denial letter will not be issued to the candidate and the failed examination information will be added to the candidate's docket file.

FACILITY COMMENTS ON THE WRITTEN EXAM WITH NRC RESOLUTION

QUESTION B.03 [1.0 point]
Which ONE of the following materials hazards has a double encapsulation requirement?

a. Corrosive

b. Explosive

c. Flammable

d. Volatile

Answer: a
REF: ADMN-6, Safety Analysis of Experiments, Material Evaluation (2) (e), pg. 3 of 5
UT Presentation: UT TRIGA Experiment Authorizations Facility comments:

Facility
Recommendation: Both a and b are discussed in reference as requiring double encapsulation. REQUEST a or b be an acceptable answer.

NRC Resolution: The NRC will accept both "a" and "b" as correct answers for question B.03.

QUESTION B.12 [1.0 point]
Per Technical Specifications, one instrumented fuel element shall be located in the _____ ring of the reactor core configuration.

a. B or G

b. C or D

c. D of F

d. E or B

Answer: a
REF: TS 2.2.1, pg. 12

Facility
Recommendation: The reference states B or C, there was a typo in answer "a" with a G in place of C, all answers are incorrect. REQUEST to remove the question.

NRC Resolution: The NRC agrees with the facility comment and question B.12 will be deleted from the examination.

QUESTION B.20 [1.0 point]
Which ONE of the following materials shall NOT be irradiated at the University of Texas at Austin TRIGA Reactor?

a. A doubly encapsulated liquid fissionable material.

b. 500 millicuries of iodine -131.

c. 2 millicuries of strontium-90.

d. 25 mg of explosive material.

Answer: d
REF: TS 3.4.2 c., pg. 18

Facility
Recommendation: The reference states the quantity is >25mg that is not allowed, so answer is not technically correct. REQUEST to remove the question.

NRC Resolution: The NRC agrees with the facility comment and question B.20 will be deleted from the examination.

QUESTION C.09 [1.0 point]
What is the ALERT level set point for the Ar-41 CAM?

a. 2000 cpm

b. 4000 cpm

c. 6000 cpm

d. 10000 cpm

Answer: b
REF: OPER-1, Startup - Shutdown Checks, Attachment, Radiation Monitors, pg. 1 of 2
MAIN-4, Area Radiation Monitor Systems, PRM AR-1000 gas monitor Calibration, 3., pg. 1 of 2

Facility
Recommendation: Per reference, A is the correct answer. The reference states the alert for the AR-1000 gas monitor is 2000 cpm. The alert for Particulate Detector is 400 cpm. REQUEST to change correct answer to “a”

NRC Resolution: The NRC agrees with the facility comments and will accept “a” as the correct answers for question C.09.

QUESTION C.12 [1.0 point]
The REFLECTOR is back filled with _____ to leak test.

a. Air

b. Argon

c. CO_2

d. Helium

Answer: d
REF: UT Presentation: Reactor Mechanical Design

Facility
Recommendation: I am not formally contesting the question, but would like to inform you that is not an item that I would emphasize a Reactor operator to know. It is not a parameter for operating, but merely a nice to know about the testing when we had a new reflector installed. Not sure if that question could be stricken from the test or not. Thanks.

NRC Resolution: The NRC understands the facility comments. Question C.12 will be deleted from the examination.

QUESTION C.19 [1.0 point, 0.33 points each]
Match the type of radiation monitor with its specific radiological purpose.

Radiation Monitor	**Radiological Purpose**
a. Particulate Air Monitor	1. Used to determine the effluent radiation release of argon-41.
b. Gaseous Air Monitor	2. Used to detect radioisotopes released due to fuel element failure (a design basis accident).
c. Area Radiation Monitors	3. Used to minimize personnel radiation exposures.

C.19
Answer: a. = 2, b. = 3, c. = 1
REF: SAR 9.5, pg. 9-10

Facility
Recommendation: The reference provides definitions that indicate the correct answer should be a=2, b=1, c=3. REQUEST to change the answer to reflect a=2, b=1, c=3

NRC Resolution: The NRC agrees with the facility comments and will accept “a=2”, “b=1”, “c=3” as the correct answers for question C.19.

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

FACILITY: University of Texas at Austin

REACTOR TYPE: TRIGA

DATE ADMINISTERED: 09/28/2017

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

A. RX THEORY, THERMO & FAC OP CHARS

A N S W E R S H E E T

Multiple Choice (Circle or X your choice)
If you change your Answer, write your selection in the blank.

A01 a b c d ___

A02 a b c d ___

A03 a b c d ___

A04 a b c d ___

A05 a b c d ___

A06 a b c d ___

A07 a b c d ___

A08 a b c d ___

A09 a b c d ___

A10 a b c d ___

A11 a b c d ___

A12 a b c d ___

A13 a b c d ___

A14 a b c d ___

A15 a b c d ___

A16 a b c d ___

A17 a b c d ___

A18 a b c d ___

A19 a b c d ___

A20 a b c d ___

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

B. NORMAL/EMERG PROCEDURES & RAD CON

A N S W E R S H E E T

Multiple Choice (Circle or X your choice)
If you change your Answer, write your selection in the blank.

B01 a b c d ___

B02 a b c d ___

B03 a b c d ___

B04 a b c d ___

B05 a b c d ___

B06 a b c d ___

B07 a b c d ___

B08 a b c d ___

B09 a b c d ___

B10 a b c d ___

B11 a b c d ___

~~B12 a b c d ___~~ Deleted per facility comment

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 ___~~ Deleted per facility comment

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

C. PLANT AND RAD MONITORING SYSTEMS

A N S W E R S H E E T

Multiple Choice (Circle or X your choice)
If you change your Answer, write your selection in the blank.

C01 a b c d ___

C02 a b c d ___

C03 a b c d ___

C04 a b c d ___

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 ___~~ Deleted per facility comment

C13 a b c d ___

C14 a ___ b ___ c ___ d ___

C15 a ___ b ___ c___ d ___ e ___

C16 a b c d ___

C17 a b c d ___

C18 a b c d ___

C19 a ___ b ___ c ___

C20 a b c d ___

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

NRC RULES AND GUIDELINES FOR LICENSE EXAMINATIONS

During the administration of this examination the following rules apply:

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

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

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

4. Use black ink or dark pencil only to facilitate legible reproductions.

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

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

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

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

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

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

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

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

EQUATION SHEET

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

$$T_{\frac{1}{2}} = \frac{0.693}{\lambda} \quad \Delta\rho = \frac{K_{eff_2} - K_{eff_1}}{K_{eff_1} K_{eff_2}}$$

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

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

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

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

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

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

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

1 kg = 2.21 lbm

1 Horsepower = 2.54 x 10^3 BTU/hr

1 Mw = 3.41 x 10^6 BTU/hr

1 BTU = 778 ft-lbf

°F = 9/5 °C + 32

1 gal (H_2O) ≈ 8 lbm

°C = 5/9 (°F - 32)

c_P = 1.0 BTU/hr/lbm/°F

c_p = 1 cal/sec/gm/°C

UNIVERSITY OF TEXAS AT AUSTIN

Operator Licensing Examination

Week of September 28, 2017

QUESTION A.01 [1.0 point]
All atoms of a given element have the same _____.

a. Atomic Mass

b. Mass Number

c. Atomic Number

d. Number of Neutrons

QUESTION A.02 [1.0 point]
The use of a reflector results in _____.

a. The production of neutrons.

b. A high neutron absorption cross section.

c. A decrease in the critical mass of fissile material.

d. The decrease of the average power output for a given peak neutron flux.

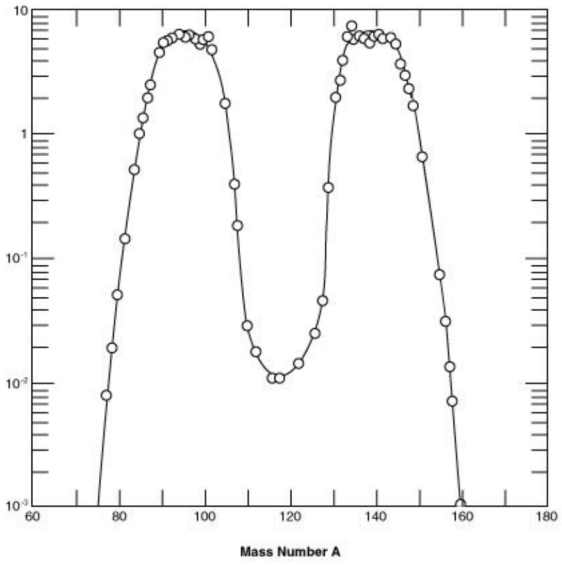
QUESTION A.03 [1.0 point]
The following graph for U-235 shows……

a. Differential rod worth curve in the core.

b. Distribution of fission product yield.

c. Radial flux distribution in the core.

d. Neutron energy distribution in the moderator.



QUESTION A.04 [1.0 point]
Which ONE of the following is NOT a "pure" beta-emitter?

a. ^{14}C

b. ^{32}P

c. ^{35}S

d. ^{60}Co

QUESTION A.05 [1.0 point]
_____ is the total distance in centimeters traveled in 1 second by all the neutrons present in 1 cm^3.

a. Neutron Flux

b. Neutron Density

c. Neutron Diffusion

d. Neutron Cross Section

QUESTION A.06 [1.0 point]
Most text books list β for a U^{235} fueled reactor as 0.0065 ΔK/K and β_{eff} as being 0.0075 ΔK/K. Why is β_{eff} larger than β?

a. Delayed neutrons are born at higher energies than prompt neutrons resulting in a greater worth for these neutrons.

b. Delayed neutrons are born at lower energies than prompt neutrons resulting in a less loss due to leakage for these neutrons.

c. The fuel includes U^{238} which has a relatively large for fast fission.

d. Some U^{238} in the core becomes Pu^{239} (by neutron absorption) which has a larger for fission.

QUESTION A.07 [1.0 point]
As the moderator temperature increases, the resonance escape probability _____.

a. Increases, since the moderator becomes less dense.

b. Decreases, since neutrons are more likely to be absorbed by U-238 and Pu-240.

c. Remains constant, since the effect of moderator temperature change is relatively small.

d. Increases, since the moderator-to-fuel ratio increases.

QUESTION A.08 [1.0 point]
Two minutes following shutdown, reactor power is at 10 kW and decreases with a constant reactor period. Which ONE of the following is the correct power for three minutes later?

a. 0.5 kW

b. 1.1 kW

c. 3.3 kW

d. 6.7 kW

QUESTION A.09 [1.0 point]
The term _____ defines the condition where no delay neutrons are required.

a. Prompt Jump

b. Prompt Drop

c. Asymptotic Period

d. Prompt Critical

QUESTION A.10 [1.0 point]
During the minutes following a reactor scram, reactor power decreases on a negative 80 second period, corresponding to the half-life of the longest lived delayed neutron precursor, which is approximately _____.

a. 20 seconds

b. 40 seconds

c. 55 seconds

d. 80 seconds

QUESTION A.11 [1.0 point]
During a Subcritical Multiplication "1/M" plot, data is required to be taken. What does the 1/M represent?

a. The inverse of fuel elements presented in the core.

b. The inverse of the moderator coefficient of reactivity.

c. The inverse migration length of neutrons of varying energies.

d. The inverse multiplication of the count rate between generations.

QUESTION A.12 [1.0 point]
Which ONE of the following contributing components has the highest percentage of relative magnitude to the prompt negative temperature coefficient of TRIGA reactors?

a. Doppler Broadening of ^{238}U Resonances

b. Control Rod Locations

c. Leakage from Core

d. Zirconium Hydride Effect

QUESTION A.13 [1.0 point]
The reaction ${}^{3}_{1}H \rightarrow {}^{3}_{2}He^{+} + \_\_\_ + \overline{\upsilon_e}$ is an example of:

a. Alpha Decay

b. Beta Decay

c. Electron Capture

d. Gamma Emission

QUESTION A.14 [1.0 point]
The reactor is critical at 5 watts. Which ONE of the following correctly describes the reactor behavior when a reactivity worth of 0.50 % ΔK/K is IMMEDIATELY inserted to the reactor core?

a. Critical

b. Subcritical

c. Supercritical

d. Prompt Critical

QUESTION A.15 [1.0 point]
A reactor is operating at 5 kW. A positive reactivity worth of 0.5% ΔK/K is added to the reactor. What is the resulting period? β=0.007

a. 2.47 sec

b. 4.02 sec

c. 40.0 sec

d. 740 sec

QUESTION A.16 [1.0 point]
Which ONE of the following types of neutrons has a neutron generation time of ~13 seconds?

a. Fast

b. Prompt

c. Delayed

d. Thermal

QUESTION A.17 [1.0 point]
Which ONE of the following factors describes the bases for limits on rod configuration?

a. Rod Speed

b. Total Reactor Power

c. Delayed Neutron Fraction

d. Axial and Radial Flux Shaping

QUESTION A.18 [1.0 point]
Which ONE of the following parameters for a finite reactor has a value greater than one?

a. Fast Fission factor (ε)

b. Thermal Utilization Factor (f)

c. Resonance escape probability (p)

d. Thermal Non-Leakage probability (L_{Th})

QUESTION A.19 [1.0 point]
Which ONE of the following is the best approximation of the amount of energy released by the fission of one atom of U-235?

a. 5 - 10 MeV

b. 50 - 70 MeV

c. 100 - 120 MeV

d. 180 - 210 MeV

QUESTION A.20 [1.0 point]
Which ONE of the following is the time period in which the Xe^{135} inventory peaks in the reactor core after a power changer?

a. 4 to 8 hours after a power increase from 50% to 100%.

b. 4 to 8 hours after a power decrease from 100% to 50%.

c. 7 to 18 hours after a startup to 100%.

d. 7 to 18 hours after a shutdown from 100%.

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

QUESTION B.01 [1.0 point]
The Emergency Response Plan defines "Derived Air Concentration (DAC)" as:

a. The concentration of a given radionuclide in the air which, if breathed by the reference man for a working year of 2,000 hours under conditions of light work, results in an intake of one ALI.

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

c. The dose equivalent to organs or tissues of reference (T) that will be received from an intake of radioactive material by an individual during the 50-year period following the intake.

d. The sum of the effective dose equivalent (for external exposures) and the committed effective dose equivalent (for internal exposures).

QUESTION B.02 [1.0 point]
"Total worth of the transient rod shall be limited to 2.82 % Δk/k, and the total withdrawal time for the rod shall not exceed 15 seconds". This is an example of a:

a. Safety Limit

b. Limiting Safety System Setting

c. Limiting Condition for Operation

d. Surveillance Requirement

QUESTION B.03 [1.0 point]
Which ONE of the following materials hazards has a double encapsulation requirement?

a. Corrosive

b. Explosive

c. Flammable

d. Volatile

QUESTION B.04 [1.0 point]
The Emergency Response Plan allows the emergency workers to incur exposures limits of _____ Rem for corrective actions and _____ Rem for whole body exposure limit for life-saving.

a. 5 and 10

b. 10 and 25

c. 25 and 50

d. 25 and 100

QUESTION B.05 [1.0 point]
A radioactive sample which initially was reading 50 R/hr has decayed over 8 hours to 25 R/hr. What will the sample read in another 4 hours?

a. 12.5 R/hr

b. 17.7 R/hr

c. 18.8 R/hr

d. 22.9 R/hr

QUESTION B.06 [1.0 point]
Which ONE of the following procedures requires a Radiation Work Permit (RWP) as part of the equipment and materials needed for the procedure?

a. Movement of Fuel (FUEL-1)

b. Control Rod Calibration (SURV-6)

c. Area Radiation Monitor Systems (MAIN-4)

d. Operation of Air Confinement Systems (OPER-5)

QUESTION B.07 [1.0 point]
By September 1, 2017, you have actively performed the functions of a Reactor Operator for the following hours during the last quarter:

June 11, 2017	0.5 hours
July 24, 2017	1.5 hours
August 16, 2017	1.0 hours

What requirements must you meet in order to maintain your Reactor Operator license today?

a. None. You've met the minimum requirements of 10 CFR 55.53.

b. You must perform 4 hours of shift functions under the direction of a licensed operator or licensed senior operator as appropriate.

c. You must perform 6 hours of shift functions under the direction of a licensed operator or licensed senior operator as appropriate.

d. You must submit a new application form to the NRC requesting a waiver to reactivate your license.

QUESTION B.08 [1.0 point]
Per Technical Specifications, the Fuel Element Temperature monitor circuit shall be calibrated on a _____ basis.

a. Annual

b. Semiannual

c. Quarterly

d. Monthly

QUESTION B.09 [1.0 point]
All of the following are Emergency Action Levels for Notification of Unusual Event EXCEPT:

a. Severe natural events being experienced that are causing observable damage to reactor systems.

b. Fire in the reactor room lasting fewer than 15 minutes or fire in other parts of the building.

c. Bomb threats or civil disturbances directed toward the reactor facility, or threats to or breaches of physical security.

d. Damage to reactor cooling system allowing uncontrolled leakage of water exceeding allowable release limits outside the facility boundary.

QUESTION B.10 [1.0 point]
The dose rate from a mixed beta-gamma point source is 100 mrem/hour at a distance of 1 foot, and is 0.1 mrem/hour at a distance of 20 feet. What percentage of the source consists of beta radiation?

a. 20%

b. 40%

c. 60%

d. 80%

QUESTION B.11 [1.0 point]
Which ONE of following types of radiation has the HIGHEST Quality Factor specified in 10CFR20?

a. Beta

b. Gamma

c. Alpha Particles

d. Neutron of unknown energy

~~**QUESTION B.12 [1.0 point]**~~ Deleted per facility comment
~~Per Technical Specifications, one instrumented fuel element shall be located in the _____ ring of the reactor core configuration.~~

~~a. B or G~~

~~b. C or D~~

~~c. D of F~~

~~d. E or B~~

QUESTION B.13 [1.0 point]
Which ONE of the following incidents has an immediate notification requirement to the NRC?

a. Reactor safety limit violation.

b. Release of radioactivity in excess of limits.

c. Individual receives a total effective dose equivalent of 5 rems (0.05 Sv) or more.

d. Release of material such that an individual could receive in 24 hours, five times the Annual Limit of Intake.

QUESTION B.14 [1.0 point]
Per Technical Specifications, a fuel element shall be considered damaged and must be removed from the core if in measuring the elongation, the length exceeds the original length by:

a. 1/10 inch

b. 1/15 inch

c. 1/16 inch

d. 1/20 inch

QUESTION B.15 [1.0 point]
Which ONE of the following experiments requires an Argon purge valve for startup?

a. Center Tube Experiment

b. Rotary Specimen Rack Experiment

c. Pneumatic Transfer System Experiment

d. Three Element Cutout Irradiator Experiment

QUESTION B.16 [1.0 point]
Per HP-003, and in support of ALARA, the NETL occupational dose limit for the typical radiation worker is established as the total effective dose equivalent equal to:

a. 2% of the NRC limit

b. 10% of the NRC limit

c. 20 % of the NRC limit

d. Not applicable. Same as the NRC limit

QUESTION B.17 [1.0 point]
In accordance with Technical Specifications, the Reactor is SECURE when all of the following conditions exist EXCEPT:

a. The console key removed from the lock.

b. Power is unavailable to the control rod drive mechanism electromagnets.

c. No work is in progress involving core fuel, core structure, installed control rods and drives.

d. No experiments are being moved or serviced that have, on movement, a reactivity worth equal to or exceeding $1.00.

QUESTION B.18 [1.0 point]
Per procedure OPER-3, which ONE of the following modes requires the Reactor Operator to determine BOTH Transient Reactivity and Final Transient Rod (TR) position?

a. Manual Mode

b. Auto Mode

c. Square Wave Mode

d. Pulse Mode

QUESTION B.19 [1.0 point]
10 CFR 20 requires that dose equivalent to the embryo/fetus during the entire pregnancy, due to the occupational exposure of a declared pregnant woman, does not exceed _____.

a. 0.5 rem

b. 5.0 rem

c. 0.1 rem

d. 1.0 rem

~~**QUESTION B.20 [1.0 point]**~~ Deleted per facility comment
~~Which ONE of the following materials shall NOT be irradiated at the University of Texas at Austin TRIGA Reactor?~~

~~a. A doubly encapsulated liquid fissionable material.~~

~~b. 500 millicuries of iodine -131.~~

~~c. 2 millicuries of strontium-90.~~

~~d. 25 mg of explosive material.~~

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

QUESTION C.01 [1.0 point]
The Reactor Coolant pump capacity is _____ gpm.

a. 10

b. 75

c. 250

d. 400

QUESTION C.02 [1.0 point]
Which ONE of the following is a PORTABLE Radiation Monitor?

a. Eberline, model: PRS-2/NRD, BF3 Counter (n) type with a 0-5 R/hr range.

b. Eberline, model: RMSII-6, Cylinder GM (γ) type with a 0.1-10,000 mr/hr range.

c. Ludlum, model: M-333, Pancake GM (β) type with a 10-100,000 cpm range.

d. GA (TRIGA), model: AR-1000, scintillator (β) type with a 1-1 x 10^7 cpm range.

QUESTION C.03 [1.0 point]
The Heat Exchanger is required to be ON when operating the reactor at or above _____.

a. 1 kW

b. 5 kW

c. 50 kW

d. 100 kW

QUESTION C.04 [1.0 point]
Which ONE of the following failures does NOT provide a persistent indication of radioactivity release?

a. Fuel Element Failure

b. Demineralizer Failure

c. Neutron Startup Source Failure

d. Experiment or Experiment Facility Failure

QUESTION C.05 [1.0 point]
Per Technical Specifications, the maximum excess reactivity shall be:

a. 0.2% ΔK/K

b. 2.2% ΔK/K

c. 2.8% ΔK/K

d. 4.9% ΔK/K

QUESTION C.06 [1.0 point]
Which ONE is true for the NPP-1000 detector? The NPP-1000 outputs _____.

a. Linear Power

b. Log Power

c. Peak Power

d. Period

QUESTION C.07 [1.0 point]
The stress imposed on the TRIGA fuel element clad is a function of all of the following EXCEPT:

a. Fuel Temperature

b. Hydrogen-To-Zirconium Ratio

c. Fuel Burnup

d. Uranium Concentration

QUESTION C.08 [1.0 point]
Which ONE of the following limits is specific to a Permanent Neutron Beam Experiment?

a. Direct continuous surveillance of area.

b. RWP exists covering access to area.

c. Reactor shutdown if unanticipated alarm.

d. Dose rate measurements shall be made, recorded, and filed by HP.

QUESTION C.09 [1.0 point]
What is the ALERT level set point for the Ar-41 CAM?

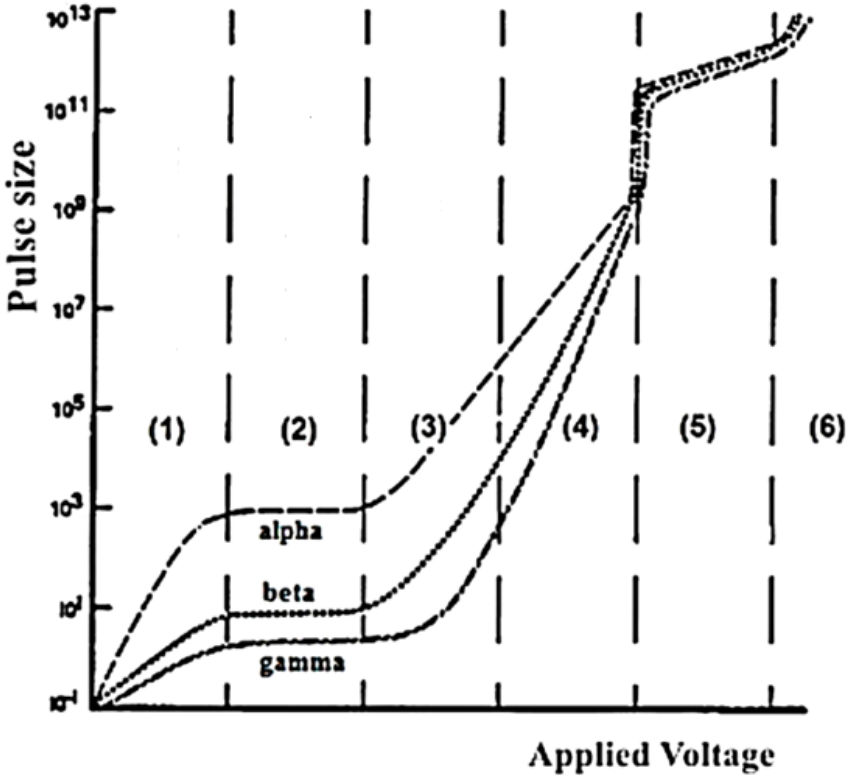
e. 2000 cpm

f. 4000 cpm

g. 6000 cpm

h. 10000 cpm

QUESTION C.10 [1.0 point]
The figure below is an example of the gas amplification curve for gas-filled detectors. Which ONE of the following Regions corresponds to the GEIGER-MUELLER Region?



a. Region 2

b. Region 3

c. Region 4

d. Region 5

QUESTION C.11 [1.0 point]
The top grid plate contains a total of _____ hole/holes.

a. 1

b. 4

c. 110

d. 121

~~**QUESTION C.12 [1.0 point]** Deleted per facility comment~~
~~The REFLECTOR is back filled with _____ to leak test.~~

~~a. Air~~

~~b. Argon~~

~~c. CO_2~~

~~d. Helium~~

QUESTION C.13 [1.0 point]
Which ONE of the following reactor beam lines is tangential and currently not used?

a. BP 1

b. BP 2

c. BP 3

d. BP 4

QUESTION C.14 [1.0 point, 0.25 each]
Match the correct control rod drive assembly.

a. Armature	1. Attached to the lower end of the draw tube, engages an iron armature.
b. Electromagnet	2. Used to provide rod position information.
c. Pinion Gear	3. Screwed and pinned into the upper end of a connecting rod that terminates at its lower end in the control rod.
d. Potentiometer	4. Engages a rack attached to the magnet draw tube.

QUESTION C.15 [1.0 points, 0.20 points each]
Match the two control rod types design parameters by its material.

Material	**Control Rod**
a. Al cladding	1. Transient
b. 304SS cladding	2. Fuel Followed (FFCR)
c. UZrH portion	3. Both
d. Air follower	
e. Boron Carbide absorber	

QUESTION C.16 [1.0 point]
Several interlocks prevent the movement of the rods in the UP direction under conditions such as the following EXCEPT:

a. Scrams not reset.

b. Magnet not coupled to armature.

c. Mode switch in MANUAL position.

d. Source level below minimum count.

QUESTION C.17 [1.0 point]
Which ONE of the following Safety Channels SCRAM on loss of timer reset?

a. High Voltage

b. Magnet Current

c. Manual Scram Console Button

d. Watchdog Trip

QUESTION C.18 [1.0 point]
Both the NP and the NPP instruments at NETL are _____.

a. Fission Chamber

b. Gamma Ion Chamber

c. Compensated Ion Chamber

d. Uncompensated Ion Chamber

QUESTION C.19 [1.0 point, 0.33 points each]
Match the type of radiation monitor with its specific radiological purpose.

Radiation Monitor	**Radiological Purpose**
d. Particulate Air Monitor	4. Used to determine the effluent radiation release of argon-41.
e. Gaseous Air Monitor	5. Used to detect radioisotopes released due to fuel element failure (a design basis accident).
f. Area Radiation Monitors	6. Used to minimize personnel radiation exposures.

QUESTION C.20 [1.0 point]
Actuation of the isolation damper in the argon purge system occurs:

a. By manual operation of the fan control switch.

b. By manual operation of the main air supply system.

c. Automatically after air confinement signal.

d. Automatically after airborne particulate radioactivity exceeds a setpoint.

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

A.01
Answer: c
REF: DOE Handbook, Volume 1, Module 1, pg. 4

A.02
Answer: c
REF: Glasstone & Sesonske, Nuclear Reactor Engineering, Section 4.46-4.48, pg. 170-171

A.03
Answer: b
REF: DOE Manual Vol. 1, NP-01, pg. 57

A.04
Answer: d
REF: Chart of the nuclides

A.05
Answer: a
REF: Glasstone & Sesonske, Nuclear Reactor Engineering, Section 2.118, pg. 72

A.06
Answer: b
REF: Burns, Section 3.2.4, pg. 3-12

A.07
Answer: b
REF: Burns, Section 3.3.2, pg. 3-18

A.08
Answer: b
REF: $P = P_o e^{t/\tau}$
$P = 10\ kW * e^{180/-80}$
$P = 10\ kW * 0.105 = 1.05\ kW$

A.09
Answer: d
REF: Knief, Nuclear Engineering, 2nd ed., pg. 142

A.10
Answer: c
REF: Burns, Section 1.3.3, pg. 1-6 and 1-7

A.11
Answer: d
REF: DOE Handbook, Volume 2, Module 4, “Subcritical Multiplication”, pg. 1-9

A.12
Answer: d
REF: UT Presentation: Theory and Principles of Operation, Fuel Temperature Coefficient slide
West et al., "Kinetic Behavior of TRIGA Reactors", GA-7882, 1967, Table V, pg. 22

A.13
Answer: b
REF: DOE Handbook, Volume 1, Module 1, pg. 24

A.14
Answer: c
REF: Burn, Section 4.2, Figure 4-1, pg. 4-2
0.5 % $\Delta K/K = 0.005$ $\Delta K/K = \rho$, $\rho > 0$
$\rho = (k_{eff} - 1) / k_{eff}$, then $k_{eff} = 1.005$
When $k > 1$, $\rho > 0$ and reactor is supercritical

A.15
Answer: b
REF: $T = (\beta-\rho)/\lambda\rho$
$T = (0.007-0.005)/(0.1/sec)(0.005)$
$T = 0.002/5E^{-4}$
$T = 4$ sec

A.16
Answer: c
REF: Burns, Section 3.3.7, pg. 3-27

A.17
Answer: d
REF: Burns, Example 7.4 (b), pg. 7-11

A.18
Answer: a
REF: DOE Handbook, Volume 2, Module 3, Figure 1, pg. 11
UT Presentation: Theory and Principles of Operation, Six Factor Formula: Neutron Life Cycle slide

A.19
Answer: d
REF: Lamarsh, Table 3.6, pg. 88
Foster and Wright, Basic Nuclear Engineering, 4th ed., table 4.2, pg. 76, "The energy release per fission is approximately 200 MeV."

A.20
Answer: d
REF: Lamarsh 3rd ed., Figure 7.14, pg. 381
UT Presentation: Theory and Principles of Operation, Reactor Kinetics: FPPs slide

B.01
Answer: a
REF: ERP 1.1.1, pg. 5 of 34
UT Presentation: Radiation Control and Safety, Definitions slide

B.02
Answer: c
REF: TS 3.1.3, pg. 13

B.03
Answer: a and b correct per facility comment
REF: ADMN-6, Safety Analysis of Experiments, Material Evaluation (2) (e), pg. 3 of 5
UT Presentation: UT TRIGA Experiment Authorizations

B.04
Answer: d
REF: ERP 3.3, pg. 18 of 34

B.05
Answer: b
REF: $A = A_0 e^{-(\lambda t)}$
$25 = 50\ e^{-(\lambda \times 8 \times 3600)}$
$\lambda = 2.4 \times 10^4$ sec
$A = 25e^{(-2.4 \times 104 \times 4 \times 3600)}$
A = 17.7 R/hr

B.06
Answer: a
REF: FUEL-1, F. Equipment, Materials, pg. 3 of 7

B.07
Answer: c
REF: 10 CFR 55.53 (e) & (f)

B.08
Answer: a
REF: MAIN-2, Instrument System Features, I. Procedure, A. Introduction, pg. 4 of 18
TS 4.2.4, pg. 21

B.09
Answer: b
REF: ERP 1.2.2, pg. 7 of 34
PLAN-E, Attachment “Emergency Classification”, pg. 1 of 1
UT Presentation: UT TRIGA PLAN-0, E, S

B.10
Answer: c
REF: At 20 feet, there is no beta radiation. Gamma at 20 feet = 0.1 mrem/hour, gamma at 1 foot = 40 mrem/hour. Therefore beta at 1 foot = 60 mrem /hour = 60%.

B.11
Answer: c
REF: 10 CFR 20.1004

~~**B.12**~~
~~Answer: a Deleted per facility comment~~
~~REF: TS 2.2.1, pg. 12~~

B.13
Answer: d
REF: PLAN-0, II. Procedure, D. Additional Notification Requirements, pg. 7 of 7
TS 6.6.2, pg. 34
10 CFR 20.2202(a)(2)
UT Presentation: UT TRIGA PLAN-0, E, S

B.14
Answer: a
REF: TS 3.1.4 a., pg. 13

B.15
Answer: b
REF: OPER-1, Experiment Startup/Shutdown Checks Attachments, pg. 1 of 1

B.16
Answer: c
REF: HP-003, NETL ALARA Program, II. Procedure, F. Radiation Control, pg. 5 of 7
UT Presentation: Topic 2.2.6 (F) Radiation Control and Safety, NETL Dose Limits

B.17
Answer: b
REF: TS 1.18.2, pg. 8

B.18
Answer: c
REF: OPER-3, II. Procedure, C.1., pg. 4 of 5

B.19
Answer: a
REF: 10 CFR 20.1208 (a)

~~**B.20**~~
~~Answer: d Deleted per facility comment~~
~~REF: TS 3.4.2 c., pg. 18~~

C.01
Answer: c
REF: SAR Table 5-1, pg. 5-9

C.02
Answer: a
REF: PLAN-E, Attachment “Emergency Equipment”, pg. 1 of 2

C.03
Answer: d
REF: UT Presentation: Reactor Coolant and Purification System
OPER-4, Operation of Reactor Water Systems, II. Procedure, C. Pool Coolant System, 1.a, pg. 7 of 8

C.04
Answer: b
REF: OPER-4, Operation of Reactor Water Systems, Abnormal Conditions Attachment, D. Radioactivity Release to Water, 3. Persistent - indication of radioactivity release, pg. 6 of 6

C.05
Answer: d
REF: TS 3.1.3, pg. 13

C.06
Answer: c
REF: UT presentation: NM, NP, NPP Detectors
SAR Figure 6-1, pg. 6-3

C.07
Answer: d
REF: UT Presentation: TRIGA Reactor Fuel Safety Limits
SAR 11.2.2, pg. 11-15

C.08
Answer: c
REF: UT Presentation: UT TRIGA Experiment Authorizations

C.09
Answer: a
REF: OPER-1, Startup - Shutdown Checks, Attachment, Radiation Monitors, pg. 1 of 2
MAIN-4, Area Radiation Monitor Systems, PRM AR-1000 gas monitor Calibration, 3., pg. 1 of 2

C.10
Answer: d
REF: UT Presentation: NM, NP, NPP Detectors

C.11
Answer: d
REF: UT Presentation: Reactor Mechanical Design
SAR 4.4.3, pg. 4-57

~~**C.12**~~
~~Answer: d~~ Deleted per facility comment
~~REF: UT Presentation: Reactor Mechanical Design~~

C.13
Answer: b
REF: UT Presentation: Reactor Mechanical Design
SAR Table 7-2, pg. 7-26

C.14
Answer: a. = 3, b. = 1, c. = 4 d. = 2
REF: SAR 4.4.8.2, pg 4-67

C.15
Answer: a. = 1; b. = 2; c. = 2; d, = 1; e. = 3
REF: SAR Table 4-11, pg. 4-65
UT Presentation: Reactor Mechanical Design

C.16
Answer: c
REF: SAR 6.1.4, pg. 6-12

C.17
Answer: d
REF: TS 3.2.3 f., pg. 14

C.18
Answer: d
REF: UT Presentation: NM, NP, NPP Detectors
SAR Figure 6-1. pg. 6-3

C.19
Answer: a. = 2, b. = 1, c. = 3
REF: SAR 9.5, pg. 9-10

C.20
Answer: a
REF: SAR 7.2.2, pg. 7-5