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

December 16, 2021

Dr. Sean McDeavitt, Director
Texas A&M University
Nuclear Engineering and Science Center
Texas Engineering Experiment Station
1095 Nuclear Science Road, MS 3575
College Station, TX 77843

SUBJECT: EXAMINATION REPORT NO. 50-128/OL-22-01, TEXAS A&M UNIVERSITY ENGINEERING EXPERIMENT STATION

Dear Dr. McDeavitt:

During the week of October 4, 2021, the U.S. Nuclear Regulatory Commission (NRC) administered operator licensing examinations at the Texas A&M University Engineering Experiment Station. 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 you and 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. If you have any questions regarding the examination, please contact Michele DeSouza at (301) 415-0747 or Michele.DeSouza@nrc.gov.

Sincerely,

Travis L. Tate Digitally signed by Travis L. Tate

Travis L. Tate, 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. 50-128

Enclosures:
1. Examination Report No. 50-128 /OL-22-01
2. Facility Comments with NRC Resolution
3. Written Examination

cc (w/o enclosures): See next page

cc:

Mayor, City of College Station
P.O. Box Drawer 9960
College Station, TX 77840-3575

Governor's Budget and
Policy Office
PO Box 12428
Austin, TX 78711-2428

Scott Miller, Reactor Operations Manager
Texas A&M University
Nuclear Engineering and Science Center
Texas Engineering Experiment Station
1095 Nuclear Science Road, MS 3575
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Dr. Dimitris C. Lagoudas, Deputy Director
Texas A&M University
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241 Zachry Engineering Center
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Radiation Program Officer
Bureau of Radiation Control
Department of State Health Services
Division for Regulatory Services
1100 West 49th Street, MC 2828
Austin, TX 78756-3189

Ashley Forbes, Director
Radiation Materials Division, MC 233
Texas Commission on Environmental Quality
P.O. Box 13087
Austin, TX 78711-3087

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

State Energy Conservation Office
Comptroller of Public Accounts
P.O. Box 13528
Austin, TX 78711-3528

SUBJECT: EXAMINATION REPORT NO. 50-128/OL-22-01, TEXAS A&M UNIVERSITY ENGINEERING EXPERIMENT STATION DATED: DECEMBER 16, 2021

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ADAMS ACCESSION No.: ML21350A402 NRR-079

Office	NRR/DANU/UNPO/CE	NRR/DANU/UNPO/OLA	NRR/DANU/UNPO/BC
Name	MDeSouza	ZTaru	TTate
Date	10/08/2021	12/13/2021	12/16/2021

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

REPORT NO.: 50-128/OL-22-01

FACILITY DOCKET NO.: 50-128

FACILITY LICENSE NO.: R-83

FACILITY: Texas A&M University Engineering Experiment Station

EXAMINATION DATES: October 5-7, 2021

SUBMITTED BY: *Michele C DeSouza* 10/08/2021
Michele C DeSouza, Chief Examiner Date

SUMMARY:
During the week of October 4, 2021, the NRC administered operator licensing examinations to two Senior Reactor Operator (SRO) candidates and three Reactor Operator (RO) candidates. Two SRO and two RO candidates passed all applicable portions of the examinations. One RO candidate failed Category B of the written examination.

REPORT DETAILS

1. Examiner: Michele C DeSouza, Chief Examiner, NRC

2. Results:

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

3. Exit Meeting:
   Michele C DeSouza, Chief Examiner, NRC
   Scott Miller, Reactor Supervisor, Texas A&M Engineering Experiment Station

Prior to administration of the written examination, based on facility comments, adjustments were accepted. Comments provided corrections and additional clarity to questions/answers and identified where changes were appropriate based on current facility conditions. After completion of the written examination, two facility comments were received and accepted. Upon completion of all operator licensing examinations, the NRC examiner met with facility staff representatives to discuss the results. At the conclusion of the meeting, the NRC examiner thanked the facility for their support in the administration of the examination.

FACILITY COMMENTS:

Category B: QUESTION B.10 [1.0 point]
According to the Texas A&M Technical Specifications, which ONE of the following statements describes a limiting condition for operation imposed on experiments?

a. The reactivity effects associated with the moderator temperature is to be considered.

b. The absolute reactivity worth of all experiments in the reactor shall not exceed $2.00.

c. No experiment shall be inserted or removed unless all control blades are fully inserted.

d. An experiment which will not cause a 20-second period can be inserted in the core when the reactor is at power.

*<u>*Issue with the question:</u> there is no correct answer within the answer options for question B.10.*

NRC RECOMMENDATION: NRC accepts deletion of this question from this examination.

Category B: QUESTION B.11 [1.0 point]
Which ONE of the following is most likely a concern when evaluating the liquid waste system sump for disposal prior to discharge?

a. Argon-41

b. Nitrogen-16

c. Carbon-14

d. Hydrogen-3

*<u>*Justification for removal:</u> our facility has no way of monitoring Tritium. It is not one of our monitored isotopes and subsequently was not in our study material.*

NRC RECOMMENDATION: NRC accepts deletion of this question from this examination.

Texas A&M University

Operator Licensing Examination

Week of October 04, 2021

ENCLOSURE 3

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

FACILITY: Texas A&M University

REACTOR TYPE: TRIGA

DATE ADMINISTERED: 10/05/2021

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**
18.00	**33.3**	___________	_____	**B. NORMAL AND EMERGENCY OPERATING PROCEDURES AND RADIOLOGICAL CONTROLS**
20.00	**33.3**	___________	_____	**C. FACILITY AND RADIATION MONITORING SYSTEMS**
58.00		___________ **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, and 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 ___

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 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 ___~~ **QUESTION DELETED**

~~B11 a b c d ___~~ **QUESTION DELETED**

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 ___

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 ___

(***** 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.

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

EQUATION SHEET

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

$$DR = DR_0 e^{-\mu x}$$

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

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

1 Curie = 3.7 x 10^{10} dis/sec
1 Horsepower = 2.54 x 10^3 BTU/hr
1 BTU = 778 ft-lbf
1 gal (H_2O) ≈ 8 lbm
c_P = 1.0 BTU/hr/lbm/°F
1ft = 30.48 cm

1 kg = 2.21 lbm
1 Mw = 3.41 x 10^6 BTU/hr
°F = 9/5 °C + 32
°C = 5/9 (°F - 32)
c_p = 1 cal/sec/gm/°C

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

QUESTION A.01 [1.0 point]
Reactivity is defined as the:

a. Fractional change in neutron population per generation

b. Number of neutrons by which neutron population changes per generation

c. Rate of change of reactor power measured in neutron per second

d. Change in the number of neutrons per second that causes a fission event

QUESTION A.02 [1.0 point]
Which ONE of the following answers provides the number of protons, the number of neutrons, and the number of electrons in the Uranium-235 nucleus ($_{92}U^{235}$)?

a. 92; 92; 143

b. 143; 92; 143

c. 92; 143; 92

d. 143; 143; 92

QUESTION A.03 [1.0 point]
Delayed neutrons contribute more to reactor stability than prompt neutrons because they ________ the average neutron generation time and are born at a __________ kinetic energy.

a. Decrease, lower

b. Increase, lower

c. Decrease, higher

d. Increase, higher

QUESTION A.04 [1.0 point]
A reactor is subcritical 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 = 0.68	Reproduction Factor = 1.96

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

a. 0.695

b. 0.698

c. 0.702

d. 0.704

QUESTION A.05 [1.0 point]
The effective multiplication factor (K_{eff}) can be determined by dividing the number of neutrons produced from fission in the third generation by the number of neutrons produced from fission in the _________ generation.

a. First

b. Second

c. Third

d. Fourth

QUESTION A.06 [1.0 point]
What is the effect of delayed neutrons on the neutron flux decay following a scram from full power?

a. Adds positive reactivity due to the fuel temperature decrease following the scram

b. Limits the final rate at which power decreases to a -80 second period

c. Adds negative reactivity creating a greater shutdown margin

d. Decreases the mean neutron lifetime

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

QUESTION A.07 [1.0 point]
Reactor is at 100 W. The reactor operator inserts an experiment of $0.50 reactivity worth into the core. This insertion will cause:

Given:
T: reactor period, ℓ*: Prompt neutron lifetime; ρ: reactivity insertion; β: beta fraction;
λ-eff: delayed neutron precursor constant

a. A number of prompt neutrons is twice as much as a number of delayed neutrons

b. The resultant period is a function of the delayed neutron precursors $T = \left[\frac{\beta-\rho}{(\lambda_{eff})(\rho)}\right]$

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

d. A sudden drop in delayed neutrons

QUESTION A.08 [1.0 point]
Which ONE of the following most accurately describes the reason that fission products such as Xenon-135 and Samarium-149 have the most substantial impact in reactor design and operation?

a. Xenon-135 and Samarium-149 cause excess positive reactivity in the core

b. Xenon-135 and Samarium-149 burn up causes an increase in the thermal flux

c. Xenon-135 and Samarium-149 have large absorption cross sections resulting in a large removal of neutrons from the reactor

d. Xenon-135 and Samarium-149 produce fast fission neutrons, resulting in the net increase in the fast neutron population of the reactor core

QUESTION A.09 [1.0 point]
If beta (β) for U-235 is 0.0065 and beta effective (β_{eff}) for U-235 is approximately 0.0070, how does this difference affect reactor period in the reactor period equation, T=(β-p)/λp? This difference produces a _________ for a given addition of reactivity with beta effective (β_{eff}).

a. Longer period

b. Shorter period

c. Stable period

d. Decay constant (λ) increase

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

QUESTION A.10 [1.0 point]
Which ONE of the following is defined as the balance between the rate of production of fast neutrons from thermal fission and rate of absorption of thermal neutrons by the fuel?

a. Utilization Factor

b. Reproduction Factor

c. Infinite Multiplication Factor

d. Effective Multiplication Factor

QUESTION A.11 [1.0 point]
Energy Yield (ΔQ) from a nuclear fission reaction is in the range of (or is approximately):

a. 1000 MeV

b. 200 MeV

c. 1.86 keV

d. < 1 eV

QUESTION A.12 [1.0 point]
A reactor is subcritical if:

a. $\rho = 1.0$

b. $K_\infty = 1.0$, $\rho = \beta$

c. $K_{eff} < 1.0$ or $\rho < 0.0$

d. $K_{eff} > 1.0$ or $\rho > 0.0$

QUESTION A.13 [1.0 point]
What is the meaning of any point on a differential rod worth curve?

a. The negative reactivity added as the rod is inserted

b. The cumulative area under the differential curve starting from the bottom of the core

c. The zero reactivity when the rod is on the bottom and the positive reactivity being added as the rod is withdrawn

d. The amount of reactivity that one unit (e.g. one inch, one percent) of rod motion would insert at that position in the core

QUESTION A.14 [1.0 point]
Which ONE of the following changes does not require a movement of control rods in order to maintain constant reactor power?

a. Pool water temperature decrease

b. U-235 burnup

c. Xe-135 buildup

d. N-16 formation

QUESTION A.15 [1.0 point]
The reaction ${}_{93}Np^{239} \rightarrow$ _____ + ${}_{94}Pu^{239}$ is an example of:

a. Gamma Emission

b. Electron Capture

c. Alpha Decay

d. Beta Decay

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

QUESTION A.16 [1.0 point]
Which ONE of the following is the primary mechanism for transferring heat through the cladding of a fuel rod?

a. Conduction

b. Convection

c. Radiation

d. Mass Transfer

QUESTION A.17 [1.0 point]
Which ONE of the following is the major source of heat generation after an operating reactor has been shut down and cooled down for several days?

a. Corrosion product activation

b. Delayed neutron reactions

c. Fission fragment decay

d. Resonance capture

QUESTION A.18 [1.0 point]
If a source strength is 10,000 neutrons per second (N/sec) and it produces the stable neutron count rate of 50,000 N/sec. What is the neutron multiplication factor?

a. 0.70

b. 0.75

c. 0.80

d. 0.85

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

QUESTION A.19 [1.0 point, 0.25 each]
Match the items in Column A with the isotopes in Column B.
The most important fission product poison is ^{135}Xe. The process that shows how this isotope is formed and its decay is:

Column A

$$\underbrace{\mathbf{a}}_{fission} \xrightarrow[19s]{} {}_{-1}^{0}\beta + \underbrace{\mathbf{b}}_{fission} \xrightarrow[6.57h]{} {}_{-1}^{0}\beta + \underbrace{{}_{54}^{135}Xe}_{fission} \xrightarrow[9.1h]{} {}_{-1}^{0}\beta + \mathbf{c} \xrightarrow[2.3E6y]{} \mathbf{d}\ (stable)$$

Column B

1. $_{56}Ba^{135}$
2. $_{52}Te^{135}$
3. $_{53}I^{135}$
4. $_{55}Cs^{135}$

QUESTION A.20 [1.0 point]
Of all the energy released per fission event, the largest amount appears in the form of:

a. Kinetic energy of prompt and delayed neutrons

b. Kinetic energy of fission fragments

c. Alpha and beta radiation

d. Gamma radiation

(***** End of Category A *****)

QUESTION B.01 [1.0 point]
According to the Texas A&M Technical Specifications, when the reactor is not secured, which ONE of the following is the MINIMUM staffing required during the reactor maintenance?

a. Reactor Operator at reactor control console

b. Reactor under direct control of an Reactor Operator, Reactor Operator in the reactor bay, Reactor Supervisor on call

c. Reactor Operator at reactor control console, member of maintenance staff in the reactor bay

d. Reactor under direct control of an Senior Reactor Operator and member of maintenance staff

QUESTION B.02 [1.0 point]
In an emergency, 10 CFR 50.54 allows reasonable action that departs from a license condition or a technical specification when this action is immediately needed to protect the public health and safety. In this case, what is the minimum level of authorization or approved needed to depart from a license condition or technical specification?

a. Senior Reactor Operator, Texas A&M

b. Reactor Supervisor, Texas A&M reactor

c. Director, Texas A&M reactor

d. President, Texas A&M University

QUESTION B.03 [1.0 point]
The radiation dose limits for an individual member of the public, received as a result of facility operations, are provided in ________.

a. 10 CFR 20

b. 10 CFR 50

c. 10 CFR 55

d. 10 CFR 70

QUESTION B.04 [1.0 point]
According to the Texas A&M Technical Specifications, which ONE condition below is NOT permissible when the reactor is operating?

a. Fuel temperature = 750 ºC

b. Shutdown margin = $0.50

c. Primary pool temperature = 70 ºC

d. Maximum reactivity excess of reference core condition = $7.85

QUESTION B.05 [1.0 point]
According to the Texas A&M Technical Specifications, Texas A&M Reactor Safety Limit for steady state fuel temperature is ________ ºC.

a. 750

b. 830

c. 1050

d. 1150

QUESTION B.06 [1.0 point]
According to the Texas A&M Emergency Preparedness Plan, which ONE of following events is NOT an event that would be considered an unusual event?

a. Civil disturbance toward the reactor facility

b. Tornado in the immediate vicinity of the reactor

c. Prolonged fire at the facility

d. Medical incident occurs from a laboratory accident involving radioactive contamination

QUESTION B.07 [1.0 point]
According to the Texas A&M Radiation Safety Program, the ________________ reviews personnel doses quarterly. If the Texas A&M personnel doses exceed limits then __________ reviews.

a. Radiation Safety Officer, Management

b. Senior Reactor Operator, Director

c. Associate Director, Training Coordinator

d. Reactor Operator, Reactor Operations Supervisor

QUESTION B.08 [1.0 point]
According to the Texas A&M Emergency Preparedness Plan dose limits in excess of normal 10 CFR 20 limits can be exceeded in an emergency. The dose limits become, ________ Rem to save a life and, ________ Rem to mitigate or reduce the severity of an emergency.

a. 5, 20

b. 25, 10

c. 10, 15

d. 25, 5

QUESTION B.09 [1.0 point]
According to the Texas A&M Technical Specifications, which ONE of the following surveillance activities is NOT performed annually?

a. Control Rod(s) Calibrations

b. Area Radiation Monitors

c. Fuel Element Temperature

d. Facility Air Monitors

~~**QUESTION B.10 [1.0 point]**~~ **QUESTION DELETED**

~~According to the Texas A&M Technical Specifications, which ONE of the following statements describes a limiting condition for operation imposed on experiments?~~

~~a. The reactivity effects associated with the moderator temperature is to be considered.~~

~~b. The absolute reactivity worth of all experiments in the reactor shall not exceed $2.00.~~

~~c. No experiment shall be inserted or removed unless all control blades are fully inserted.~~

~~d. An experiment which will not cause a 20-second period can be inserted in the core when the reactor is at power.~~

~~**QUESTION B.11 [1.0 point]**~~ **QUESTION DELETED**

~~Which ONE of the following is most likely a concern when evaluating the liquid waste system sump for disposal prior to discharge?~~

~~a. Argon-41~~

~~b. Nitrogen-16~~

~~c. Carbon-14~~

~~d. Hydrogen-3~~

QUESTION B.12 [1.0 point, 0.25 each]

Match the channel in Column A with the number in Column B.
What are the MINIMUM number of measuring channels required to be OPERATING during reactor STEADY STATE MODE operations?
(Answers may be used once, more than once, or not at all)

Column A	Column B
a. Reactor Power Level	1. 1
b. Primary Pool Water Temperature	2. 2
c. Fuel Temperature	3. 3
d. Facility Air Monitor	4. 4

QUESTION B.13 [1.0 point]
The Texas A&M Requalification Program must be conducted for a continuous period not to exceed 24 months in duration, in accordance with _______.

a. 10 CFR 19

b. 10 CFR 20

c. 10 CFR 50

d. 10 CFR 55

QUESTION B.14 [1.0 point]
The reactor is shutdown with the pulse rod stuck all the way out. Calculate the amount of reactivity by which the reactor is shutdown with a stuck pulse rod.
Assume the following values: Shim Rod Worth = $2.95; Regulating Rod Worth = $2.75; Pulse Rod Worth = $2.25; Excess reactivity = $2.00.

a. $0.25

b. $2.00

c. $3.60

d. $5.70

QUESTION B.15 [1.0 point, 0.25 each]
Match the item in Column A with the value in Column B.
According to the NRC regulations, what are the annual occupational dose limits?
(Answers may be used once, more than once, or not at all)

a. Total Effective Dose Equivalent (Whole Body)	1. 50.0 rem
b. Sum of Deep Dose Equivalent and Committed Dose Equivalent to any organ or tissue	2. 15.0 rem
c. Lens Dose Equivalent to the lens of the eye	3. 5.0 rem
d. Shallow Dose Equivalent to the skin	4. 0.5 rem

QUESTION B.16 [1.0 point]
Which ONE of the following materials SHALL NOT be irradiated in the reactor core, in accordance with Texas A&M Technical Specifications?

a. Any movable material

b. Any fissionable material

c. Any corrosive material

d. Any explosive material

QUESTION B.17 [1.0 point]
Which ONE of the following events does NOT require the presence of a licensed Senior Reactor Operator at the scene?

a. Reactor Startup and approach to power

b. Insertion of experiment of $0.70

c. Removal of Safety Control Rod for inspection

d. Fuel relocations within the core region

QUESTION B.18 [1.0 point]
According to the Texas A&M Emergency Preparedness Plan, who is the individual responsible for termination of an emergency?

a. Police Chief

b. Public Relations Coordinator

c. Emergency Director

d. Radiation Safety Officer

QUESTION B.19 [1.0 point]
According to the Texas A&M Technical Specifications, the fuel elements or fueled devices in storage are maintained in an array with a k_{eff} of less than:

a. 0.95

b. 0.90

c. 0.85

d. 0.80

QUESTION B.20 [1.0 point]
There has been a confirmed breach of cladding for multiple fuel elements. According to the Texas A&M Emergency Preparedness Plan, this event would be classified as a(n):

a. Non-Classified Event

b. Medical Incident

c. Unusual Event

d. Alert

(***** End of Category B *****)

Category C: Facility and Radiation Monitoring Systems

QUESTION   C.01   [2.0 points, 0.5 each]
Match the input signals listed in Column A with their AUTOMATIC control system responses in Column B (Items in Column B may be used once, more than once or not at all). Assume reactor is in operation.

____________ Column A	Column B
a. HV Wide Range Linear Channel = 140 V	1. Indication ONLY
b. Servo Fault	2. Rod Withdrawal Prohibit
c. Power Channel = 1.25 MW	3. Scram
d. Shim Rod withdrawal in Pulse Mode	4. Rod Run-in

QUESTION   C.02   [1.0 point]
Which ONE of the following statements is NOT correct regarding the Servo Flux Control System?

a. Alarm if the Regulating Rod is inserted less than 20% fully withdrawn

b. Regulating Rod moves in response to the signal from the Log Power Channel

c. Regulating Rod moves in response to the signal from the Linear Power Channel

d. Regulating Rod control is automatically shifted back to manual if the level drifts out of +/- 5% range

QUESTION   C.03   [1.0 point]
Which ONE of the following provides a reactor scram in any mode of operation?

a. Low Pool Level

b. High Power Level

c. High Pool Conductivity

d. High Fuel Temperature

QUESTION   C.04   [1.0 point]
What is the nominal Hydrogen – Zirconium ration in the TRIGA LEU fuel elements?

a. 1.6 Hydrogen atoms to 1.0 Zirconium atoms

b. 1.0 Hydrogen atoms to 1.6 Zirconium atoms

c. 30 Hydrogen atoms to 20 Zirconium atoms

d. 20 Hydrogen atoms to 30 Zirconium atoms

QUESTION   C.05   [1.0 point]
What is the purpose of the 1-3/4 inch diameter holes through the grid plate, located in the southwest corner of the four fuel rod assemblies?

a. Accommodate a void follower in the transient rod

b. Provide a coolant flow path through the grid plate

c. Accommodate a fuel followed control rod

d. Provide a mounting location for in-core experiments

QUESTION   C.06   [1.0 point]
What is the main purpose for setting a conductivity limit of the pool water?

a. Minimize Argon-41 release to the public

b. Extend integrity of resin bed on the demineralizer

c. Minimize the possibility of corrosion of the cladding on the fuel elements

d. Maintain the departure of nucleate boiling ratio (DNBR) greater than the unity

QUESTION   C.07   [1.0 point]
When conducting a control drop test at fully out position of the Shim Rod, which ONE of the following is an acceptable value?

a. 1000 msecond

b. 1200 msecond

c. 1300 msecond

d. 1500 msecond

QUESTION   C.08   [1.0 point]
In the event of a loss of normal electrical power, which ONE of the following will emergency power distribute power to?

a. Reactor Console

b. Coolant Pumps

c. Emergency Lights

d. Radiation Monitoring Systems

QUESTION   C.09   [1.0 point]
Which ONE of the following indications does the Pulse Channel provide after firing a pulse?

a. Energy and Fuel Temperature

b. Peak Power and 1 kW Interlock

c. Peak Power and Reactor Period

d. Percent Power and Energy

QUESTION   C.10   [1.0 point]
Which ONE of the following are NOT required in the pneumatic lab?

a. operable radiation monitor

b. direct communication to the control room

c. access to the reactor scram

d. a shield for radioactive material

QUESTION   C.11   [1.0 point]
When on a long-term basis, where is more than 95% of the facility's Argon-41 is produced?

a. Dry Tube

b. Reactor Pool

c. Open Beam Port Tubes

d. Pneumatic Irradiation Systems

QUESTION   C.12   [1.0 point]
Which ONE of the following is the MAIN reason for NOT operating the coolant pumps in dry (no prime) for no longer than two minutes during reactor operation?

a. Damaging the coolant pipes

b. Damaging the pump motor

c. Increasing the amount of N-16 in the reactor pool

d. Increasing the amount of Ar-41 released to the reactor bay

QUESTION C.13 [1.0 point]
For calibration of the control rod, what is the technique called when '*the operator determines the rod reactivity by measuring the rate of decrease in power level by scram of the calibrated rod from the desired height*'?

a. Rod Drop Method

b. Positive Period Method

c. Thermal Power Calibration Method

d. Positive Period-Differential Worth Method

QUESTION C.14 [1.0 point]
Which ONE of the following elements is MAINLY used as the neutron absorber on the Texas A&M control rods?

a. Boron

b. Zirconium-Hydride

c. Borated Graphite

d. Gold-Indium-Cadmium

QUESTION C.15 [1.0 point]
What is a reason for not exceeding a flow rate of 70 gpm for an emergency pool fill using the demineralizer system?

a. Blow out the demineralizer resin into the pool

b. Destroy the recirculation pump control switch

c. Cause channeling through the demineralizer resin column

d. Destroy the conductivity probe in the demineralizer

QUESTION   C.16   [1.0 point]
The __________ neutron startup source utilizes a _________ reaction.

a. Am-Be; (α,η)

b. Sb-Be; (γ,η)

c. Am-Li; (α,η)

d. Am-Li; (γ,η)

QUESTION   C.17   [1.0 point]
Which ONE of the following best describes how the Uncompensated Ion Chamber (UIC) and Compensated Ion Chamber (CIC) operates?

a. The CIC has two chambers, both can detect gamma rays but only one is coated with Boron-10 for (n,α) reaction; whereas the UIC has only one chamber coated with Boron-1- for (n,α) reaction.

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

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

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

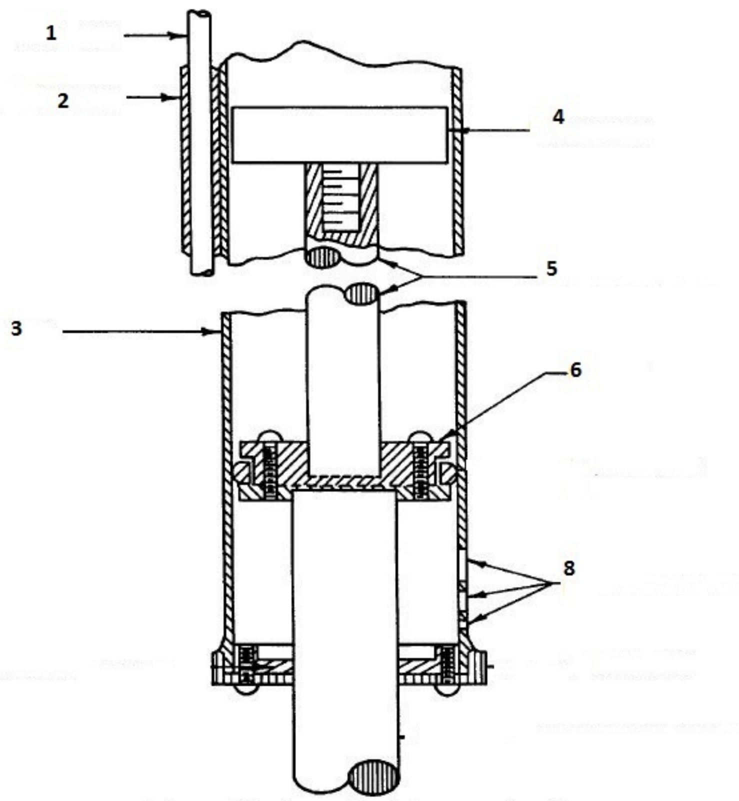
QUESTION C.18 [2.0 points, 0.50 each]
Match the components listed in Column A to the appropriate position locator listed in the following diagram of the control rod armature

a. Piston

b. Barrel

c. Armature

d. Dashpot Port



(***** End of Category C *****)
(********** End of the Exam **********)

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

A.01
Answer: a
Reference: Burns, Section 1.3.1, page 1-5

A.02
Answer: c
Reference: Nuclides and Isotopes
92 protons, 143 neutrons, 92 electrons

A.03
Answer: b
Reference: Burns, Section 3.2.4, pg. 3-12 and Section 3.4.4, page 3-33

A.04
Answer: b
Reference: Burns, Section 3.3.1, page 3-16

A.05
Answer: b
Reference: Burns, Section 3.3.1, page 3-16

A.06
Answer: b
Reference: Burns, Section 4.10.12, page 4-32 to 4-33

A.07
Answer: b
Reference: Burns, Section 4.6, page 4-17

A.08
Answer: c
Reference: DOE Fundamentals Handbook, NP-03, page 34

A.09
Answer: a
Reference: Burns, Example 3.4.3, page 3-32, 3-33
In the reactor period equation, $T=(\beta-\rho)/\lambda\rho$, if Beta effective is used instead of Beta for U-235, the term $(\beta_{eff}-\rho)$ is larger giving a longer period.

A.10
Answer: b
Reference: DOE Fundamentals Handbook, NP-03, page 6

A.11
Answer: b
Reference: Lamarsh 3rd, Table 3.6, page 88

A.12
Answer: c
Reference: Burns, Table 3.5, page 3-22

A.13
Answer: d
Reference: Burns, Example 7.2 (b), page 7-4

A.14
Answer: d
Reference: Burns, Problem 7.7.4, page 7-17

A.15
Answer: d
Reference: DOE Fundamentals Handbook, NP-01, page 24

A.16
Answer: a
Reference: Lamarsh 3rd, Section 8.3, page 417

A.17
Answer: c
Reference: DOE Fundamentals Handbook, NP-03, page 34

A.18
Answer: c
Reference: CR = S/(1-K) → 50000 = 10000/(1 - K) = 1 -X = 10000/50000
K = 0.8

A.19
Answer: a. 2; b. 3; c. 4; d. 1
Reference: Lamarsh 3rd ed., Section 7.5, pg. 377
Burns, Figure 8.1, page. 8-6

A.20
Answer: b
Reference: Glasstone, Nuclear Reactor Engineering, Section 1.47

Category B: Normal and Emergency Operating Procedures and Radiological Controls

B.01
Answer: d
Reference: Texas A&M Technical Specifications, Section 6.1.3 and SAR 12.1.3

B.02
Answer: a
Reference: 10 CFR 50.54(y)

B.03
Answer: a
Reference: 10 CFR 20

B.04
Answer: c
Reference: Texas A&M Technical Specifications, Sections 3.1, 3.1.3 and 3.1.6

B.05
Answer: d
Reference: Texas A&M Technical Specifications, Section 2.1

B.06
Answer: d
Reference: Texas A&M Emergency Prepardness Plan, Sections 4.1 & 4.2

B.07
Answer: a
Reference: Texas A&M Radiation Safety Program, Section 8.4(2)

B.08
Answer: d
Reference: Texas A&M Emergency Prepardness Plan, Section 3.5

B.09
Answer: c
Reference: Texas A&M Technical Specifications Sections 4.1.3, 4.2.2 and 4.5

~~**B.10**~~ **QUESTION DELETED**
~~Answer: b~~
~~Reference: Texas A&M Technical Specifications, Section 3.6~~

Category B: Normal and Emergency Operating Procedures and Radiological Controls

~~**B.11**~~ **QUESTION DELETED**
~~Answer: d~~
~~Reference: Texas A&M SAR 11.2.2~~

B.12
Answer: a. 2; b. 1; c. 1; d. 4
Reference: Texas A&M Technical Specifications, Section 3.2.1, Tables 1 and 3

B.13
Answer: d
Reference: 10 CFR 55.59(a)(1)

B.14
Answer: c
Reference: Shim rod + Reg rod = $5.70. Excess reactivity - $5.70 = -$3.60

B.15
Answer: a. 3; b. 1; c. 2; d. 1
Reference: 10 CFR 20.1201

B.16
Answer: b
Reference: Texas A&M Technical Specifications 3.6

B.17
Answer: b
Reference: Texas A&M Technical Specifications 6.1.3

B.18
Answer: c
Reference: Texas A&M Emergency Preparedness Plan 3.3

B.19
Answer: d
Reference: Texas A&M Technical Specifications 5.6

B.20
Answer: c
Reference: Texas A&M Emergency Preparedness Plan, Section 7.2

Category C: Normal and Emergency Operating Procedures and Radiological Controls

C.01
Answer: a. 1; b. 1; c. 3; d. 2
Reference: Texas A&M Technical Specifications 3.3, SAR 7.0

C.02
Answer: b
Reference: Texas A&M SAR 7.1, Figure 7-1 and SOP III-C

C.03
Answer: d
Reference: Texas A&M Technical Specifications 3.2.2

C.04
Answer: a
Reference: Texas A&M Technical Specifications 5.2

C.05
Answer: c
Reference: Texas A&M SAR 4.2.5

C.06
Answer: c
Reference: Texas A&M Technical Specifications 3.8.1

C.07
Answer: a
Reference: Texas A&M Technical Specifications 3.2.3

C.08
Answer: c
Reference: Texas A&M SAR 8.2

C.09
Answer: d
Reference: Texas A&M SAR 7.2.3.2

C.10
Answer: c
Reference: Texas A&M SOP IV-C, page 84

C.11
Answer: b
Reference: Texas A&M SAR 11.1.1

C.12
Answer: b
Reference: NRC General Knowledge

C.13
Answer: a
Reference: Texas A&M SOP II, Procedure K

C.14
Answer: c
Reference: Texas A&M SAR 4.2.2

C.15
Answer: c
Reference: NRC Previous Exam

C.16
Answer: b
Reference: Texas A&M SAR 4.2.4 and Chart of Nuclides

C.17
Answer: a
Reference: NRC Previous Exam

C.18
Answer: a. 6; b. 3; c. 4; d. 8
Reference: Texas A&M SAR 7.3.1