July 30, 2015

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

SUBJECT: EXAMINATION REPORT NO. 50-128/OL-15-01, TEXAS A&M UNIVERSITY

Dear Dr. McDeavitt:

During the week of April 27, 2015, and on June 25, 2015, the U.S. Nuclear Regulatory Commission (NRC) administered operator licensing examinations at your Nuclear Science Center at Austin TRIGA reactor facility. The examinations were conducted according to NUREG-1478, "Operator Licensing Examiner Standards for Research and Test Reactors," Revision 2, published in June 2007. Examination questions and preliminary findings were discussed with you, and Mr. Jerry Newhouse at the conclusion of the examinations.

In accordance with Title 10 of the *Code of Federal Regulations*, Section 2.390, a copy of this letter and the enclosures will be available electronically for public inspection in the NRC Public Document Room or from the Publicly Available Records component of NRC's Agencywide Documents Access and Management System (ADAMS). ADAMS is accessible from the NRC 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 Mrs. Paulette Torres at (301) 415-5656, or via email at Paulette.Torres@nrc.gov.

Sincerely,

/RA/

Kevin Hsueh, Chief
Research and Test Reactors Oversight Branch
Division of Policy and Rulemaking
Office of Nuclear Reactor Regulation

Docket No. 50-128

Enclosures:
1. Examination Report No. 50-128/OL-15-01
2. Facility Comments on the Written Examination with NRC Resolution
3. Written Examination with Facility Comments Incorporated

cc: Mr. Jerry Newhouse, Assistant Director

cc: w/o enclosures: See next page

July 30, 2015

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

SUBJECT: EXAMINATION REPORT NO. 50-128/OL-15-01, TEXAS A&M UNIVERSITY

Dear Dr. McDeavitt:

During the week of April 27, 2015, and on June 25, 2015, the U.S. Nuclear Regulatory Commission (NRC) administered operator licensing examinations at your Nuclear Science Center TRIGA reactor facility. The examinations were conducted according to NUREG-1478, "Operator Licensing Examiner Standards for Research and Test Reactors," Revision 2, published in June 2007. Examination questions and preliminary findings were discussed with you, and Mr. Jerry Newhouse at the conclusion of the examinations.

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DISTRIBUTION:
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ADAMS Accession No: ML15195A470 **NRR - 079**

OFFICE	NRR/DPR/PROB	NRR/DPR/PROB	NRR/DPR/PROB
NAME	PTorres	NParker	KHsueh
DATE	07/01/2015	07/20/2015	07/30/15

OFFICIAL RECORD COPY

cc:

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Reactor Newsletter
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Comptroller of Public Accounts
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U. S. NUCLEAR REGULATORY COMMISSION
OPERATOR LICENSING INITIAL EXAMINATION REPORT

REPORT NO.: 50-128/OL-15-01

FACILITY DOCKET NO.: 50-128

FACILITY LICENSE NO.: R-83

FACILITY: Texas A&M University TRIGA Reactor

EXAMINATION DATES: April 27-30, 2015, and June 25, 2015

SUBMITTED BY: ***/RA/*** 07/01/2015
Mrs. Paulette Torres, Chief Examiner Date

SUMMARY:

During the week of April 27, 2015, and June 25, 2015, the NRC administered operator licensing examinations to five Reactor Operator (RO), four Senior Reactor Operator Instant (SROI) and three Senior Reactor Operator Upgrade (SRO-U) license candidates. One RO candidate and one SROI candidate failed the written portion of the examination. The remainder of the candidates passed all applicable portions of the examinations.

REPORT DETAILS

1. Examiners: Mrs. Paulette Torres, NRC
   Mr. Phillip Young, NRC

2. Results:

	RO PASS/FAIL	SRO PASS/FAIL	TOTAL PASS/FAIL
Written	4/1	3/1	7/2
Operating Tests	5/0	7/0	12/0
Overall	4/1	6/1	10/2

3. Exit Meeting:

   Mrs. Paulette Torres, NRC
   Mr. Phillip Young, NRC
   Mr. Jerry Newhouse, Assistant Director
   Dr. Sean McDeavitt, Director

At the conclusion of the examinations, the examiners met with members of the facility staff to discuss the results of the examinations. The facility licensee agreed to email their comments on the written examination that were incorporated in the examination report (see Enclosure 2).

FACILITY COMMENTS ON THE WRITTEN EXAMINATION WITH NRC RESOLUTION

QUESTION A.02 [1.0 point]
The ideal moderator has small atomic mass for _____ fractional energy loss per collision; _____ neutron scattering cross section, so the distance between collisions is small; and a _____ absorption cross section so that the thermal utilization of the neutrons is dependent primarily on the characteristics of the fuel.

a. small, small, large

b. large, small, large

c. large, small, small

d. small, large, small

Answer: b
REF: DOE Fundamentals Handbook, Volume 1, Module 2, *Neutron Moderation*, pg. 24

Facility comments: Section A Question 2: I do not believe there is a correct answer choice. According to the reference given in the answer key, the answer should be "large, large, small." If a correct answer is available, this is definitely a good question. But as it is, it should be deleted.

NRC Resolution: The NRC agrees with the facility that the answer given in the reference is not part of the examination answer choices. Therefore, question A.02 will be deleted from the examination.

QUESTION B.18 [1.0 point]
Which ONE of the following conditions is allowed per Technical Specifications?

a. 4 pounds of explosive materials.

b. A single experiment with a reactivity worth of $1.10.

c. The sum of the absolute reactivity of all experiments of $7.85.

d. A total annual discharge of Argon-41 into the environment of more than 30 Ci per year.

Answer: a
REF: TS Section 3.6.2, pg. 27

Facility comments: I believe there are two correct answer choices. According to TS 3.6.1, "Reactivity Limits," Specification 2, individual secured experiments up to $2 are allowed. According to TS 3.6.2, "Material Limitations," Specification 1.d, explosive materials in quantities greater than or equal to 5 pounds (TNT-equivalent) are prohibited. Both answers "a" and "b" should be considered correct.

NRC Resolution: The NRC agrees with the facility comments. The NRC will accept both "a" and "b" as correct answers for question B.18.

QUESTION C.11 [1.0 point]
What is the purpose of the Pulse Stop Electro-Mechanical Interlock?

a. Prevent pulsing above 1 kW.

b. Prevent the reactor from being pulsed while on a positive period.

c. Prevent pulsing of the reactor in steady state mode.

d. Prevent application of air to the transient rod unless the cylinder is fully inserted.

Answer: d
REF: TS 3.2.2, Table 2b basis, pg. 20

Facility comments: I do not believe there is a correct answer choice. The reference we provided to you, TS 3.2.2, "Reactor Safety Systems and Interlocks," Basis has an error. It currently describes the reason for the electro-mechanical interlock to prevent application of air to the transient rod unless the cylinder is fully inserted. That information is wrong. The true reason is to prevent application of air to the transient rod unless the pulse stop is installed. This error has already been identified and is in progress of being corrected. If a correct answer is available, this is definitely a good question. But as it is, it should be deleted.

NRC Resolution: The NRC understands the facility comment that the reference information (TS 3.2.2, Table 2b basis) had an error and is in the process of being corrected. Question C.11 will be deleted from the examination.

QUESTION C.18 [1.0 point]
Which ONE of the following interlocks is associated only with the Shim Safety control rod?

a. Rod Down

b. Rod In Override

c. Rod Jammed

d. Rod Out

Answer: c
REF: SAR 7.3.1, pg. 115

Facility comments: I do not believe there is a correct answer choice. According to SAR 7.3.1.2, "Regulating Rod Control," pg. 121, the regulating rod also has a rod jammed interlock. This question should be deleted.

NRC Resolution: The NRC agrees with the facility comment and question C.18 will be deleted from the examination.

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

FACILITY: Texas A&M University

REACTOR TYPE: TRIGA

DATE ADMINISTERED: 06/25/2015

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
19.00 ~~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
18.00 ~~20.00~~	33.3	_____	_____	C. FACILITY AND RADIATION MONITORING SYSTEMS
57.00 ~~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 ___~~ deleted per facility comment

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 ___

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 *****)

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 ___~~deleted per facility comment

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 ___~~deleted per facility comment

C19 a b c d ___

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

ENCLOSURE 2

TEXAS A & M UNIVERSITY
TRIGA REACTOR

Operator Licensing Written Examination

06/25/2015

QUESTION A.01 [1.0 point]
What is the kinetic energy range of a thermal neutron?

a. > 1 MeV

b. 100 KeV – 1 MeV

c. 1 eV – 100 KeV

d. < 1 eV

~~**QUESTION A.02 [1.0 point]**~~
~~The ideal moderator has small atomic mass for _____ fractional energy loss per collision; _____ neutron scattering cross section, so the distance between collisions is small; and a _____ absorption cross section so that the thermal utilization of the neutrons is dependent primarily on the characteristics of the fuel.~~

~~a. small, small, large~~

~~b. large, small, large~~

~~c. large, small, small~~

~~d. small, large, small~~

QUESTION A.03 [1.0 point]
Which ONE defines an integral rod worth curve?

a. Conforms to an axial flux shape.

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

c. Any point on the curve represents the amount of reactivity that one inch of rod motion would insert at that position in the core.

d. Reactivity is highest at the top of the core and lowest at bottom of the core.

QUESTION A.04 [1.0 point]
You've just increased power at a research reactor. As a result fuel temperature increased from 100°C to 120°C. For this reactor the fuel temperature coefficient (α_{tf}) is -0.01% k/k/°C, and the average rod worth for the regulating rod is 0.05% k/k/inch. How far and in what direction must you move the regulating rod to compensate? (Assume all other factors which could affect reactivity remain unchanged.)

a. 2 inches inward
b. 2 inches outward
c. 4 inches inward
d. 4 inches outward

QUESTION A.05 [1.0 point]
Following 8 hours at 1 MW, the reactor operator reduces reactor power to 50%. Rod control is placed in manual mode and all rod motion is stopped. Which one of the following describes the response of reactor power, without any further operator actions, and the PRIMARY reason for its response?

a. Power increases due to the burnout of xenon.
b. Power increases due to the burnout of samarium.
c. Power decreases due to the buildup of xenon.
d. Power decreases due to the buildup of samarium.

QUESTION A.06 [1.0 point]
Which ONE of the following statements describes the subcritical reactor response as K_{eff} approaches unity?

a. A LARGER change in neutron level results from a given change in K_{eff} and a SHORTER period of time is required to reach the equilibrium neutron level for a given change in K_{eff}.

b. A LARGER change in neutron level results from a given change in K_{eff} and a LONGER period of time is required to reach the equilibrium neutron level for a given change in K_{eff}.

c. A SMALLER change in neutron level results from a given change in K_{eff} and a SHORTER period of time is required to reach the equilibrium neutron level for a given change in K_{eff}.

d. A SMALLER change in neutron level results from a given change in K_{eff} and a LONGER period of time is required to reach the equilibrium neutron level for a given change in K_{eff}.

QUESTION A.07 [1.0 point]
Assume that the NSCR pool contains 106, 000 gallons at 90 degrees F and it heats up to 93 degrees F in two hours at indicated 400Kw. Assume no heat is removed from the pool. Based on your calculation results you should recommend to the SRO:

a. Make adjustment to correct the linear power channel indication.

b. Add more ice to the bath and wait two more hours.

c. Lower the reactor power to the steady state power calculated.

d. Maintain the power and wait for the ice bath to melt some more.

QUESTION A.08 [1.0 point]
During a startup you increase reactor power from 100 watts to 195 watts in a minute. Which ONE of the following is reactor period?

a. 30 seconds.

b. 60 seconds.

c. 90 seconds.

d. 120 seconds.

QUESTION A.09 [1.0 point]
Which ONE of the reactions below is an example of a photoneutron source?

a. $_{92}U^{238} \rightarrow {}_{35}Br^{87} + {}_{57}La^{148} + 3n + \gamma$

b. $_{51}Sb^{123} + n \rightarrow {}_{51}Sb^{124} + \gamma$

c. $_{1}H^{2} + \gamma \rightarrow {}_{1}H^{1} + n$

d. $_{4}Be^{9} + \alpha \rightarrow {}_{6}C^{12} + n$

QUESTION A.10 [1.0 point]
In a just critical reactor, adding one dollar worth of reactivity will cause:

a. A sudden drop in neutron flux.

b. The reactor period to be equal to $(\beta-\rho)/\lambda\rho$.

c. All prompt neutron term to become unimportant.

d. The resultant period to be a function of the prompt neutron lifetime.

QUESTION A.11 [1.0 point]
Which ONE of the following statements best describes on how moderator temperature affects the core operating characteristics?

a. Increase in moderator temperature will increase the neutron multiplication factor due to the resonance escape probability increase.

b. Increase in moderator temperature will increase the neutron multiplication factor due to the fast non leakage probability decrease.

c. Increase in moderator temperature will decrease the neutron multiplication factor due to the reproduction factor increase.

d. Increase in moderator temperature will decrease the neutron multiplication factor due to the resonance escape probability decrease.

QUESTION A.12 [1.0 point]
The neutron microscopic cross-section for absorption σ_a generally:

a. Increases as neutron energy increases.

b. Decreases as target nucleus mass increases.

c. Increases as target nucleus mass increases.

d. Decreases as neutron energy increases.

QUESTION A.13 [1.0 point]
Which ONE of the following factors in the “six factor” formula is the MOST affected by the CONTROL RODS?

a. Fast fission factor

b. Reproduction factor

c. Thermal utilization factor

d. Resonance escape probability

QUESTION A.14 [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 fission product poisons (e.g., Xe) increase in concentration within the fuel matrix and add negative reactivity via neutron absorption.

d. 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.

QUESTION A.15 [1.0 point]
The first pulse has a reactivity worth of $1.20 which results in a peak power of 200 MW. If the second pulse has a peak power of 5000 MW, the corresponding reactivity worth is:
Given: =0.0070

a. $1.50

b. $1.75

c. $2.00

d. $2.50

QUESTION A.16 [1.0 point]
Which ONE of the following is the most correct reason for having an installed neutron source within the core? An installed neutron source is very important during startup because without of a neutron source _____.

a. The chain reaction in the reactor core would NOT start.
b. The startup channel would NEVER indicate neutron population.
c. The compensating voltage on the source range detector doesn't work.
d. The reactor could result in a sudden increase in power if the control rods were pulled out far enough.

QUESTION A.17 [1.0 point]
The number of neutrons passing through a one square centimeter of target material per second is the definition of:

a. Neutron Population (np)
b. Neutron Impact Potential (nip)
c. Neutron Flux (nv)
d. Neutron Density (nd)

QUESTION A.18 [1.0 point]
A reactor is subcritical with a K_{eff} of 0.955. A positive reactivity of $5.00 is inserted into the core (β = 0.007 delta k/k). At this point, the reactor is:

a. Supercritical.
b. Exactly critical.
c. Prompt critical.
d. Subcritical.

QUESTION A.19 [1.0 point]
The _____ of the six factor formula will _____ due to the insertion of control rods in the NSCR core.

a. reproduction factor; increases
b. resonance escape probability; decreases
c. fast non-leakage probability; increases
d. thermal utilization factor; decreases

QUESTION A.20 [1.0 point]
During a fuel loading of the NSCR core, as the reactor approaches criticality, the value of 1/M:

a. Increases toward unity.
b. Decreases toward unity.
c. Increases toward infinity.
d. Decreases toward zero.

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

QUESTION B.01 [1.0 point]
NSC reactor uses a diffuser system to dissipate Nitrogen-16 and Argon-41, thereby reducing the dose rate at the pool surface. Argon-41 is produced by neutron absorption of argon-40. Argon-41 decays by a:

a. 6.13 MeV gamma with a half-life of 7.14 seconds.

b. 1.29 MeV gamma with a half-life of 1.83 hours.

c. Neutron emission with a half-life of 1.83 hours.

d. 7.11 MeV gamma with a half-life of 7.14 seconds.

QUESTION B.02 [1.0 point]
According to SOP Reactor Startup, if the startup is the first startup of the week, the reactor will be taken to a power level of 300 watts to:

a. Allow enough time to start-up the reactor.

b. Position the transient rod cylinder.

c. Prevent exceeding the 1 MW license limit.

d. Help determine core excess and core bumup.

QUESTION B.03 [1.0 point, 0.33 each]
The length of the pool is divided into three regions which are designated as "operating positions". The reactor may be operated in any of these regions. Match the following core positions in Column A with their respective purpose in Column B.

Column A	Column B
a. Stall	1. Includes the region from the eight foot position to the west pool wall.
b. Pool	2. Consists of the area at the east end of the pool.
c. Cell	3. Extends from the gate jamb to a position eight feet from the west pool wall.

QUESTION B.04 [1.0 point]
You are a reactor operator at the NSC reactor, handling irradiated samples in accordance with NSCR procedures and precautions. One of the irradiated samples you pull directly from the core measures **100 rem/hr at 1 meter**. If you moved **10 meters** away how long would you have to wait before you would exceed your Total Effective Dose Equivalent (TEDE) limit for radiation exposure?

a. 0.5 hr

b. 1 hr

c. 2 hrs

d. 5 hrs

QUESTION B.05 [1.0 point]
The ultimate purpose of SOP Power Calibration is to establish the calibration of the _____ by the performance of a pool calorimetric.

a. Linear Power Channel

b. Log Power Channel

c. Integrated Pulse Power Channel

d. Pool Water Temperature Channel

QUESTION B.06 [1.0 point]
According to the NSCR Emergency Preparedness Plan, the _____ is responsible for the termination of an emergency classified as an “ALERT” at the reactor.

a. Emergency Director

b. Senior Reactor Operator

c. University Police

d. U.S. Nuclear Regulatory Commission

QUESTION B.07 [1.0 point]
Facility Air Monitor Systems, FAM channel 3 – Stack gas and FAM channel 5 – Xenon Monitor share a _____ detector by means of two different single channel analyzers.

a. Geiger-Mueller tube

b. Beta scintillation

c. Ionization chamber

d. NaI(TI) gamma scintillation crystal

QUESTION B.08 [1.0 point]
Which ONE of the following is the definition for “Annual Limit on Intake (ALI)”? A 10CFR20 derived limit based on _____.

a. 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 mrem.

b. 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 mrem for noble gases.

c. 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.

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

QUESTION B.09 [1.0 point]
Which ONE of the following is the definition of a REM? A REM is _____.

a. Equal to an absorbed dose of 100 ergs/gram or 0.01 joule/kilogram.

b. Equal to the absorbed dose in rads multiplied by the quality factor.

c. A measure of the dose of any ionizing radiation to body tissues in terms of the energy absorbed per unit mass of the tissue.

d. A quantity of radiation absorbed, per unit of mass, by the body or by any portion of the body.

QUESTION B.10 [1.0 point]
How would an accessible area be posted if the radiation level in the area is 75 mR/hr?

a. Caution - Airborne Radioactivity Area

b. Caution - Restricted Area

c. Caution - Radiation Area

d. Caution - High Radiation Area

QUESTION B.11 [1.0 point]
In accordance with 10 CFR Part 50.47(b)(11), under what conditions a radiation worker can have exposure in excess of 10CFR20 limits?

a. During any emergency.

b. In an emergency, when the exposure is authorized on a once in a lifetime basis with preference given to the eldest able bodied volunteers.

c. As long as the radiation worker don't exceed 50 Rem whole body for life saving.

d. In an emergency declared by the Emergency Director with concurrence of the Senior Reactor Operator on site.

QUESTION B.12 [1.0 point]
You are currently the licensed operator at the control of the reactor. Which ONE of the following violates 10 CFR Part 55.53 "Conditions of licenses"?

a. Last license medical examination was 26 months ago

b. Last requalification operating test was 11 months ago

c. Last quarter you were the licensed operator for 6 hours

d. Last requalification written examination was 13 months ago

QUESTION B.13 [1.0 point]
While the reactor is shutdown, work has been ongoing to set up a radiation experiment in an open beam port. The responsible experimenter is breaking for lunch. Which ONE of the following actions MUST be taken? With the beam port left open,

a. No specific actions are required unless the beam port is to remain open while the reactor is critical.

b. The NSC Director has to ensure that a “High Radiation Area” is in place along with an electronic warning device.

c. Appropriate physical restraints shall be placed in position around established beam port experiments and gates to beam port areas shall be kept locked when not under the immediate surveillance of the responsible experimenter.

d. The experimenter needs approval of the duty SRO to exit the lower research level during access control conditions.

QUESTION B.14 [1.0 point]
Aside from a licensed reactor operator or senior reactor operator present in the control room, which one of the following correctly describes additional Technical Specification staffing requirements whenever the reactor is not secured?

a. SRO on call on the Texas A&M campus and a second person in the facility capable of being reached from the control room.

b. Radiation Safety Staff member on call on the Texas A&M campus and a second person in the facility capable of being reached from the control room.

c. The NSC Director on call within 10 miles of the facility capable of reaching the facility in 15 minutes and at least two individuals present at the NSC facility complex capable of being reached from the control room.

d. Two individuals present at the facility complex during periods of reactor maintenance and under the direct control of the SRO when the reactor is unsecured.

QUESTION B.15 [1.0 point]
Upon actuation of the emergency evacuation horn and subsequent scramming of the reactor, which ONE of the following is a Reactor Operator responsibility?

a. Evacuate to the Emergency Support Center (ESC) and report to the Emergency Director.

b. Contact the Health Physicist and NSC management.

c. Inform the Emergency Director of any missing individuals.

d. Advise on action to be taken when personnel have received a significant radiation dose.

QUESTION B.16 [1.0 point]
According to the NSCR Emergency Preparedness Plan, which ONE of the following would be classified as an ALERT?

a. Tornado

b. Bomb threat

c. Pool leakage which can be corrected by isolation of the leak or by adding makeup water.

d. Release of Xe-125 equal to, or more than, 700 Ci from the reactor building.

QUESTION B.17 [1.0 point]
Which ONE of the following statements correctly describes the requirements for startup following an Unscheduled Shutdown that resulted in a reportable occurrence?

a. SRO must perform the restart of the reactor.

b. Approval for startup must be given by a member of management.

c. USNRC approval is required and the SRO must supervise the resumption of operation.

d. NSC Director must supervise the resumption of operation.

QUESTION B.18 [1.0 point]
Which ONE of the following conditions is allowed per Technical Specifications?

e. 4 pounds of explosive materials.

f. A single experiment with a reactivity worth of $1.10.

g. The sum of the absolute reactivity of all experiments of $7.85.

h. A total annual discharge of Argon-41 into the environment of more than 30 Ci per year.

QUESTION B.19 [1.0 point]
_____ are thresholds for establishing emergency classes and initiating appropriate emergency measures.

a. Protective Action Guides

b. Emergency Procedures

c. Emergency Action Levels

d. Emergency Planning Zones

QUESTION B.20 [1.0 point]
According to NSCR Technical Specifications, a _____ of each of the reactor safety system channels and interlocks for the intended mode of operation shall be performed before each day's operation or before each operation extending more than one day.

a. Visual Inspection

b. Channel Calibration

c. Channel Check

d. Channel Test

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

QUESTION C.01 [1.0 point]
The point of raw water make-up at the Recirculation/Demineralization System is:

a. After the reactor pool but before the recirculation pump.

b. After the recirculation pump but before the solids filter.

c. After the cotton wound filter but before the reactor pool.

d. Between the solids filter and the ion exchange demineralizer.

QUESTION C.02 [1.0 point]
Per Technical Specifications, what is the basis for keeping primary coolant temperature at a maximum of 60°C?

a. To avoid damaging the regenerative mixed bed of ion exchanged resin in the demineralizer.

b. To avoid damaging the heat exchanger plates.

c. To not risk reaching a departure of nucleate boiling ratio (DNBR) of unity for 1MW steady state.

d. To not risk reaching a fuel temperature greater than the Safety Limit.

QUESTION C.03 [1.0 point]
Can the NSCR be operated without Reactor Bridge ARM and Building Particulate Monitor (FAM Channel 4)?

a. Yes, for a period of no more than 1 week during maintenance.

b. Yes, with a gamma sensitive instrument substituted for the inoperable channel.

c. Yes, with the approval of the SRO on duty.

d. No. More than two monitors are not operating therefore the reactor shall be shutdown.

QUESTION C.04 [1.0 point]
Which ONE of the following Pool Water Systems has a three-inch drain line?

a. The pool floor

b. The irradiation cell floor

c. The valve pit

d. The skimmer system

QUESTION C.05 [1.0 point]
Which ONE of the following instrumentation and control systems provides the power level input to a servo controller for automatic power control?

a. The log drawer

b. The pulse drawer

c. The safety drawers

d. The wide range linear drawer

QUESTION C.06 [1.0 point]
Which ONE of the following Control Rod Drive Mechanism (CRDM) for Shim Safety Control Rods holds the control rods in position while the reactor is in operation?

a. The electromagnet

b. The motor

c. The piston

d. The armature

QUESTION C.07 [1.0 point]
The cell door is open and the reactor is within eight feet of the irradiation cell window. This is an example of a:

a. Manual scram

b. Experiment scram

c. Interlocked scram

d. Bridge lock scram

QUESTION C.08 [1.0 point]
All of the following indicators are displayed in both the reception room (emergency support center) and the control room EXCEPT:

a. Digital rod height indication

b. Digital fuel temperature indication

c. HVAC system control

d. Area radiation monitoring indication

QUESTION C.09 [1.0 point]
Per Technical Specifications, which ONE of the following requires two operable channels for operation?

a. Fuel Element Temperature

b. High Power Level Detector Power Supply

c. Preset Timer

d. Pool Water Temperature

QUESTION C.10 [1.0 point]
The start-up source used in the NSCR is a _____ source.

a. Am-Li

b. Am-Be

c. Sb-Be

d. Pu-Be

~~**QUESTION C.11 [1.0 point]**~~
~~What is the purpose of the Pulse Stop Electro-Mechanical Interlock?~~

~~e. Prevent pulsing above 1 kW.~~

~~f. Prevent the reactor from being pulsed while on a positive period.~~

~~g. Prevent pulsing of the reactor in steady state mode.~~

~~h. Prevent application of air to the transient rod unless the cylinder is fully inserted.~~

QUESTION C.12 [1.0 point]
Which ONE of the following flexible quick disconnect valves allows for operation in a limited area of the pool?

a. The diffuser system

b. The Facility air monitor (FAM) - 2

c. The pneumatic sample transfer system

d. The transient rod air

QUESTION C.13 [1.0 point]
Which ONE of the following Facility Air Monitors (FAM), upon alarm actuation, automatically shuts down the air handling system?

a. FAM Channel 2 – Fission Product

b. FAM Channel 3 – Stack Gas

c. FAM Channel 4 – Building Particulate

d. FAM Channel 6 – Building Gas

QUESTION C.14 [1.0 point]
There is a loss of coolant flow through the heat exchanger resulting in significant pool leakage and a gradual pool temperature increase. Which of the following is the greatest issue/concern as a result of this event?

a. Overheating the TRIGA fuel, resulting in clad failure and fission product release.

b. Overheating the TRIGA fuel, resulting in Zirconium-Hydride reaction which releases explosive hydrogen gas.

c. Groundwater contamination to the surrounding water table.

d. The protection of personnel from radiation hazards.

QUESTION C.15 [1.0 point, 0.25 each]
Badges indicate the level of access authorized to an individual. Match the level of personnel access in Column A with the respective color-coded badge in Column B.

Column A	Column B
a. Unescorted Access	1. Orange
b. Limited Access	2. Yellow
c. Grounds Access	3. Blue
d. Visitor	4. Green

QUESTION C.16 [1.0 point]
Which ONE of the followings is an example of a confinement building intermediate zone of negative pressure for effective isolation of possible contaminated areas?

a. Beam Ports

b. Building entry

c. Control Room

d. Upper Research Level

QUESTION C.17 [1.0 point]
If the conductivity of the bulk pool water is higher than 5.0 μmhos/cm,

a. No action needed.

b. The reactor must immediately shutdown.

c. Is a reportable occurrence to the USNRC.

d. The reactor can continue to operate for a period not to exceed two weeks.

~~**QUESTION C.18 [1.0 point]**~~
~~Which ONE of the following interlocks is associated only with the Shim Safety control rod?~~

~~e. Rod Down~~

~~f. Rod In Override~~

~~g. Rod Jammed~~

~~h. Rod Out~~

QUESTION C.19 [1.0 point]
The solids filter of the Recirculation/Demineralization System contains all EXCEPT:

a. Wood chips

b. Activated charcoal

c. Small gravel

d. Large gravel

QUESTION C.20 [1.0 point]
Which ONE is true for the Stack Gas, Facility Air Monitor?

a. Monitors for Ar-41 entering the exhaust stack.

b. Monitors for Xe-125 entering the exhaust stack.

c. Monitors for radioactive particulate above the reactor core.

d. Monitors for radioactive particles in the confinement building.

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

A.01
Answer: d
REF: DOE Fundamentals Handbook, Volume 1, Module 2, *Neutron Moderation*, pg. 23

~~**A.02**~~
~~Answer: b~~
~~REF: DOE Fundamentals Handbook, Volume 1, Module 2, *Neutron Moderation*, pg. 24~~

A.03
Answer: b
REF: Burn, Section 7.3, pg. 7-5 to 7-7

A.04
Answer: d
REF: DOE Handbook volume 2, module 3, pg. 26
-0.0001k/k/°C * 20°C = -0.002k/k. To compensate must add +0.002k/k.
(0.002k/k) / (0.0005%k/k/inch) = 4 inches in the positive (outward) direction.

A.05
Answer: c
REF: Burn, R., Introduction to Nuclear Reactor Operations, © 1988, §§ 8.1 —8.4, pp. 8-3 — 8-14.

A.06
Answer: b
REF: Burn, R., Introduction to Nuclear Reactor Operations, © 1988, Chapt. 5, pp. 5-1, 5-28

A.07
Answer: a
REF: Q=mc(Tfin-Tini) where: m=106,000 gal.x 8lbm/gal=848,000 lbm; c=1 BTU/□F-lbm; Tfin=93 and Tini=90. Q=848,000 lbmx1BTU/□F-lbmx1.5□F=1.0272E6 BTU/hr x $2.93E^{-4}$ = 373Kw

A.08
Answer: c
REF: $P = P_0 e^{t/\tau}$ —> $\tau = t/\ln(P/P_0)$ $\tau = 60/\ln(195/100) = 60/\ln(1.95) = 89.84 \approx 90$ sec.

A.09
Answer: c
REF: R. R. Burn, Introduction to Nuclear Reactor Operations, page 5-3.

A.10
Answer: d
REF Introduction to Nuclear Operation, Reed Burn, 1988, Sec 4.2, page 4-4

A.11
Answer: d
REF: Burn, R., Introduction of Nuclear Reactor Operations, © 1982, Sec 3.3.1

A.12

Answer: d
REF: Burn, R., Introduction to Nuclear Reactor Operations, © 1982

A.13
Answer: c
REF: Burn, R., Introduction to Nuclear Reactor Operations, © 1982, Sec 3.2.2,page 3-18.

A.14
Answer: d
REF: TRIGA Fuel Design

A.15
Answer: c
REF: ρ =ρ($)*β; ρ1=$1.20*0.007= 0.0084 Δk/k
(Peak1 /Peak2)*(0.0084-.007)2 = (ρ1- β) 2
0.000049=(ρ1- β) 2 ;0.007= ρ1- β or ρ1=0.007+0.007= 0.014 Δk/k or $2.0 Or
Peak2 (ρ$1-$1) 2 = Peak1*(ρ$2-$1 /)2
(ρ$1-$1.0) 2 = (5000/200)*($1.20-$1.0)2
ρ$1-$1.0 = $1.0, ρ$1 = $2.0

A.16
Answer: d
REF: Burn, R., Introduction to Nuclear Reactor Operations, © 1982, Page 4-21.

A.17
Answer: c
REF: DOE Handbook Vol. 2

A.18
Answer: d
REF: Lamarsh, Introduction to Nuclear Engineering, 2nd Edition, pg. 282.
$5.00 = 0.035 delta k/k. Reactor is initially subcritical by 0.045 delta k/k.

A.19
Answer: d
REF: Burn, R., Introduction to Nuclear Reactor Operations, 1988, page 3-17.

A.20
Answer: d
REF: Burn, R., Introduction to Nuclear Reactor Operations, 1988, page 5-16.

B.01
Answer: b
REF: SAR 5.6, pg. 100
Argon-41 is produced by absorption neutron from Ar-40 in air, decays by β-γ. Hazards are mainly due to a single gamma at 1.29 MeV. Ar-41(half life: 1.83 hrs.) is due largely to neutron activation of air dissolved in the reactor primary coolant.

B.02
Answer: d
REF: SOP Reactor Startup, pg. 2 of 4

B.03
Answer: a,2 b,3 c,1
REF: SOP Movement of Reactor Bridge, pg. 1

B.04
Answer: d

REF: $(DR_1)(R_1)^2 = (DR_2)(R_2)^2$
$(100\ R/hr)(1\ m)^2 = (X)(10\ m)^2 = 1\ R/hr$
Occupational whole-body dose (i.e., TEDE) limit per 10 CFR 20= 5 Rem for
The individual would have to stay in the area for 5 hours before they exceeded this dose limit.

B.05
Answer: a
REF: SOP Power Calibration, pg. 1 of 3

B.06
Answer: a
REF: EPP 3.3, pg. 16

B.07
Answer: d
REF: SOP Health Physics Maintenance and Surveillance, pg. 1 of 5
SAR 7.7.2, pg. 126

B.08
Answer: c
REF: 10CFR20.1003

B.09
Answer: b
REF: 10CFR20.1004(a), “Rem is the special unit of any of the quantities expressed as dose equivalent. The dose equivalent in rems is equal to the absorbed dose in rads multiplied by the quality factor (1 rem=0.01 sievert).”

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

B.11
Answer: b
REF: EPP 3.5, pg. 16
SOP Evacuation Procedures, pg. 4

B.12
Answer: a
REF: 10 CFR Part 55.53
- 55.53(i) – the licensee shall have a biennial medical examination.
- 55.53(h), 55.59(c) – annual operating tests
- 55.53(e) – the licensee shall actively perform the functions of a licensed operator for a minimum of 4 hours per calendar quarter.
- 55.53(h), 55.59(c)(1) – ”The requalification program must be conducted for a continuous period not to exceed 2 years”

B.13
Answer: c
REF: SOP Beam Port Experiments, pg. 3 of 4

B.14
Answer: d
REF: TS 6.1.3, pg. 54-55

B.15
Answer: a
REF: SOP Evacuation Procedures, pg. 2

B.16
Answer: d
REF: EPP Table I, pg. 18-19

B.17
Answer: b
REF: SOP Reactor Startup, section 6.e, pg. 4 of 4

B.18
Answer: a & b correct per facility comment
REF: TS Section 3.6.2, pg. 27

B.19
Answer: c
REF: EPP 2.8, pg. 9

B.20
Answer: c
REF: TS 4.2.2 (1), pg. 39

C.01
Answer: b
REF: SAR Figure 5.5, pg. 98

C.02
Answer: c
REF: TS 3.8.3, pg. 33

C.03
Answer: d
REF: TS 3.5.1 table 3, pg. 24

C.04
Answer: b
REF: SAR 5.1, pg. 94

C.05
Answer: d
REF: SAR 7.2, pg. 106 and SAR 7.2.3.3, pg. 108

C.06
Answer: a
REF: SAR 7.2.3.6, pg. 109 and SAR 7.3.1, pg. 116

C.07
Answer: c
REF: SAR 7.2.3.6, pg. 109

C.08
Answer: a
REF: For a SAR Table 7.2, pg. 124
For b SAR 7.2.37, pg. 109
For c SAR 9.1.2, pg. 128
For d SAR 11.1.1.1, pg. 145

C.09
Answer: b
REF: TS 3.2.2, Table 2a, pg. 19

C.10
Answer: c
REF: SAR 4.2.4, pg. 30

~~**C.11**~~
~~Answer: d~~
~~REF: TS 3.2.2, Table 2b basis, pg. 20~~

C.12
Answer: c
REF: SAR 4.2.5, pg. 30

C.13
Answer: a
REF: SAR 7.7.2, pg. 126

C.14
Answer: d
REF: SOP Implementing Procedure for Unisolable Pool Leak, pg. 1
SAR 5.2, pg. 96

C.15
Answer: a,3 b,1 c,4 d,2
REF: SOP NSC Access Control Procedure, pg. 2 of 2

C.16
Answer: d
REF: SAR 6.2.1, pg. 103

C.17
Answer: d
REF: TS 3.8.1 (1), pg. 32

~~**C.18**~~
~~Answer: c~~
~~REF: SAR 7.3.1, pg. 115~~

C.19
Answer: a
REF: SAR Figure 5.5, pg. 98

C.20
Answer: a
REF: SAR 7.7.2, pg. 126