February 23, 2015

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-15-01, UNIVERSITY OF TEXAS AT AUSTIN

Dear Mr. Whaley:

During the week of January 21, 2015, 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 Patrick Isaac at (301) 415-1019, or via email at Patrick.Isaac@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. 50-602

Enclosures:
1. Examination Report No. 50-602/OL-15-01
2. Facility Comments with NRC Resolution
3. Written Examination with Facility Comments Incorporated

cc: w/o enclosures: See next page

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NAME	PIsaac	CRevelle	KHsueh
DATE	02/12/2015	2/23/2015	02/23/2015

OFFICIAL RECORD COPY

cc:

Governor's Budget and
Planning Office
P.O. Box 12428
Austin, TX 78711

Bureau of Radiation Control
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Austin, TX 78756

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Test, Research, and Training
Reactor Newsletter
University of Florida
202 Nuclear Sciences Center
Gainesville, FL 32611

Dr. Steven Biegalski, Director
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Austin, TX 78758

ENCLOSURE 1
U. S. NUCLEAR REGULATORY COMMISSION
OPERATOR LICENSING INITIAL EXAMINATION REPORT

REPORT NO.: 50-602/OL-15-01

FACILITY DOCKET NO.: 50-602

FACILITY LICENSE NO.: R-129

FACILITY: University of Texas at Austin TRIGA Reactor

EXAMINATION DATES: January 21, 2015

SUBMITTED BY: **/RA/** **02/10/2015**
Patrick Isaac, Chief Examiner Date

SUMMARY:

During the week of January 21, 2015, the NRC administered operator licensing examination to one Reactor Operator (RO) license candidate. The candidate passed 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	1/0	N/A	1/0
Operating Tests	1/0	N/A	1/0
Overall	1/0	N/A	1/0

3. Exit Meeting:
Patrick Isaac, Chief Examiner, NRC
Paulette Torres, Examiner, NRC
Michael Krause, Manager, Reactor Supervisor, University of Texas at Austin

At the conclusion of the site visit, 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).

ENCLOSURE 2
FACILITY COMMENTS ON THE WRITTEN EXAM WITH NRC RESOLUTION

QUESTION B.04 [1.0 point]
When the reactor is in square wave mode, which ONE control rod drive interlock function prevents air actuation if linear power is more than 1 KW?

a. Startup withdrawal

b. Simultaneous withdrawal

c. Pulse withdrawal

d. Transient withdrawal

Answer: d
REF: TS 3.2.2, pg. 14

Facility comments: The words pulse and transient are relatively similar when used in discussions about TRIGA reactors, especially when referring to the power bursts. When describing the interlock, the interlock function is what the operators recognize and not the somewhat analogous names associated therewith. This name use is demonstrated by the specific air actuated control rod being referred to as the transient or pulse rod and this tends to smudge the descriptors even in the section of the technical specifications to which the exam question was directed. A case in point occurs directly in the section about which the question was developed, in TS Section 3.2.2, there are references to both the transient rod and non- pulse rods (implying the transient rod is a pulse rod) hence further contributing to the naming association and also the possible confusion in the way the interlocks were named versus the actual interlock description and function. The candidate's interchange of these names was contributed to by the way the names were used throughout documents and he should not be penalized for a situation where the wording in the TS should have been more carefully thought about at the time of their creation.

Facility Recommendation: This question and topic area references items described in the technical specifications. However, as written, uses terms which are frequently interchangeable descriptors instead of testing knowledge about the actual function of the interlock. In the future, I suggest this question be rephrased to eliminate ambiguity and interchangeability of the pulse and transient nomenclature and I will review to see how it is listed in our new proposed TS. Therefore I request it be removed.

NRC Resolution: The NRC agrees with most of the facility comments; however the question will not be removed from the examination as recommended. Since the issue, as described by the facility comments, is the similarity between the terms used in distractors "c" and "d", the NRC will accept both "c" and "d" as correct answers for question B.04.

QUESTION B.06 [1.0 point]
Per PLAN-E 3.00, you control the spread of radioactive contamination by all of the following EXCEPT:

a. Immediate measurement of activity on hands and feet.

b. Sweeping or brushing surfaces, or using compressed air.

c. Identification of potential problem areas.

d. Removal of contaminated clothing and washing of skin surfaces.

B.06
Answer: b
REF: PLAN-E 3.00, D.2., pg. 5 of 5

Facility comments: Immediately after completing the oral exam and going through the written exam with me the candidate told me he did not see the hanging word EXCEPT on the second line of the question which was clearly required to determine the correct answer. The problem here is a human factors issue in the physical layout of the question on the page and the capitalization of the word QUESTION directly above and PLAN-E caused the candidate not to quickly accurately select the expected answer. After he saw the word "except" he immediately knew what the correct answer was.

Facility Recommendation: I cannot say this was a bad question but I suggest improving readability by not leaving the last word which is key to determining the correct answer hanging on a separate line.

NRC Resolution: Thank you for the comment. We will consider writing the question differently in the future.

QUESTION B.11 [1.0 point]
Which ONE of the following requires NRC approval for changes?

a. NETL procedure OPER-2, Reactor Startup and shutdowns.

b. The requalification program.

c. The names and telephone numbers of the reactor facility personnel list.

d. The number of Nuclear Reactor Committee members from four to three.

Answer: b
REF: TS 6.1.4, pg. 29

Facility comments: This question is appropriate for an SRO exam but not as appropriate for an RO exam since this question is primarily administrative in nature and not something an RO would encounter without the guidance of an SRO.

Facility Recommendation: The Tech Spec referenced refers to an "Approved NRC Program" and does not address a change approval even being an option such as those referring to Emergency and Physical Security Plans in 10CFR. This has the implication that there is a program which was approved at the time of licensing and does not specifically discuss how to request a change or imply they are even allowed. This question is therefore requested as a candidate for being thrown out.

NRC Resolution: The NRC agrees with the facility that none of the answers are totally correct. Therefore, question B.11 will be deleted from the examination.

QUESTION B.15 [1.0 point]
Per 10 CFR 55.53 “Conditions of Operator Licenses”, which ONE of the following is a condition of your reactor operating license?

a. Transferrable between facilities.

b. Subject to all NRC rules and regulations.

c. Subject to an annual medical examination.

d. Must be exercised for at least 8 hours per quarter.

Answer: b
REF: 10 CFR 55.53

Facility comments: This question refers to a requirement stated in 10 CFR 55.53(d) however the answer provided as the correct answer is not stated as listed in the CFR referenced and is thus open for interpretation and not completely correct .

Facility Recommendation: The answer listed as correct is "Subject to All NRC Rules and Regulations" whereas the 10 CFR regulation actually reads "Subject to all APPLICABLE NRC rules and regulations”. The candidate did not select the NRC expected answer because he interpreted ALL NRC RULES to include not only RTR applicable ones but also those for Commercial Reactors which is clearly not the case therefore a viable answer was not in the list to choose from. This question should therefore be considered for rewording and thrown out of the current exam.

NRC Resolution: The NRC agrees with the facility comment and question B.15 will be deleted from the examination.

ENCLOSURE 3
U. S. NUCLEAR REGULATORY COMMISSION
NON-POWER REACTOR LICENSE EXAMINATION

FACILITY: University of Texas at Austin

REACTOR TYPE: TRIGA

DATE ADMINISTERED: 01/21/2015

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
20.00	33.3	_____	_____	A. REACTOR THEORY, THERMODYNAMICS AND FACILITY OPERATING CHARACTERISTICS
18.00 ~~20.00~~	33.3	_____	_____	B. NORMAL AND EMERGENCY OPERATING PROCEDURES AND RADIOLOGICAL CONTROLS
20.00	33.3	_____	_____	C. FACILITY AND RADIATION MONITORING SYSTEMS
58.00 ~~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 ___

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 ___ (0.25 each)

B09 a b c d ___

B10 a b c d ___

~~B11 a b c d ___~~ deleted per facility comment

B12 a b c d ___

B13 a b c d ___

B14 a b c d ___

~~B15 a b c d ___~~ deleted per facility comment

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 ___

C12 a b c d ___

C13 a b c d ___

C14 a ___ b ___ c ___ (0.33 each)

C15 a b c d ___

C16 a b c d ___

C17 a ___ b ___ c ___ d ___ (0.25 each)

C18 a b c d ___

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

UNIVERSITY OF TEXAS AT AUSTIN
TRIGA REACTOR

Operator Licensing Examination

Week of January 21, 2015

QUESTION A.01 [1.0 point]
Which ONE is true about "subcritical multiplication"? As the reactor approaches criticality, the parameter

a. k_{eff} approaches zero.

b. 1/M approaches zero.

c. M approaches one.

d. ρ approaches infinity.

QUESTION A.02 [1.0 point]
Which ONE of the following is the approximated time for xenon-135 to decay away to provide a clean, xenon free core, assuming the reactor ran for 1 week for 24 hours? _____ after shutdown.

a. 8 hours

b. 18 hours

c. 24 hours

d. 72 hours

QUESTION A.03 [1.0 point]
The reactor is shutdown with a k_{eff} of 0.952. Initial power is 250 mW. The operator withdraws a control rod thereby adding 110 cents of reactivity. What would be the new power level? Given β=0.007.

a. 127 mW

b. 214 mW

c. 293 mW

d. 525 mW

QUESTION A.04 [1.0 point]
Which ONE is true about "excess reactivity"?

a. Ensures that the reactor can be shut down from any condition of operation

b. Ensures that the fuel temperature safety limit will not be exceeded

c. Is the change in reactivity caused by control rod motion

d. Is the amount of reactivity in excess of the amount of reactivity needed to make the reactor critical

QUESTION A.05 [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.06 [1.0 point]
The ideal moderator has _____ atomic mass for large 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. Low, low, high

b. Low, high, low

c. High, low, high

d. High, high, low

QUESTION A.07 [1.0 point]
Which ONE is true about “reflectors”?

a. Produces neutrons

b. Have a high neutron absorption cross section

c. Limit the chain reaction by absorbing neutrons

d. Flatten the neutron flux profile of a reactor core

QUESTION A.08 [1.0 point]
The term “macroscopic cross section” is defined as:

a. The average distance travelled by a neutron between interactions in a material.

b. An indication of energy loss per collision.

c. The probability of neutron interaction per centimeter of travel in a material.

d. The effective cross sectional area of a single nucleus presented to an oncoming neutron.

QUESTION A.09 [1.0 point]
The reactor is operating at a constant power of 300kW. The reactor is scrammed by the sudden insertion of control rods worth 7% Δk/k in reactivity. What is the power (prompt drop) immediately after scram?

a. 100 kW

b. 60 kW

c. 30 kW

d. 10 kW

QUESTION A.10 [1.0 point]
Which one of the following is the MAJOR source of energy released during fission?

a. Kinetic energy of the fission neutrons.

b. Kinetic energy of the fission fragments.

c. Decay of the fission fragments.

d. Prompt gamma rays.

QUESTION A.11 [1.0 point]
You start with a cold critical reactor and you insert a control rod to change the k_{eff}=0.994. How much reactivity was inserted by the control rods in units of cents? Given β=0.007.

a. -86.2 ¢

b. -60.4 ¢

c. -0.862 ¢

d. -0.604 ¢

QUESTION A.12 [1.0 point]
Which ONE of the following factors is not affected by the amount of moderator in the reactor?

a. Thermal non-leakage probability.

b. Resonance escape probability.

c. Thermal utilization factor.

d. Reproduction factor.

QUESTION A.13 [1.0 point]
You start with 10^{10} atoms of ^{60}Co ($t_{1/2}$ = 1,925.1 days). How many years will it take for the number of atoms to decay to 5 x 10^{8} atoms?

a. 4.32 years

b. 11.5 years

c. 22.9 years

d. 34.6 years

QUESTION A.14 [1.0 point]
Reactor period is defined as:

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

b. The time required for the reactor power to double

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

d. The fraction of all neutrons that are born as delayed neutrons

QUESTION A.15 [1.0 point]
Which ONE of the following has the lowest thermal neutron cross section?

a. Cd-113

b. Xe-135

c. Sm-149

d. U-235

QUESTION A.16 [1.0 point]
Which ONE is true about the four factor formula?

a. Neutron leakages can be reduced by increasing the size of the core.

b. Neutron leakages can be reduced by using a reflector.

c. Neutron leakages can be reduced by increasing moderator temperature.

d. There is no leakage term. The reactor is considered to be infinite in size.

QUESTION A.17 [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.18 [1.0 point]
Which ONE of the following describes the term prompt jump?

a. A rapid rise in power level due to an increase in the production of prompt neutrons.

b. A reactor which has attained criticality on prompt neutrons alone.

c. A reactor which is critical using both prompt and delayed neutrons.

d. A negative reactivity insertion which is less than k_{eff}.

QUESTION A.19 [1.0 point]
Xenon-135 is formed directly by decay of _____.

a. Iodine-135

b. Tellurium-135

c. Cesium -135

d. Barium-135

QUESTION A.20 [1.0 point]
The term “delayed neutron” is defined as:

a. A neutron born directly from fission.

b. A neutron in equilibrium with its surroundings.

c. A neutron born due to decay of a fission product.

d. A neutron at an energy level greater than its surroundings.

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

QUESTION B.01 [1.0 point]
Per Technical Specifications, which ONE of the following Measuring Channels has to be operable for both manual mode and pulsing mode of operation?

a. Fuel Temperature

b. Power Level

c. Pulse Power

d. Pulse Energy

QUESTION B.02 [1.0 point]
Which ONE is true for the Continuous Air Monitor (Argon-41)?

a. Particulate collection

b. Sample reactor room air within 5 meters of the pool at the pool access level.

c. Alarm set point shall be equal to or less than a measurement concentration of 2×10^{-9} $\mu Ci/cm^3$

d. If not operable, operating the reactor with the auxiliary air purge system shall be limited to a period of ten days.

QUESTION B.03 [1.0 point]
10 CFR 20 defines the "Annual Limit on Intake (ALI)" as:

a. The concentration of a given radionuclide in air which, if breathed for a working year of 2000 hours, would result in a committed effective dose equivalent of 5 rems.

b. The dose equivalent to organs that will be received from an intake of radioactive material by an individual during the 50-year period following the intake.

c. The amount of radioactive material taken into the body by inhalation or ingestion in one year which would result in a committed effective dose equivalent of 5 rems.

d. Limits on the release of effluents to an unrestricted environment.

QUESTION B.04 [1.0 point]
When the reactor is in square wave mode, which ONE control rod drive interlock function prevents air actuation if linear power is more than 1 KW?

a. Startup withdrawal

b. Simultaneous withdrawal

c. Pulse withdrawal

d. Transient withdrawal

QUESTION B.05 [1.0 point]
According to Technical Specifications, the Excess Reactivity is limited to _____.
Given β=0.0075

a. $0.42

b. $2.84

c. $6.53

d. $7.47

QUESTION B.06 [1.0 point]
Per PLAN-E 3.00, you control the spread of radioactive contamination by all of the following EXCEPT:

e. Immediate measurement of activity on hands and feet.

f. Sweeping or brushing surfaces, or using compressed air.

g. Identification of potential problem areas.

h. Removal of contaminated clothing and washing of skin surfaces.

QUESTION B.07 [1.0 point]
In accordance with Technical Specifications, a _____ of the Reactor Safety System shall be done prior to each day operation, after repair or modifications, or prior to each extended period of operation.

a. Channel Test

b. Channel Check

c. Channel Calibration

d. Visual Inspection

QUESTION B.08 [1.0 point, 0.25 point each]
Match the 10 CFR 55 requirements for maintaining an active operator license in column A with the corresponding time period from column B (answers can be used more than once).

Column A	Column B
a. Medical Exam	1 year
b. Pass Requalification Operating Test	2 years
c. Renewal Application of Existing License	4 years
d. Pass Requalification Written Examination	6 years

QUESTION B.09 [1.0 point]
A GM detector with window open reads a radiation source as 200 mR/hr. The new reading is 50 mR/hr with the window closed. What would be the gamma and beta doses?

a. The gamma dose rate is 20 mR/hr and the beta rate is 180 mR/hr.

b. The gamma dose rate is 50 mR/hr and the beta rate is 150 mR/hr.

c. The dose rate from gammas is half of the betas.

d. Gamma and beta dose rates are the same.

QUESTION B.10 [1.0 point]
"The maximum transient reactivity insertion for the pulse operation of the reactor shall be 2.2% Δk/k in the pulse mode." This is an example of a:

a. Safety Limit.

b. Limiting Safety System Setting.

c. Limiting Condition of Operation.

d. Surveillance Requirement.

~~**QUESTION B.11 [1.0 point]**~~
~~Which ONE of the following requires NRC approval for changes?~~

~~a. NETL procedure OPER-2, Reactor Startup and shutdowns.~~

~~b. The requalification program.~~

~~c. The names and telephone numbers of the reactor facility personnel list.~~

~~d. The number of Nuclear Reactor Committee members from four to three.~~

QUESTION B.12 [1.0 point]
The Radiation Work Permits (RWP) initiator is responsible for all of the following EXCEPT:

a. Assigning an RWP number, logging the RWP, and completing the appropriate sections of the RWP.

b. Ensuring that all personnel who will be working under the RWP have read and signed the RWP.

c. Enforcing the requirements of the RWP.

d. Notifying personnel in adjacent areas of potential hazards of the work and possible impact.

QUESTION B.13 [1.0 point]
Minor, one time, changes that do not change the original intent of a procedure may be made at the discretion of the _____.

a. Reactor Supervisor

b. NETL Director

c. Senior Reactor Operator

d. Reactor Oversight Committee

QUESTION B.14 [1.0 point]
Per Technical Specifications, a moveable experiment shall have a reactivity worth less than _____, and the reactivity worth of any single secured experiment shall be less than _____.

a. $1.00 and $2.00

b. $1.00 and $2.50

c. $2.00 and $3.00

d. $2.50 and $3.00

~~**QUESTION B.15 [1.0 point]**~~
~~Per 10 CFR 55.53 "Conditions of Operator Licenses", which ONE of the following is a condition of your reactor operating license?~~

~~a. Transferrable between facilities.~~

~~b. Subject to all NRC rules and regulations.~~

~~c. Subject to an annual medical examination.~~

~~d. Must be exercised for at least 8 hours per quarter.~~

QUESTION B.16 [1.0 point]
Which ONE is an example of a non-reactor specific event described in the Emergency Response procedure (PLAN-E)?

a. Bomb threat.

b. Fuel element failure.

c. Measured dose rate.

d. Individual injury.

QUESTION B.17 [1.0 point]
Which ONE of the following defines the term “Radiation Area”?

a. Any area to which access is limited for any reason.

b. Any area to which access is limited for the purpose of protecting individuals against undue risks from exposure to radiation and radioactive materials.

c. Area where radiation exposure rates would result in a dose equivalent in excess of 5 mrem (0.05 mSv) in one hour at 30 centimeters from the radiation source.

d. Area where radiation exposure rates would result in a dose equivalent in excess of 0.1 rem (1 mSv) in one hour at 30 centimeters from the radiation source.

QUESTION B.18 [1.0 point]
If a gamma source measures 425 mR/hr at one foot, what will it measure at three feet?

a. 0.021 mR/hr

b. 47 mR/hr

c. 142 mR/hr

d. 207 mR/hr

QUESTION B.19 [1.0 point]
An experiment with a reactivity worth of greater than one dollar needs to be relocated. Who may authorize that action?

a. The Senior Reactor Operator

b. The Facility Director

c. The Reactor Operations Committee

d. The Nuclear Regulatory Commission

QUESTION B.20 [1.0 point]
In support of ALARA, the NETL occupational dose limit for the typical radiation worker is established as the TEDE equal to _____ per year.

a. 0.1 rem

b. 5.0 rem

c. 50 mrem

d. 1000 mrem

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

QUESTION C.01 [1.0 point]
Which ONE of the followings interlocks prevents the movement of the rods in the down direction?

a. Scrams not reset.

b. Magnet not coupled to armature.

c. Regulating rod in the AUTO mode.

d. Mode switch in one of the pulse positions.

QUESTION C.02 [1.0 point]
The pneumatic transfer tube is located at the:

a. C ring

b. D ring

c. F ring

d. G ring

QUESTION C.03 [1.0 point]
The TRIGA reactor core is located below:

a. The reflector platform.

b. The top surface of top grid pate.

c. The top surface bottom grid plate.

d. The top surface of safety plate.

QUESTION C.04 [1.0 point]
Which ONE of the following design features prevents the accidental siphoning of reactor pool water?

a. The action of the coolant discharge nozzle.

b. The capacity of the primary water makeup system.

c. A positive pressure difference between the shells inside the heat exchanger.

d. Holes located in the suction and discharge lines approximately ½ meter below the normal water level.

QUESTION C.05 [1.0 point]
Which ONE of the following materials is used as the neutron absorber for the Transient Rod?

a. Aluminum

b. Cadmium

c. Boron Carbide

d. Stainless Steel

QUESTION C.06 [1.0 point]
Which ONE of the following standard experimental facilities provides access to the point of maximum flux in the core?

a. Beam Tube Facilities

b. Central Thimble

c. Pneumatic Specimen Tube

d. Rotary Specimen Rack

QUESTION C.07 [1.0 point]
What kind of detector feeds the NM-1000?

a. Fission chamber

b. Compensated ion chamber

c. Geiger-Mueller

d. Scintillation

QUESTION C.08 [1.0 point]
A Senior Reactor Operator shall be present at the facility during the following EXCEPT:

a. The initial startup and approach to power.

b. A recovery from an unscheduled shutdown.

c. All fuel element or control rod relocation.

d. Fuel temperature calibration.

QUESTION C.09 [1.0 point]
The reactor must shutdown if the water conductivity exceeds _____.

a. 0.2 μmhos/cm

b. 1.25 μmhos/cm

c. 2.0 μmhos/cm

d. 5.0 μmho/cm

QUESTION C.10 [1.0 point]
Which ONE of the following Measuring Channels is controlled automatically by the Regulating Rod?

a. Fuel temperature

b. Power level

c. Pulse power

d. Pulse energy

QUESTION C.11 [1.0 point]
Which ONE of the following provides limited gamma shielding when the beam tube plugs are removed?

a. An inner shield plug.

b. An outer shield plug.

c. A lead-filled shutter and a lead-lined door.

d. A removable cover plate.

QUESTION C.12 [1.0 point]
Which ONE of the following is a primary function of the Reactor Coolant System?

a. To dissipate heat generated in the reactor.

b. To minimize corrosion of all reactor components.

c. To maintain a minimal level of radioactivity in the reactor pool water.

d. To maintain optical clarity of pool water.

QUESTION C.13 [1.0 point]
While performing a fuel element inspection, you noticed that the transverse bend of one fuel element is 1.20 mm. Which ONE of the following is the correct action to take?

a. Continue the fuel inspection because this bend is within Technical Specifications limit.

b. Continue the fuel inspection because Technical Specifications requires the elongation measurement only.

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

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

QUESTION C.14 [0.33 point each]
Match each type of radiation monitor in Column A with its specific radiological purpose in Column B.

Column A	Column B
a. Particulate air monitor	1. Used to warn personnel of potential radiation exposures.
b. Gaseous air monitor	2. Used to detect radioisotopes released due to fuel element failure.
c. Area radiation monitors	3. Used to determine the effluent radiation release of Argon-41.

QUESTION C.15 [1.0 point]
Fuel element temperature must be limited in the standard TRIGA fuel element in order to avoid fuel element failure due to which of the following mechanisms:

a. Distortion of the fuel element due to a phase change of the 304 stainless steal.

b. Fission product built up.

c. Excessive pressure from expansion of Argon-41.

d. Excessive pressure caused by air, fission product gases, and zirconium hydride hydrogen dissociation.

QUESTION C.16 [1.0 point]
Per Technical Specifications, the radiation shielding requirements of the Reactor Coolant System are fulfilled by keeping the water depth at least at _____ measured from the pool bottom to the pool water surface.

a. 5.25 meters

b. 6.50 meters

c. 4.80 meters

d. 6.10 meters

QUESTION C.17 [0.25 point each]
Match the steps for the Regulating Rod in column A with the events after a reactor scram in column B.

Column A	Column B
a. First step	1. The reactor shuts down
b. Second step	2. The control rod is inserted
c. Third step	3. The magnet is de-energized
d. Fourth step	4. The armature is released

QUESTION C.18 [1.0 point]
Which ONE of the following statements correctly describes the purpose of the potentiometer in the control rod drive assembly?

a. Provides rod position indication when the electromagnet engages the connecting rod armature.

b. Provides a variable voltage to the rod drive motor for regulating control rod speed.

c. Provides potential voltage as required for resetting the electromagnet current.

d. Provides the potential voltage to relatch the connecting rod to the electromagnet.

QUESTION C.19 [1.0 point]
Which ONE of the following will result in a reactor scram?

a. Bulk pool water exceeds 40°C.

b. Instrumented fuel element temperature exceeds 500°C.

c. Withdrawing two control rods at the same time.

d. Loss of high voltage to NP-1000.

QUESTION C.20 [1.0 point]
Upon initiation of a high air particulate radioactivity signal in the reactor room, the ventilation system:

a. Actuates the isolation damper in the argon purge system

b. Actuates the standard operation mode

c. Dampers shut and isolate the reactor bay

d. Is operating normally

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

A.01
Answer: b
REF: Burns, Table 5.5, pg. 5-15

A.02
Answer: d
REF: Burns, Section 8.4, pg. 8-10, Figure 8.3, pg. 8-11

A.03
Answer: c
REF: Given: $\Delta k/k_{(1)} = (keff_1 - 1)/keff_1 = (0.952 - 1) / 0.952 = -0.0504$
$\Delta k/k$ safety blade = \$ * β = (\$1.1) (0.0070) = \$0.0077
$\Delta k/k_{(2)} = \Delta k/k_{(1)} + \Delta k/k$ safety blade = - 0.0504 + 0.0077 = - 0.0427
$keff_2 = 1 / (1 - \Delta k/k_{(2)}) = 1 / (1 - (- 0.0427)) = 0.959$
$(1 - keff_1)(CR_1) = (1 - keff_2)(CR_2) = (1 - 0.952)(250mW) = (1 - 0.959)(CR_2)$
CR_2 = 293 mW

A.04
Answer: d
REF: TS Section 3.1.4, pg. 15 (Answer for a and b is shutdown margin)
DOE Handbook part 2, module 3, p. 50 (Answer for c is control rod worth)

A.05
Answer d
REF: DOE Fundamentals Handbook, Volume 1, Module 2, *Neutron Moderation*, pg. 23

A.06
Answer: b
REF: Reed Training Manual (September 2009), Section 7.4, pg. 113

A.07
Answer: d
REF: Reed Training Manual (September 2009), pg. 116

A.08
Answer: c
REF: Burns, Section 2.5, pg. 2-36 to 2-47

A.09
Answer: c
REF: Given P_0 = 300 kW, then $P_1 = \frac{\beta(1-\rho)}{\beta-\rho} P_0 = \frac{0.007(1-(-0.07))}{0.007-(-0.07)} 300$ = 29.18 kW

A.10
Answer: b
REF: Burns, Section 3.2.1, and Table 3.2, pg. 3-4 and 3-5

A.11
Answer: a
REF: Given k_{eff}=1, then $\rho = \frac{k_{eff}-1}{k_{eff}} = \frac{0.994-1}{0.994} = -0.006\frac{\Delta k}{k}$

$\Delta\rho(\$) = \frac{\Delta\rho\left(\frac{\Delta k}{k}\right)}{\beta} = \frac{-0.006\left(\frac{\Delta k}{k}\right)}{0.007} = -\$0.862$

$\Delta\rho(¢) = \Delta\rho(\$) * 100 = -\$0.862(100) = -86.2¢$

A.12
Answer: d
REF: Reed Training Manual (September 2009), Section 10.5, pg. 167. The fuel utilization factor (also called the reproduction factor) is not affected by the moderator since it is purely a function of the nuclear characteristics of ^{235}U.

A.13
Answer: c
REF: $N(t)=N_0e^{-\lambda t} \rightarrow N(t)/N_0=e^{-\lambda t} \rightarrow \ln(N(t)/N_0)=-\lambda t$
$\lambda = \ln(2)/t_{1/2}$

$t = \frac{ln\frac{N(t)}{N_0}}{-\lambda} = \frac{\ln\left(\frac{5x10^8}{10^{10}}\right)}{\frac{\ln(2)}{-(1925.1\ days)/(365 days/years)}}$

t=22.9 years

A.14
Answer: a
REF: DOE Handbook part 2, module 4, pg. 21

A.15
Answer: d
REF: Burns, Table 2.5, pg. 2-59. Also, Table 8.1, pg. 8-2

A.16
Answer: d
REF: Reed Training Manual (September 2009), equation 8.13, pg. 125

A.17
Answer: b
REF: Burn, Section 7.3, pg. 7-5 to 7-7

A.18
Answer: a
REF: Burns, Section 4.7, pg. 4-21

A.19
Answer: a
REF: Burns, Figure 8.1, pg. 8-6

A.20
Answer: c
REF: Burns, Section 3.2.2, pg. 3-7

B.01
Answer: a
REF: TS 3.2.4, pg.15

B.02
Answer: d
REF: TS 3.3.3 b, pg. 17

B.03
Answer: c
REF: 10CFR20.1003

B.04
Answer: c and d are both correct per facility comment
REF: TS 3.2.2, pg. 14

B.05
Answer: c
REF: TS 3.1.1, pg. 13
The maximum excess reactivity shall be 4.9% Δk/k.
$\Delta\rho(\$) = \frac{\Delta\rho\left(\frac{\Delta k}{k}\right)}{\beta} = \frac{0.049\left(\frac{\Delta k}{k}\right)}{0.0075} = \$6.53$

B.06
Answer: b
REF: PLAN-E 3.00, D.2., pg. 5 of 5

B.07
Answer: a
REF: TS 4.2.3, pg. 21

B.08
Answer: a, 2 years (10 CFR 55.53)
b, 1 years (10 CFR 55.59)
c, 6 years (10 CFR 55.55)
d, 2 years (10 CFR 55.59)

REF: 10 CFR 55.53 “Conditions of Operator Licenses”
10 CFR 55.55 “Expiration”
10 CFR 55.59 “Requalification”

B.09
Answer: b
REF: With the aluminum shield in place, with the shield in place, only gammas are measured, so the gamma dose rate is 50 mR/hr. Without the shield, both gamma and beta are measured, so the beta dose rate must be 200 mR/hr - 50 mR/hr =150 mR/hr.

B.10
Answer: b
REF: TS 2.2.3, pg. 12

~~**B.11**~~
~~Answer: b~~
~~REF: TS 6.1.4, pg. 29~~ deleted per facility comment

B.12
Answer: a
REF: HP-7, II. B.3 and B.6, pg. 4 and 5 of 11

B.13
Answer: c
REF: ADMN-1, C.1., pg. 6 of 7

B.14
Answer: b
REF: TS 3.4.1, pg.18

~~**B.15**~~
~~Answer: b~~
~~REF: 10 CFR 55.~~53 deleted per facility comment

B.16
Answer: d
REF: PLAN-E 3.01, pg. 1 of 1

B.17
Answer: c
REF: 10 CFR20.1003 “Definitions“

B.18
Answer: b
REF: Given $DR_1(d_1)^2 = DR_2\ (d_2)^2$
Then $DR_2 = \frac{DR_1}{(d_2/d_1)^2}$

$$DR_2 = \frac{425\ mR}{(3/1)^2}$$

$$DR_2 = 47.2\ mR/hr$$

B.19
Answer: a
REF: TS 6.1.3, pg. 28

B.20
Answer: d
REF: HP-003 3.00, F, pg. 5 of 7

C.01
Answer: c
REF: SAR, section 6.1.4, pg. 6-12

C.02
Answer: d
REF: SAR, Table 4-6, pg. 4-51

C.03
Answer: b
REF: SAR, Figure 4-25, pg. 4-55

C.04
Answer: d
REF: SAR 5.2.1, pg. 5-6

C.05
Answer: c
REF: SAR, Table 4-11, pg. 4-65

C.06
Answer: b
REF: SAR, Section 8.1.1, pg. 8-1

C.07
Answer: a
REF: SAR, Figure 6-1, pg. 6-3 and Section 6.1.1, pg. 6-6

C.08
Answer: d
REF: TS 6.1.3, pg. 28

C.09
Answer: d
REF: TS 3.3.1, pg. 16

C.10
Answer: b
REF: SAR, Section 6.1.4, pg. 6-12 and TS 3.2.4, pg. 15

C.11
Answer: c
REF: SAR 8.1.4.3, pg. 8-6

C.12
Answer: a
REF: SAR Chapter 5, pg. 5-1

C.13
Answer: a
REF: TS 3.1.4, pg. 13

C.14
Answer: a,2 b,3 c,1
REF: SAR, Section 9.5, pg. 9-10

C.15
Answer: d
REF: TS A.2.1, pg. 38

C.16
Answer: b
REF: TS 3.3.1 b, pg. 16

C.17
Answer: a,3 b,4 c, 2 d,1
REF: SAR, Section 4.4.8.2, pg. 4-67

C.18
Answer: a
REF: SAR 4.4.8.2, pg. 4-67

C.19
Answer: d
REF: TS 3.2.4, pg. 15 and SAR 6.1.5, pg. 6-13

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