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

September 5, 2019

Dr. Kenan Unlu, Director
The Pennsylvania State University
Breazeale Nuclear Reactor
Radiation Science and Engineering Center
University Park, PA 16802-2301

SUBJECT: EXAMINATION REPORT NO. 50-005/OL-19-02, THE PENNSYLVANIA STATE UNIVERSITY BREAZEALE RESEARCH REACTOR

Dear Dr. Unlu:

During the week of July 29, 2019, the U.S. Nuclear Regulatory Commission (NRC) administered an operator licensing examination at your Pennsylvania State University Breazeale research reactor. The examinations were conducted according to NUREG-1478, "Operator Licensing Examiner Standards for Research and Test Reactors," Revision 2. Examination questions and preliminary findings were discussed with those members of your staff identified in the enclosed report at the conclusion of the examination.

In accordance with Title 10 of the *Code of Federal Regulations*, Section 2.390, a copy of this letter and the enclosures will be available electronically for public inspection in the NRC Public Document Room or from the Publicly Available Records (PARS) component of NRC's Agencywide Documents Access and Management System (ADAMS). ADAMS is accessible from the NRC Web site at http://www.nrc.gov/reading-rm/adams.html. The NRC is forwarding the individual grades to you in a separate letter which will not be released publicly. Should you have any questions concerning this examination, please contact Ms. Michele DeSouza at (301) 415-0747 or via e-mail at Michele.DeSouza@nrc.gov.

Sincerely,

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

Docket No. 50-005

Enclosures:
1. Examination Report No. 50-005/OL-19-02
2. Facility Comments with NRC Resolution
3. Written Examination

cc: Jeffrey Geuther
cc w/o enclosures: See next page

cc:

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Test, Research and Training
Reactor Newsletter
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U. S. NUCLEAR REGULATORY COMMISSION
OPERATOR LICENSING INITIAL EXAMINATION REPORT

REPORT NO.: 50-005/OL-19-02

FACILITY DOCKET NO.: 50-005

FACILITY LICENSE NO.: R-002

FACILITY: The Pennsylvania State University

EXAMINATION DATES: July 29 - 30, 2019

SUBMITTED BY: _____ 8/20/19
Ashley D. Ferguson, Chief Examiner Date

SUMMARY:

During the week of July 29, 2019, the NRC administered the operator licensing examinations to one Senior Reactor Operator Upgrade (SRO-U) and one Senior Reactor Operator Instant (SRO-I) candidates. The results of the examination are as follows.

REPORT DETAILS

1. Examiners: Ashley D. Ferguson, Chief Examiner, NRC

2. Results:

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

3. Exit Meeting:
Dr. Kenan Unlu, Director, Radiation Science and Engineering Center (RSEC)
Candace Davison, Assistant Director for Education and Outreach, RSEC
Sean M. Herrmann, Senior Reactor Operator, RSEC
Ashley Ferguson, Chief Examiner, NRC

At the conclusion of the meeting, the NRC Examiner thanked the facility for their support in the administration of the examinations. The examiner discussed the weaknesses observed from the operating tests which include a familiarity with the process for implementing changes to technical specifications and other documents associated with the reactor license, and a lack of familiarity with exposure limits set forth in 10 CFR 20. The facility should consider strengthening these areas for future examinations. The facility licensee agreed to email their comments on the written examination which were either incorporated the examination report or discussed in Enclosure 2.

FACILITY COMMENTS ON THE WRITTEN EXAM WITH NRC RESOLUTION

QUESTION A.10 [1.00 point]
During Reg Rod calibration, doubling time was recorded to be 68 seconds. What was reactor period?

a. 47 seconds

b. 98 seconds

c. 113 seconds

d. 136 seconds

Answer: c
Reference: T = DT/ln(2) = 68 seconds/0.693 = 98.124 ≈98 seconds

Facility Comments & Recommendations: The question asks the examinee to calculate the reactor period corresponding to a doubling time of 68 seconds. The reference calculation given in the answer key correctly finds 98 seconds to be the reactor period, but the letter of the correct answer in the key is listed as c -113 seconds. The facility recommends that the correct answer be switched to b - 98 seconds.

NRC Resolution: The NRC accepts the facility recommendation. Answer choice "b" will be accepted as the correct answer choice for Question A.10.

QUESTION B.07 [1.00 point]
Which ONE of the following follow-up actions should be taken upon discovering contamination on a smear, in accordance with AOP-4?

a. Evacuate the Controlled Access Area (CAA).

b. Sweep up and dispose of any dirt piles in the contaminated area.

c. Re-survey the area using a different detector to verify that contamination is present.

d. Establish an exclusion boundary around the potentially contaminated area to prevent unnecessary entry.

Answer: d
Reference: PSBR AOP 4, Rev. 10, pg. 2

Facility Comments & Recommendations: The question asks, "Which ONE of the following follow-up actions should be taken upon discovering contamination on a smear, in accordance to AOP-4?" The correct answer is given as d - "Establish an exclusion

boundary around the potentially contaminated area to verify that contamination is present." While this answer is correct, trainees are frequently told during on-the-job training that it is good practice to perform the action described in answer c-"Re-survey the area using a different detector to verify that contamination is present." Therefore, the facility requests that either c or d be accepted as correct answers.

NRC Resolution: Thank you for the comment. The NRC finds the correct answer choice to be "d" in accordance with AOP-4. We will consider writing the question differently in the future.

QUESTION B.12 [1.00 point]
Per PSBR Technical Specifications, the minimum number of radiation monitoring equipment required to be operable are:

a. 2 Area Radiation Monitors.

b. 1 Area Radiation Monitor + 1 Portable Radiation Monitor.

c. 1 Area Radiation Monitor + 1 Continuous Air Monitor.

d. 2 Continuous Air Monitors.

Answer: b
Reference: PSBR TS 3.6

Facility Comments & Recommendations: The question asks "Per PSBR Technical Specifications, the minimum number of radiation monitoring equipment required to be operable are:" and gives b - "1 Area Radiation Monitor+ 1 Portable Radiation Monitor" as the correct answer. In fact, according to TS 3.6.1, the minimum requirement is one area radiation monitor plus one continuous air radiation monitor. Therefore, the facility recommends that the correct answer be changed to c -"1 Area Radiation Monitor+ 1 Continuous Air Monitor."

NRC Resolution: The NRC accepts the facility recommendation. Answer choice "c" will be accepted as the correct answer choice for Question B.12.

QUESTION B.15 [1.00 point]
As a licensed SRO, which ONE of the following conditions would violate 10 CFR 55.53, "Conditions of licenses.,"

a. Your last license renewal was 60 months ago.

b. Your last quarter shift operations total was 3 hours.

c. Your last medical examination was performed 15 months ago.

d. Your last requalification written examination was conducted 18 months ago.

B.15
Answer: b
Reference: 10 CFR 55, "Operators' Licenses"

Facility Comments & Recommendations: The question asks, "As a licensed SRO, which ONE of the following conditions would violate 10 CFR 55.53, "Conditions of Licenses?" and gives a correct answer of b - "Your last quarter shift operations total was 3 hours." The facility notes that the specified regulation states that the "licensee shall perform the functions of an operator or senior reactor operator for a minimum of four hours per calendar quarter." The function of an SRO is not specifically to operate the reactor, but also to direct operations and to direct fuel movement. The wording of the PSBR requalification plan is similar: " Each licensee shall actively perform the functions of the licensed position for a minimum of four hours per calendar quarter." (AP-3 p. 4). Neither 10 CFR nor the local Requalification Plan require the SRO to operate the reactor for any amount of time each quarter. In fact, the practice at the PSBR is to calculate the SRO's proficiency hours based solely of hours spent directing operations, not including their hours operating the reactor console (unless they were the duty SRO at the time). The PSBR requalification plan and 10 CFR 55.53 allows for other functions of an SRO to be credited for proficiency in addition to operations hours. Due the lack of a correct answer the facility asks that question B.15 be withdrawn.

NRC Resolution: Thank you for your comment. The NRC acknowledges that SRO shift operations can include directing operations and fuel movements. The NRC finds answer choice "b" to be the correct answer in accordance with 10 CFR 55. We will consider writing the question differently in the future.

QUESTION B.18 [1.00 point]
Which of the following activities requires an RWP?

a. Qualifying a new operating position.

b. Removal and disposal of the demineralizer resins.

c. Placing an encapsulated sample in the vertical tubes.

d. Performing a source check on the area radiation monitor.

Answer: c
Reference: AOP-8, Rev. 14, pg. 6

Facility Comments & Recommendations: The question asks, "Which ONE of the following activities requires a Radiation Work Permit?" The correct answer is given as c - "Placing an encapsulated sample in the vertical tubes." This selection is not supported by the reference given in the answer key (AOP-8) or any other facility reference material. Two possible correct answers exist. The first is a - "Qualifying a new operating position," which would require an RWP due to the possibility of creating high radiation areas (see AP-17 p. 3) unless the staff follow procedure SOP-7 which allows for new positions to be qualified without an RWP. (The use of SOP-7 was not stipulated in the question). B - "Removal and disposal of demineralizer resins" is required to have an RWP per AOP-8. Therefore, the facility requests that the correct answer be changed from c to both a and b.

NRC Resolution: The NRC accepts the facility recommendation. Answer choice "a" and "b" will be accepted as the correct answer choice for Question B.18.

QUESTION C.02 [1.00 point]
Which ONE of the following is TRUE regarding personnel dosimeters used at the PSBR?

a. Thermoluminescent dosimeters (TLDs) a are currently used at the PSBR which when heated give of light characteristics of the radiation energy that was absorbed.

b. TLDs are currently used at the PSBR, which use selected frequencies of laser light causing luminescence in portion to the radiation exposure received.

c. Optically stimulated Luminescence (OSL) dosimeters are currently used at the PSBR, which when heated give of light characteristics of the radiation energy that was absorbed.

d. OSL dosimeters are currently used at the PSBR, which use selected frequencies of laser light causing luminescence in portion to the radiation exposure received.

Answer: d
Reference: PSBR Training Manual, Chapter 6, pg. 10

Facility Comments & Recommendations: The question asks, "Which ONE of the following is TRUE regarding personal dosimeters used at the PSBR?" and gives a correct answer of "D - OSL dosimeters are currently used at the PSBR .... " The reference used to justify the NRC answer is the PSBR Training Manual, Ch. 6, p. 10, which does state that the dosimeters used at the PSBR are OSLDs. In fact, the dosimeters were changed several weeks before the exam to Mirian InstaDose + dosimeters. According to the Mirian product literature (www.instadose.com/instadose), these dosimeters use direct ion storage technology and are neither OLSDs or TLDs. Therefore, the facility believes that there is no correct answer and requests that the question be withdrawn.

NRC Resolution: The NRC understands the facility comments. Question C.02 will be deleted from the examination.

QUESTION C.09 [1.00 point]
Which ONE of the flowing conditions would initiate a stepback?

a. Pulse timer timed out.

b. Reactor bay truck door is open.

c. Square Wave Termination Request.

d. Radiation High from East Bay Monitor.

Answer: c
Reference: PSBR SAR, Chapter 7.3.1.2, pg. VII-15

Facility Comments & Recommendations: The question asks, "Which ONE of the following questions would initiate a stepback?" and gives a correct answer of c - Square Wave Termination Request. In fact, a square wave termination request initiates a scram (SAR 7.3.1.3) and a step back is initiated by any Reactor Operation Inhibit conditions (SAR 7.2.1.2), which include the truck door being open (Training Manual ch. 4, p. 49). The facility requests that the correct answer be changed from c. to b.

NRC Resolution: The NRC accepts the facility recommendation. Answer choice “b” will be accepted as the correct answer choice for Question C.09.

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

FACILITY: Pool

REACTOR TYPE: TRIGA

DATE ADMINISTERED: 07/30/2019

CANDIDATE: _____

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

CATEGORY VALUE	% OF TOTAL	CANDIDATE'S SCORE	% OF CATEGORY VALUE	CATEGORY
20.00	33.3	_____	_____	A. REACTOR THEORY, THERMODYNAMICS AND FACILITY OPERATING CHARACTERISTICS
20.00	33.3	_____	_____	B. NORMAL AND EMERGENCY OPERATING PROCEDURES AND RADIOLOGICAL CONTROLS
19.00 ~~20.00~~	33.3	_____	_____	C. FACILITY AND RADIATION MONITORING SYSTEMS
59.00 ~~60.00~~		_____ FINAL GRADE	_____ %	TOTALS

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

_____
Candidate's Signature

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.

13. When you have completed and turned in your examination, leave the examination area. If you are observed in this area while the examination is still in progress, your license may be denied or revoked.

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

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

1 kg = 2.21 lb

1 Horsepower = 2.54 x 10^3 BTU/hr

1 Mw = 3.41 x 10^6 BTU/hr

1 BTU = 778 ft-lb

°F = 9/5 °C + 32

1 gal (H_2O) ≈ 8 lb

°C = 5/9 (°F - 32)

c_P = 1.0 BTU/hr/lb/°F

c_p = 1 cal/sec/gm/°C

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

ANSWER SHEET

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___ (0.25 each)

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 SECTION A *****)

Category B – Normal/Emergency Operating Procedures and Radiological Controls

ANSWER SHEET

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 _____ (0.25 each)

B11 a _____ b _____ c _____ d _____ (0.25 each)

B12 a b c d ___

B13 a ___ b ___ c ___ d ___ (0.25 each)

B14 a b c d ___

B15 a b c d ___

B16 a ___ b ___ c ___ d ___ (0.25 each)

B17 a b c d ___

B18 a b c d ___

B19 a b c d ___

B20 a b c d ___

(***** END OF SECTION B *****)

Category C – Facility and Radiation Monitoring Systems

ANSWER SHEET

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___ (0.25 each)

C12 a___ b___ c___ d___ (0.25 each)

C13 a b c d ___

C14 a b c d ___

C15 a b c d ___

C16 a b c d ___

C17 a b c d ___

C18 a b c d ___

C19 a b c d ___

C20 a b c d ___

(***** END OF SECION C *****)
(********** END OF EXAMINATION **********)

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

QUESTION A.01 [1.00 point]
Which ONE of the following describes the factors that have the greatest effect on the fast fission factor?

a. Arrangement of the fuel and temperature of the moderator.

b. Arrangement of the fuel and concentration of the moderator.

c. Enrichment of the fuel and temperature of the moderator.

d. Enrichment of the fuel and concentration of the moderator.

QUESTION A.02 [1.00 point]
Which ONE of the following describes the relationship between reactivity and criticality?

a. The smaller the absolute value of reactivity in the core, the further the reactor is from criticality.

b. The larger the absolute value of reactivity in the core, the further the reactor is from criticality.

c. Reactivity is zero when the reactor is critical, reactivity is negative when the reactor is supercritical.

d. Reactivity is zero when the reactor is critical, reactivity is positive when the reactor is subcritical.

QUESTION A.03 [1.00 point]
Which ONE of the following indicates ideal moderator characteristics?

a. A large neutron absorption cross section and a small neutron scattering cross section.

b. A large neutron scattering cross section and a small neutron energy loss per collision.

c. A small neutron absorption cross section and a large neutron scattering cross section.

d. A small neutron scattering cross section and a small neutron energy loss per collision.

QUESTION A.04 [1.00 point]
The rate of change of Xenon-135 concentration can be determined by:

a. Subtracting Xenon-135 decay and burnup from the thermal neutron flux.

b. Subtracting the microscopic absorption rate of Iodine-135 from the microscopic absorption rate Xenon-135.

c. Subtracting the Xenon-135 yielded from fission from the macroscopic fission cross section of the fuel.

d. Subtracting Xenon-135 decay and burnup from the number of Xenon-135 yielded from fission and iodine decay.

QUESTION A.05 [1.00 point]
If reactor period is _____, then reactor power is _____.

a. Positive, stable

b. Negative, stable

c. Positive, increasing

d. Negative, increasing

QUESTION A.06 [1.00 point]
Which ONE of the following is caused by positive reactivity insertions resulting in the rate of production of prompt neutrons changing abruptly?

a. Doubling

b. Power tilt

c. Prompt jump

d. Prompt drop

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

QUESTION A.07 [1.00 point]

A critical reactor is operating at a low power level when the primary pump is turned off. What affect will the change on coolant flow rate have on reactivity?

a. Varying the coolant flow at low power levels does not result in measurable reactivity changes.

b. Varying the coolant flow at low power levels will cause the addition of negative reactivity due to the reduction in pressure, resulting in a prompt drop.

c. Varying the coolant flow at low power levels will cause the addition of positive reactivity due to the increase of reactor coolant density, resulting in a power level increase.

d. Varying the coolant flow at low power levels will cause the addition of negative reactivity due the increase in coolant temperature, resulting in the reactor becoming subcritical.

QUESTION A.08 [1.00 point]

During startup, a reactor is critical at 0.5 kW, what will reactor power be 1 minute later if doubling time is 45 seconds.

a. .75 kW

b. 1.25 kW

c. 1.75 kW

d. 2.25 kW

QUESTION A.09 [1.00 point, 0.25 each]

The infinite multiplication factor (k_∞) can be determined by the four-factor formula: $k_\infty = \varepsilon\, p\, f\, \eta$
Match the k_∞ term in Column A with the appropriate description in Column B. (Answers can only be used once.)

Column A	Column B
a. Fast Fission (ε)	1. Increases with over moderation.
b. Resonance escape probability(p)	2. Increases with tighter fuel lattice.
c. Thermal utilization factor (f)	3. Increases with an increase in moderator temperature.
d. Reproduction (η) factor	4. Increases with a decrease in neutron absorption by the fuel

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

QUESTION A.10 [1.00 point]
During Reg Rod calibration, doubling time was recorded to be 68 seconds. What was reactor period?

a. 47 seconds

b. 98 seconds

c. 113 seconds

d. 136 seconds

QUESTION A.11 [1.00 point]
A reactor is slightly supercritical with the thermal utilization factor = 0.800. A control rod is inserted to bring the reactor back to critical. Assuming all other factors remain unchanged, the new value for the thermal utilization factor is:

a. 0.798

b. 0.800

c. 0.802

d. 0.804

QUESTION A.12 [1.00 point]
What does the 1/M represent during a Subcritical Multiplication data plot?

a. Inverse of the moderator coefficient of reactivity

b. Inverse multiplication of the count rate between generations

c. Inverse of fuel elements presented in the core

d. Inverse migration length of neutrons of varying energies

QUESTION A.13 [1.00 point]
Which ONE of the following factors has a long-term effect on K_{eff} but is of no consequence during short term and transient operation?

a. Fuel burnup.

b. Increase in fuel temperature.

c. Increase in moderator temperature.

d. Xenon and Samarium fission products.

QUESTION A.14 [1.00 point]
The count rate for a reactor is 100 cps. An operator inserts an experiment into the core, and the count rate decreases to 55 cps. Given the initial K_{eff} of the reactor was 0.95, what is the worth of the experiment?

a. $\Delta\rho = - 0.02$

b. $\Delta\rho = + 0.02$

c. $\Delta\rho = - 0.05$

d. $\Delta\rho = + 0.05$

QUESTION A.15 [1.00 point]
A reactor is operating at a power of 5 W. If there is a reactivity insertion of $\rho = 0.00065$, approximately how long is it before the reactor power reaches 5 kW? (Assume $\beta_{eff} = 0.0075$ and $\lambda = 0.07$ sec^{-1})

a. 15 min

b. 17 min

c. 19 min

d. 21 min

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

QUESTION A.16 [1.00 point]
The process in which a neutron strikes a nucleus leaving the nucleus in an excited state is referred to as:

a. Elastic scattering

b. Inelastic scattering

c. Radiative capture

d. Neutron annihilation

QUESTION A.17 [1.00 point]
Which ONE of the following design characteristics is the reason for the decrease in reactivity following an increase in fuel temperature in a TRIGA reactor?

a. A hexagonal fuel matrix.

b. High fuel element reactivity worth.

c. A negative temperature coefficient.

d. A long delay time for transferring heat to the core cooling water.

QUESTION A.18 [1.00 point]
Which ONE of the following conditions would INCREASE the shutdown margin of a reactor?

a. Depletion of Uranium fuel.

b. Depletion of a burnable poison.

c. Insertion of an experiment adding positive reactivity.

d. Lowering moderator temperature if the moderator temperature coefficient is negative.

QUESTION A.19 [1.00 point]
Which ONE of the following parameter changes will require control rod INSERTION to maintain constant power level following the change?

a. Insertion of a void into the core.

b. Buildup of samarium in the core.

c. Increase in coolant water temperature.

d. Removal of an experiment containing cadmium.

QUESTION A.20 [1.00 point]
Which ONE of the following is accurate concerning control rod worth?

a. Doubling the poison content of a rod doubles its worth.

b. Rod worth increases as reactor coolant temperature increases.

c. Rod worth increases as reactor coolant temperature decreases.

d. A rod located in the edge of the core is worth more than one located near the center of the core.

(***** END OF SECTION A *****)

Section B: Normal/Emergency Procedures and Radiological Controls

QUESTION B.01 [1.00 point]
Which ONE of the following describes the entry requirements for an SRO when entering the facility in response to an emergency condition after normal working hours?

a. An SRO may enter the facility alone using a two-way radio and radiation detector if there is someone standing by outside of the facility to summon help if needed.

b. An SRO may enter the facility alone using protective clothing and self-reading dosimeter if there is indication that the LAN is receiving information.

c. An SRO must be accompanied by an RO when entering the facility after hours, each must use a pancake probe to conduct contamination surveys upon entry.

d. An SRO must be accompanied by an RO when entering the facility after hours, each must have a self-reading dosimeter and a pancake probe to conduct contamination surveys upon entry.

QUESTION B.02 [1.00 point]
Which ONE of the following occurrences would require immediate notification to the NRC?

a. TEDE of more than 10 rems

b. An eye dose equivalent of more than 50 rems

c. A shallow-dose equivalent to the skin or extremities of 250 rads or more.

d. Release of radioactive material, inside or outside of a restricted area, that could have led to an intake of 1 occupational ALI in a 24-hour period.

QUESTION B.03 [1.00 point]
Which ONE of the following is evaluated in the determination of the expected rod height prior to reactor startup?

a. Rod worth

b. Fuel burn up

c. Xenon buildup

d. Shut down margin

Section B: Normal/Emergency Procedures and Radiological Controls

QUESTION B.04 [1.00 point]
Which ONE of the following requires the reactor to be in standby condition?

a. Performing Core loading and unloading.

b. Performing repairs to beam port collimators.

c. Performing a hot swap at the fast neutron irradiator.

d. Performing reactivity checks in movable experiments.

QUESTION B.05 [1.00 point]
If during an intrusion, imminent danger to the facility or the occupants exist, the expected response is to:

a. Abandon the facility.

b. Deescalate the situation.

c. Secure all radioactive material.

d. Maintain surveillance of reactor.

QUESTION B.06 [1.00 point]
Which ONE of the following actions is NOT required to be performed by an SRO prior to entry into a hot cell?

a. Secure the hot cell floor storage cave plugs.

b. Verify that the cell interior is in a safe condition to enter.

c. Determine if Radiation Protection Office (RPO) personnel are required by the procedure / Radiation Work Permit (RWP).

d. Verify that the in-cell radiation monitoring equipment is functional (Source Check).

Section B: Normal/Emergency Procedures and Radiological Controls

QUESTION B.07 [1.00 point]
Which ONE of the following follow-up actions should be taken upon discovering contamination on a smear, in accordance with AOP-4?

a. Evacuate the Controlled Access Area (CAA).

b. Sweep up and dispose of any dirt piles in the contaminated area.

c. Re-survey the area using a different detector to verify that contamination is present.

d. Establish an exclusion boundary around the potentially contaminated area to prevent unnecessary entry.

QUESTION B.08 [1.00 point, 0.25 each]
Match the tag-out color in Column A with the corresponding description in Column B.

Column A	Column B
a. Red	1. Equipment tag-out to alert the operating staff to equipment operating limitations.
b. Yellow	2. Administrative tag-out to alert operating staff to temporary administratively imposed limitations on the reactor.
c. White with Danger Insignia	3. Do-not operate tag-out to assure the reactor is not operated if required systems are inoperable.
d. Manila	4. Energy isolating device tag-out to ensure that equipment is de-energized and isolated from all potentially hazardous energy sources, before individuals perform maintenance.

QUESTION B.09 [1.00 point]
Which ONE of the following actions is required by the duty SRO if a safety limit is exceeded?

a. Authorizing reactor restart.

b. Initiating the AP-4 event review.

c. Ensuring the completion of corrective actions.

d. Reporting the occurrence to the Chairman of the Safeguards Committee.

Section B: Normal/Emergency Procedures and Radiological Controls

QUESTION B.10 [1.00 point, 0.25 each]
Classify each of the following events as an Unusual Event (UE) or Alert.

a. Tornado warning for Centre county.

b. Fire within the neutron beam lab that has not been extinguished after 12 minutes.

c. Non-accidental security violation by an individual with authorized access to the PSBR.

d. Continual loss of reactor pool water at a rate exceeding the combined makeup capacity of all available refill systems

QUESTION B.11 [1.00 point, 0.25 each]
Fill in the blanks for the annual dose limits (Total Effective Dose Equivalent) for each category personnel listed below. Record answers in units of mrem/yr [100/500/1,000/5,000].

a. Escorted Radiation Worker _____

b. Escorted Non-Radiation Employee _____

c. NRC Examiner _____

d. Unescorted Radiation Worker _____

QUESTION B.12 [1.00 point]
Per PSBR Technical Specifications, the minimum number of radiation monitoring equipment required to be operable are:

a. 2 Area Radiation Monitors.

b. 1 Area Radiation Monitor + 1 Portable Radiation Monitor.

c. 1 Area Radiation Monitor + 1 Continuous Air Monitor.

d. 2 Continuous Air Monitors.

Section B: Normal/Emergency Procedures and Radiological Controls

QUESTION B.13 [1.00 point, 0.25 each]
Fill out the blanks with the Limiting Conditions of Operation (LCO) listed in the PSBR Technical Specifications.

Safety System Parameter	LCO
a. Excess reactivity	_____%Δk/k (3.9/4.9/5.9)
b. Shutdown Margin	_____%Δk/k (0.025/0.075/0.175)
c. Pool conductivity	_____microsiemens (1/3/5)
d. Maximum steady state power	_____MW (1.1/1.5/2.1)

QUESTION B.14 [1.00 point]
An irradiated sample provides a dose rate of 0.1 rem/hr at 5 ft. Approximately how far from the sample will the dose be 1 mrem/hr?

a. 25 ft

b. 50 ft

c. 75 ft

d. 100 ft

QUESTION B.15 [1.00 point]
As a licensed SRO, which ONE of the following conditions would violate 10 CFR 55.53, "Conditions of licenses.,"

a. Your last license renewal was 60 months ago.

b. Your last quarter shift operations total was 3 hours.

c. Your last medical examination was performed 15 months ago.

d. Your last requalification written examination was conducted 18 months ago.

Section B: Normal/Emergency Procedures and Radiological Controls

QUESTION B.16 [1.00 point, 0.25 each]
Identify each of the following as either a Safety Limit (SL), a Limiting Safety System Setting (LSSS) or a Limiting Condition for Operation (LCO).

a. The instrumented fuel element temperature, located in the maximum elemental power density (MEPD), shall not exceed 650°C.

b. The SCRAM time of any control rod from a full up position shall be less than 1 second.

c. The temperature in a water-cooled TRIGA fuel element shall not exceed 1150°C under any operating condition.

d. The rate of reactivity insertion associated with movement of either the regulating, shim, or safety control rod SHALL be NOT greater than 0.63% Δk/k per second when averaged over full rod travel.

QUESTION B.17 [1.00 point]
Which method for measuring experimental reactivity considers the changes in rod worth due to fuel burn up?

a. Bare Core Method.

b. Regulating Rod Method.

c. Difference in Critical Rod Position Method.

d. Differences of Excess Reactivities Method.

QUESTION B.18 [1.00 point]
Which ONE of the following activities requires an Radiation Work Permit?

a. Qualifying a new operating position.

b. Removal and disposal of the demineralizer resins.

c. Placing an encapsulated sample in the vertical tubes.

d. Performing a source check on the area radiation monitor.

Section B: Normal/Emergency Procedures and Radiological Controls

QUESTION B.19 [1.00 point]
Which ONE of the following surveillances is classified as a Channel Test?

a. Expose a detector to a check source to verify that it responds.

b. Verification of the log channel performance requirements by observation.

c. Compare the prestart readings of the radiation area monitors to the previous day readings.

d. Adjust of the wide range linear channel in accordance with recent data collected during a reactor power calibration.

QUESTION B.20 [1.00 point]
A radioactive source reads 45 mrem/hr on contact. Thirty minutes later, the same source reads 20 mrem/hr. Approximately how long will it take the source to decay from a reading of 45 mrem/hr to 5 mrem/hr?

a. 1.5 hours

b. 2 hours

c. 3 hours

d. 5 hours

(***** END OF SECTION B *****)

Section C: Facility and Radiation Monitoring Systems

QUESTION C.01 [1.00 point]
Which ONE of the following is NOT an airborne radiation source at the PSBR facility, capable of providing a dose to the public?

a. Fission products form fuel failure.

b. Ar-41 from neutron activation of air.

c. Tritium from evaporate pool water loss.

d. N-16 from neutron interaction with oxygen in pool water.

~~**QUESTION C.02 [1.00 point]**~~ **Deleted per facility comment**
~~Which ONE of the following is TRUE regarding personnel dosimeters used at the PSBR?~~

~~e. Thermoluminescent dosimeters (TLDs) a are currently used at the PSBR which when heated give of light characteristics of the radiation energy that was absorbed.~~

~~f. TLDs are currently used at the PSBR, which use selected frequencies of laser light causing luminescence in portion to the radiation exposure received.~~

~~g. Optically stimulated Luminescence (OSL) dosimeters are currently used at the PSBR, which when heated give of light characteristics of the radiation energy that was absorbed.~~

~~h. OSL dosimeters are currently used at the PSBR, which use selected frequencies of laser light causing luminescence in portion to the radiation exposure received.~~

QUESTION C.03 [1.00 point]
Which ONE of the following safety channels is NOT required for PULSE operations?

a. Fuel Temperature

b. Watch dog Circuit

c. Detector Power Supply

d. SCRAM Bar on Console

Section C: Facility and Radiation Monitoring Systems

QUESTION C.04 [1.00 point]
In accordance with PSBR Technical Specifications, which ONE of the following is a design feature credited for supplying water to the pool for leak protection?

a. Recycling water from the bay air conditioner.

b. Recycling water from the liquid waste evaporator system.

c. Diverting the heat exchanger secondary flow to the pool

d. Diverting water through the secondary system from the hold-up tank

QUESTION C.05 [1.00 point]
Which ONE of the flowing is for reducing Ar-41 in the pneumatic transfer system?

a. Bromine

b. Helium

c. Carbon dioxide

d. Hydrogen fluoride

QUESTION C.06 [1.00 point]
Applying air to the transient rod cylinder by depressing F9 (Apply Air to Transient Rod) PRIOR to moving the cylinder:

a. Prepares the transient rod for square wave operations.

b. Allows the transient rod to be used as an ordinary control rod.

c. Aligns the transient rod for bank position with the other control rods.

d. Disengages the connecting rod from the piston cylinder causing a pulse.

Section C: Facility and Radiation Monitoring Systems

QUESTION C.07 [1.00 point]
Which ONE of the following is NOT a basic design principle of reactor safety system (RSS)?

a. The RSS logic is designed to fail safe in loss of power.

b. The RSS is designed to provide all reactor protection, control and monitoring functions necessary for safe operations.

c. The RSS is separated from the PCMS through use of buffered devices and by physical separation to the extent possible within the console.

d. The RSS is completely hardwired and doesn't contain any software programmable devices with embedded microprocessors for signal processing or actuation functions.

QUESTION C.08 [1.00 point]
Which ONE of the following outputs is provided by the Wide Range Monitor?

a. Fuel temperature.

b. Pulse power output of 0 to 2000 MW.

c. Linear power output of 0 to 120 percent power.

d. Rate of change of reactor power (in decades per minute).

QUESTION C.09 [1.00 point]
Which ONE of the flowing conditions would initiate a stepback?

a. Pulse timer timed out.

b. Reactor bay truck door is open.

c. Square Wave Termination Request.

d. Radiation High from East Bay Monitor.

Section C: Facility and Radiation Monitoring Systems

QUESTION C.10 [1.00 point]
Irradiated fuel elements shall be stored in a geometrical array where k_{eff} is less than _____ for all conditions of moderation?

a. 1.1

b. 1.0

c. 0.9

d. 0.8

QUESTION C.11 [1.00 point, 0.25 each]
Match the experimental facility with the corresponding descriptions.

Column A	Column B
a. D2O Thermal column	1. Designed to accommodate large silicon wafers.
b. Vertical tubes	2. Optimize neutron beam intensity with beam port #4.
c. Fast Neutron Irradiator	3. Provides space for irradiation of samples at the point of maximum neutron flux.
d. Central Thimble	4. Used to irradiate experiments that cannot be submerged in water.

QUESTION C.12 [1.00 point, 0.25 each]
Match the control rod drive mechanism from Column A with the correct function in Column B.

Column A	Column B
a. Potentiometer	1. Switch will reverse position according to whether the magnet is at or above its completely depressed position.
b. Rod down limit switch	2. Switch reverses position according to whether the magnet is at or below its full up position.
c. Drive up limit switch	3. Foot is depressed by armature when rod is fully lowered.
d. Drive down limit switch	4. Provides rod position indication.

Section C: Facility and Radiation Monitoring Systems

QUESTION C.13 [1.00 point]
The transient rod is coupled to its drive via:

a. Electromagnets

b. Solenoid valve

c. Spring coupling

d. Mechanical latch

QUESTION C.14 [1.00 point]
Which ONE of the following is TRUE regarding ionizing chambers and proportional counters?

a. Fission fragments from U-235 produce large signal pulses.

b. A beta particle, regardless of its size, will cause a pulse equal to that of an alpha.

c. An alpha will expend little of its energy in the chamber and causes a small signal pulse.

d. A gamma ray will expend most of its energy in the chamber and causes a large signal pulse.

QUESTION C.15 [1.00 point]
Which ONE of the following will occur, if there is a failure of the detector power supply for the reactor safety system channels?

a. An automatic scram will prevent the operation of the reactor.

b. A diesel generator starts automatically allowing the continued operation of the reactor.

c. Rod withdrawal interlock will prevent manual withdrawal of any rod, until power is restored.

d. The watchdog circuit timer will begin and cause a SCRAM if the power is not restored before the timing interval ends.

Section C: Facility and Radiation Monitoring Systems

QUESTION C.16 [1.00 point]
Which ONE of the following is the fill gas used in the PSBR fission chamber?

a. CO_2

b. N-Ar

c. Ar-CO_2

d. B-10

QUESTION C.17 [1.00 point]
A source of a minimum _____ GPM shall be available to ensure that a supply of water is available to replenish the reactor pool in the event of pool water leakage.

a. 75

b. 100

c. 150

d. 200

QUESTION C.18 [1.00 point]
Which ONE of the following would occur if a control rod reaches an upper limit while in 2-Rod auto mode?

a. A DCC-X Rod Drive Interlock actuates.

b. A DCC-X SCRAM request will be sent to the RSS.

c. DCC-X will "SHIM" the other rods to even them out.

d. DCC-X will prohibit manual control of the regulating rod.

Section C: Facility and Radiation Monitoring Systems

QUESTION C.19 [1.00 point]
Which ONE of the following is TRUE regarding the PSBR control rods?

a. When the control rod piston is within 2 inches of the bottom of the control rod barrel, its movement is restrained by the dashpot action to reduce bottoming impact when the control rod is scrammed.

b. The magnetic rod coupler serves a mechanical stop to limit the downward travel of the control rod assembly.

c. The control rod is inserted into the core by the rotation of the motor pinion shaft when an electromagnet is energized.

d. A spring-loaded pull rod extends vertically through the control rod assembly housing, which stops the rod drive motor at the top and bottom of travel.

QUESTION C.20 [1.00 point]
Which ONE of the following can be used if the Hot Cell ex-cell fixed area monitors are out for calibration or repair?

a. A Frisker.

b. A portable ion chamber.

c. A self-reading dosimeter.

d. An audible dose rate meter.

(***** END OF SECTION C *****)
(***** END OF EXAM *****)

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

A.01
Answer: b
Reference: DOE Fundamentals of Reactor Theory, Volume 2, NP-03 pg. 3

A.02
Answer: b
Reference: DOE Fundamentals of Reactor Theory, Volume 2, NP-03 pg. 18

A.03
Answer: c
Reference: DOE Fundamentals of Reactor Theory, Volume 2, NP-03 pg. 24

A.04
Answer: d
Reference: DOE Fundamentals of Reactor Theory, Volume 2, NP-03 pg. 35

A.05
Answer: c
Reference: DOE Fundamentals of Reactor Theory, Volume 2, NP-04 pg. 11

A.06
Answer: c
Reference: DOE Fundamentals of Reactor Theory, Volume 2, NP-04 pg. 15

A.07
Answer: a
Reference: DOE Fundamentals of Reactor Theory, Volume 2, NP-04 pg. 30

A.08
Answer: b
Reference: $P = P_0 e^{t/T}$

$DT = t(\ln 2)$

$P = P_0 2^{t/DT} = 5 * 2^{60/45} \approx 1.25\ MW$

A.09
Answer: (a) 2; (b) 1; (c) 3; (d) 4
Reference: DOE Fundamentals of Reactor Theory, Volume 2, NP-03 pg.15

A.10
Answer: ~~c~~ b Changed per facility comment
Reference: T = DT/ln(2) = 68 seconds/0.693 = 98.124 ≈98 seconds

A.11
Answer: a
Reference: Burn, *Introduction of Nuclear Reactor Operations*, Sec 3.3.1, pg. 3-16

A.12
Answer: b

Reference: DOE Fundamentals Handbook of Reactor Theory, Volume 2, NP-04 4, pg. 1-9

Answer: d
Reference: DOE Fundamentals of Reactor Theory, Volume 1, NP-02, pg. 31

A.13
Answer: a
Reference: Burn, *Introduction to Nuclear Reactor Operations,* Section 3.3.2, pg. 3-18

A.14 [1.0 point]
Answer: c
Reference: $CR_1/CR_2 = (1 - K_{eff2})/(1 - K_{eff1})$

Solve for K_{eff2}, $\frac{100}{55} = \frac{1-K_{eff2}}{1-0.95}$; therefore $K_{eff2} = 0.91$

$$\Delta\rho = \frac{(K_{eff2} - K_{eff1})}{K_{eff2}K_{eff1}} = \frac{(0.91 - 0.95)}{(0.91)(0.95)} = -0.046$$

A.15
Answer: b

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

Solving for t, $t = T \ln \frac{P}{P_0} = 151 \ln\left(\frac{5{,}000}{5}\right) = 1043\ s = 17.4\ minutes$

A.16
Answer: b
Reference: Burn, *Introduction to Nuclear Reactor Operations,* Section 2.4, pg. 2-28

A.17
Answer: c
Reference: DOE Fundamentals of Reactor Theory, Volume 2, NP-03 pg. 21

A.18
Answer: a
Reference: DOE Fundamentals of Reactor Theory, Volume 2, NP-04 pg. 28

A.19
Answer: d
Reference: DOE Fundamentals of Reactor Theory, Volume 2, NP-04 pgs. 30-31

A.20
Answer: b
Reference: DOE Fundamentals of Reactor Theory, Volume 2, NP-03 pgs. 50-53

Section B: Normal/Emergency Procedures and Radiological Controls

B.01
Answer: a
Reference: PSBR EP-1, Revision 8, pg. 5-6

B.02

Answer: c
Reference: PSBR Training Manual, Chapter 6, pg. 11

B.03
Answer: c
Reference: PSBR SOP 1, Rev. 24, pg.8

B.04

Answer: a
Reference: PSBR SOP 3, Rev. 8, pg. 1

B.05
Answer: a
Reference: PSBR EP-11, Rev 7, pg. 3

B.06
Answer: a
Reference: PSBR AOP 1, Rev. 5, pg. 4

B.07

Answer: d
Reference: PSBR AOP 4, Rev. 10, pg. 2

B.08
Answer: (a) 3; (b) 2; (c) 4; (d) 1
Reference: PSBR AP 10, Rev. 6, pgs. 1-3

B.09
Answer: b
Reference: PSBR AP-4, Rev. 6, pg. 2

B.10
Answer: (a) UE; (b) UE; (c) UE; (d) Alert
Reference: PSBR EP-1, Rev. 18, pgs. 14-15

B.11
Answer: (a) 5,000 mrem/yr; (b) 100 mrem/yr; (c) 100 mrem/yr; (d) 5,000 mrem/yr
Reference: PSBR AP-8, Rev. 8, pgs.4-5

B.12
Answer: ~~b~~ c Changed per facility comment.
Reference: PSBR TS 3.6

B.13
Answer: (a) 4.9; (b) 0.175; (c) 5; (d) 1.1
Reference: PSBR TS 3.1.1, 3.1.2, 3.1.3, 3.3.5

B.14
Answer: b
Reference: $DR_1(d_1)^2 = DR_2(d_2)^2$

$100\ mrem(5ft)^2 = 1mremd^2$

$d = 50ft$

B.15
Answer: b
Reference: 10 CFR 55, "Operators' Licenses"

B.16
Answer: (a) LSSS; (b) LCO; (c) SL; (d) LCO
Reference: PSBR TS 2.2, 2.2, 3.0

B.17
Answer: c
Reference: PSBR SOP 5, Rev. 6, pg. 8

B.18
Answer: c a or b Changed per facility comment.
Reference: AOP-8, Rev. 14, pg. 6

B.19
Answer: a
Reference: PSBR TS 1.1

B.20

Answer: a
Reference: $DR = DR_0 e^{-\lambda t}$

$20 = 45e^{-\lambda(0.5)};\ ln\frac{20}{45} = -\lambda(0.5);\ \lambda = 1.62186$

Solve for t; $ln\frac{5}{45} = -1.62186t; t = 1.35\ hrs$

Section C: Facility and Radiation Monitoring Systems

C.01
Answer: d
Reference: PBSR SAR Chapter 11.1.1, pgs. XI-1 through 2

~~**C.02**~~ Deleted per facility comment
~~Answer: d~~
~~Reference: PSBR Training Manual, Chapter 6, pg. 10~~

C.03
Answer: c
Reference: PSBR TS, Table 2a, pg. 19

C.04
Answer: c
Reference: PSBR TS 3.3.4

C.05
Answer: c
Reference: PSBR SAR Chapter 10.2.6, pg. X-9, dated 11/30/05

C.06
Answer: b
Reference: PSBR Training Manual, Chapter 4.2.11.2, pg. 67

C.07
Answer: b
Reference: PSBR SAR, Chapter 7.2.1, pg. VII-4

C.08
Answer: d
Reference: PSBR Training Manual, Chapter 4.2.6, pg. 37

C.09
Answer: ~~c~~ b Per facility comments
Reference: PSBR SAR, Chapter 7.3.1.2, pg. VII-15

C.10
Answer: d
Reference: PSBR SAR Chapter 9.2, pg IX-1

C.11
Answer: (a) 2; (b) 4; (c) 1; (d) 3
Reference: PSBR SAR Chapter 10 pgs. X-6 through X-8

C.12
Answer: a (4); b (3); c (2); d (1)
Reference: PSBR Training Manual Chapter 4.2.11 pgs. 61-67

C.13
Answer: b
Reference: PSBR SAR Chapter 7.4, pg. VII-18

Section C: Facility and Radiation Monitoring Systems

C.14
Answer: a
Reference: PBSR Training Manual, Chapter 4.1.3, pg. 8

C.15
Answer: a
Reference: SAR Chapter 7.4.2, pg. VII-19

C.16
Answer: b
Reference: PBSR Training Manual, Chapter 4.1.14, pg. 25

C.17
Answer: b
Reference: PSBR TS 3.3.4, pg. 24

C.18
Answer: c
Reference: PSBR Training Manual, Chapter 4.2.9.1a, pg. 46

C.19
Answer: a
Reference: PSBR Training Manual, Chapter 4.2.11.1 pgs. 61-63

C.20
Answer: b
Reference: PSBR AOP-1, pg. 6

SUBJECT: EXAMINATION REPORT NO. 50-005/OL-19-02, THE PENNSYLVANIA STATE UNIVERSITY BREAZEALE RESEARCH REACTOR DATED SEPTEMBER 5, 2019.

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