September 2, 2014

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

SUBJECT: EXAMINATION REPORT NO. 50-005/OL-14-01, PENNSYLVANIA STATE UNIVERSITY BREAZEALE RESEARCH REACTOR

Dear Dr. Unlu:

During the week of August 11, 2014, the U.S. Nuclear Regulatory Commission (NRC) administered operator licensing examinations at your Pennsylvania State University Breazeale Research Reactor. The examination was 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 Phillip T. Young at (301) 415-4094 or via internet e-mail Phillip.Young@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. 50-005

Enclosures:
1. Examination Report No. 50-005/OL-14-01

cc without enclosures: see next page

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OFFICE	DPR/PROB	DIRS/IOLB	DPR/PROB
NAME	PYoung	CRevelle	KHsueh
DATE	8/19/2014	8/28/2014	9/02/2014

OFFICIAL RECORD COPY

cc:

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Breazeale Nuclear Reactor
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University Park, PA 16802-1504

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

REPORT NO.: 50-005/OL-14-01

FACILITY DOCKET NO.: 50-005

FACILITY LICENSE NO.: R-2

FACILITY: Pennsylvania State University Breazeale Reactor

SUBMITTED BY: **/RA/** 8/28/2014
Phillip T. Young, Chief Examiner Date

SUMMARY:

During the week of August 11, 2014, the NRC administered license examinations to three Senior Reactor Operator license candidates. The applicant passed all portions of the examination.

REPORT DETAILS

1. Examiner: Phillip T. Young, Chief Examiner

2. Results:

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

3. Exit Meeting

. Phillip T. Young, NRC Examiner
Dr. Kenan Unlu, Director
Mark A. Trump, Associate Director for Operations

The examiner thanked the facility for their cooperation during the administration of the examinations and acknowledged that they had no comments on the written examination.

ENCLOSURE 1

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

FACILITY: Pennsylvania State University Breazeale Reactor

REACTOR TYPE: POOL TYPE, MODIFIED TRIGA DATE

ADMINISTERED: 8/12/2014

CANDIDATE: _____

INSTRUCTIONS TO CANDIDATE:
Answers are to be written on the answer sheet provided. Attach the answer sheets to the examination. Points for each question are indicated in brackets for each question. A 70% in each section is required to pass the examination. Examinations will be picked up three (3) hours after the examination starts.

Category Value	% of Total	% of Candidates Score	Category Value	Category
20.00	33.3	_____	____	A. Reactor Theory, Thermodynamics and Facility Operating Characteristics
20.00	33.3	_____	____	B. Normal and Emergency Operating Procedures and Radiological Controls
20.00	33.3	_____	____	C. Facility and Radiation Monitoring Systems
60.00		_____	____%	TOTALS
			FINAL GRADE	

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 you 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.

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

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

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

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

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

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

$$M = \frac{1 - K_{eff_0}}{1 - K_{eff_1}}$$

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

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

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

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

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

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

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

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

$$T_{‰} = \frac{0.693}{\lambda}$$

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

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

$$DR = \frac{6CiE(n)}{R^2}$$

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

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

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

1 Curie = 3.7×10^{10} dis/sec

1 Horsepower = 2.54×10^3 BTU/hr

1 BTU = 778 ft-lbf

1 gal (H_2O) ≈ 8 lbm

c_P = 1.0 BTU/hr/lbm/°F

1 kg = 2.21 lbm

1 Mw = 3.41×10^6 BTU/hr

°F = 9/5 °C + 32

°C = 5/9 (°F - 32)

c_p = 1 cal/sec/gm/°C

Section A Reactor Theory, Thermo, and Facility Characteristics

Question A.001 (1.0 point) {1.0}

Which ONE of the following is true concerning the differences between prompt and delayed neutrons?

a. Prompt neutrons account for less than one percent of the neutron population while delayed neutrons account for approximately ninety-nine percent of the neutron population

b. Prompt neutrons are released during fast fissions while delayed neutrons are released during thermal fissions

c. Prompt neutrons are released during the fission process while delayed neutrons are released during the decay of fission products

d. Prompt neutrons are the dominating factor in determining the reactor period while delayed neutrons have little effect on the reactor period

Answer: A.01 c.
REF: Reactor Training Manual, Page 2-16.

Question A.002 (1.0 point) {1.0}

In accordance with the PSBR Technical Specifications, the term "Shutdown Margin" describes:

a. the time required for the rods to fully insert

b. the departure from K-effective = 1.00

c. the amount of subcriticality, considering the worth of all rods

d. the amount of subcriticality with the most reactive rod fully withdrawn

Answer: A.02 d.
REF: PSBR Technical Specifications, Section 1.1.42.

Section A Reactor Theory, Thermo, and Facility Characteristics

Question A.003 (1.0 point) {3.0}

Experimenters are attempting to determine the critical mass of a new fuel material. As more fuel was added the following fuel to count rate data was taken:

Fuel	Counts/Sec
1.00 kg	500
1.50 kg	800
2.00 kg	1142
2.25 kg	1330
2.50 kg	4000
2.75 kg	15875

Which one of the following is the amount of fuel needed for a critical mass?

a. 2.60 kg

b. 2.75 kg

c 2.80 kg

d. 2.95 kg

Answer: A.03 c.
REF: Glasstone, S. and Sesonske, A, Nuclear Reactor Engineering, Kreiger Publishing, Malabar, Florida, 1991, §§ 3.161 — 3.163, pp. 190 & 191.

Question A.004 (1.0 point) {4.0}

The reactor has scrammed following an extended period of operation at full power. Which one of the following accounts for a majority of the heat generated one (1) hour after the scram?

a. Spontaneous fissions

b. Delayed neutron fissions

c. Alpha fission product decay

d. Beta fission product decay

Answer: A.04 d.
REF: Burn, R., Introduction to Nuclear Reactor Operations, © 1988 pg. 3-4.

Section A Reactor Theory, Thermo, and Facility Characteristics

Question A.005 (1.0 point) {5.0}
A factor in the six-factor formula which is most affected by control rod position is:

a. Resonance escape probability
b. Fast fission factor
c. Neutron reproduction factor
d. Thermal utilization factor

Answer: A.05 d.
REF: Reactor Training Manual - *Fission Process*

Question A.006 (1.0 point) {6.0}
Coolant flows through a reactor core at a rate of 50 GPM, resulting in a coolant temperature increase of 6 degrees F. The power of the reactor is:

a. 5.3 kW.
b. 14.7 kW.
c. 44.0 kW.
d. 329.1 kW.

Answer: A.06 c.
REF: Power = (Mass flow rate)(Specific heat)(temperature increase)
Power = (50 GPM)(8.34 lbs/gallon)(1 Btu/lb-deg F)(6 deg F)(60 min/hour) Power = (150,120 Btu/hour)(1 kW/3413 Btu/hour) = 44.0 kW

Question A.007 (1.0 point) {7.0}
A reactor scram has resulted in the instantaneous insertion of .006 ΔK/K of negative reactivity. Which one of the following is the stable negative reactor period resulting from the scram?

a. 45 seconds
b. 56 seconds
c. 80 seconds
d. 112 seconds

Answer: A.07 c.
REF: Burn, R., Introduction to Nuclear Reactor Operations, © 1982, § 4.6, p. 4-16.

Section A Reactor Theory, Thermo, and Facility Characteristics

Question A.008 (1.0 point) {8.0}
The count rate is 50 cps. An experimenter inserts an experiment into the core, and the count rate decreases to 25 cps. Given the initial K_{eff} of the reactor was 0.8, what is the worth of the experiment?

a. $\Delta\rho$ = - 0.42
b. $\Delta\rho$ = + 0.42
c. $\Delta\rho$ = - 0.21
d. $\Delta\rho$ = + 0.21

Answer: A.08 a.
REF: $CR_1 / CR_2 = (1 - Keff_2) / (1 - Keff_1) \rightarrow 50 / 25 = (1 - Keff_2) / (1 - 0.8)$
Therefore $Keff_2 = 0.6$ $\Delta\rho = Keff_2 - Keff_1 / Keff_2 \cdot Keff_1 = (0.6 - 0.8)/(0.6 \cdot 0.8) = - 0.41667$

Question A.009 (1.0 point) {9.0}
A reactor startup is in progress. Each control rod withdrawal is inserting exactly EQUAL amounts of reactivity. Select the EXPECTED neutron population and count rate response as "Keff" approaches 1.0.

The change in neutron population per reactivity insertion is:

a. SMALLER, and it takes LESS time to reach a new equilibrium count rate
b. LARGER, and it takes LESS time to reach a new equilibrium count rate.
c. SMALLER, and it takes MORE time to reach a new equilibrium count rate.
d. LARGER, and it takes MORE time to reach a new equilibrium count rate.

Answer: A.09 d.
REF: Reactor Training Manual - *Introduction To Nuclear Physics*

Question A.010 (1.0 point) {10.0}
As primary coolant temperature increases, control rod worth:

a. decreases due to lower reflector efficiency.
b. decreases due to higher neutron absorption in the moderator.
c. increases due to the increase in thermal diffusion length.
d. remains the same due to constant poison cross-section of the control rods..

Answer: A.10 c.
REF: Reactor Training Manual - *Reactivity Feedback*

Section A Reactor Theory, Thermo, and Facility Characteristics

Question A.011 (1.0 point) {11.0}

A reactor has been operating at full power for one week when a scram occurs. Twelve hours later, the reactor is brought critical and quickly raised to full power. Considering xenon effects only, to maintain a constant power level for the next few hours, control rods must be:

a. inserted

b. maintained at the present position

c. withdrawn

d. withdrawn, then inserted to the original position

Answer: A.11 a.
REF: PSBR Training Manual, Pages 2-28 through 2-32

Question A.012 (1.0 point) {12.0}

Which ONE of the following describes the difference between reflectors and moderators?

a. Reflectors decrease core leakage while moderators thermalize neutrons

b. Reflectors shield against neutrons while moderators decrease core leakage

c. Reflectors decrease thermal leakage while moderators decrease fast leakage

d. Reflectors thermalize neutrons while moderators decrease core leakage

Answer: A.12 a
REF: Introduction to Nuclear Reactor Operations, Reed Robert Brown, Section 5.4

Question A.013 (1.0 point) {13.0}

Which ONE of the following statements describes the difference between Differential and Integral (IRW) rod worth curves?

a. DRW relates the worth of the rod per increment of movement to rod position. IRW relates the total reactivity added by the rod to the rod position.

b. DRW relates the time rate of reactivity change to rod position. IRW relates the total reactivity in the core to the time rate of reactivity change.

c. IRW relates the worth of the rod per increment of movement to rod position. DRW relates the total reactivity added by the rod to the rod position.

d. IRW is the slope of the DRW at a given rod position

Answer: A.13 a.
REF: Standard NRC Question

Section A Reactor Theory, Thermo, and Facility Characteristics

Question A.014 (1.0 point) {14.0}

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.

Answer: A.14 c.
REF: $P = P_0\ e^{t/\tau}$ $\tau = 60/\ln(P/P_0)$ $\tau = 60/\ln(195/100) = 60/\ln(1.95) = 89.84$ - 90 sec.

Question A.015 (1.0 point) {15.0}

The Fast Fission Factor (ε) is defined as "The ratio of the number of neutrons produced by …

a. fast fission to the number produced by thermal fission.

b. thermal fission to the number produced by fast fission.

c. fast and thermal fission to the number produced by thermal fission.

d. fast fission to the number produced by fast and thermal fission.

Answer: A.15 c.
REF: Reactor Training Manual - *Neutron Life Cycle*

Question A.016 (1.0 point) {16.0}

The amount of radioactivity in any material can be determined by:

a. Measuring the dose coming from it using an accurate radiation detector.

b. Taking the results of a. above and multiplying by (4 x pi) to account for geometry.

c. Measuring the total number of radioactive emissions given off over time.

d. First figure out c. above, then multiply the results by the correct quality factor.

Answer: A.16 c.
REF: Glasstone, 1958, CHAP 5, LAMARSH, 1983, CHAP 2.8

Section A Reactor Theory, Thermo, and Facility Characteristics

Question A.017 (1.0 point) {17.0}

A reactor operator understands that:

a. The more neutrons multiply during startup the lower the shim blades are at critical.

b. There is no fixed relationship between neutron level and criticality.

c. Neutron multiplication during startup is just neutrons getting lost at a slower rate.

d. Without the Sb-Be source the reactor would not go critical.

Answer: A.17 b.
REF: Glasstone, 1958, CHAP 14

Question A.018 (1.0 point) {18.0}

Given the lowest of the high power scrams is 110%, and the scram delay time is 0.5 sec. If the reactor is operating at 100% power prior to the scram, approximately how high will reactor power get with a positive 20 second period?

a. 113%

b. 116%

c. 124%

d. 225%

Answer: A.18 a.
REF: $P = P_0\, e^{t/\tau}$ $P_o = 110\%$ $\tau = 20$ sec. $t = 0.5$ $P = 110\, e^{0.5/20} = 112.78\%$

Question A.019 (1.0 point) {19.0}

Which ONE of the following is NOT a major contributor to the prompt negative temperature coefficient at the Penn State TRIGA reactor?

a. the U-235 doppler effect

b. the U-238 doppler effect

c. the ZrH cell effect

d. the core leakage effect

Answer: A.19 a.
REF: PSBR Training Manual

Section A Reactor Theory, Thermo, and Facility Characteristics

Question A.020 (1.0 point) {20.0}

Given: Primary coolant flow rate is 500 gallons/minute and secondary flow rate is 700 gallons/minute. The ΔT across the primary side of the heat exchanger is 13□F and secondary inlet temperature to the heat exchanger is 73□F. Assuming both the primary and secondary coolants have the same Cp value, which ONE of the following is the secondary outlet temperature?

a. 82□ F
b. 85□ F
c. 89□ F
d. 91□ F

Answer: A.20 a.

REF: $\Delta T_{sec} = (Flow_{pri}/Flow_{sec}) \times \Delta T_{pri}$ $\Delta T_{sec} = (500/700) \times 13 \text{ F} = 9.28 \text{ F}$

Secondary outlet = 73 F + 9.28 F = 82.3 F

Section B Normal/Emergency Procedures & Radiological Controls

Question B.001 (1.0 point) {1.0}
An accessible area within the facility has general radiation levels of 325 mrem/hour. What would be the EXPECTED posting for this area?

a. "Caution, Very High Radiation Area"
b. "Danger, Airborne Radioactivity Area"
c. "Danger, High Radiation Area"
d. "Caution, Radiation Area"

Answer: B.01 c.
REF: 10CFR20

Question B.002 (1.0 point) {2.0}
While working on an experiment, you receive the following radiation doses: 100 mrem (β), 25 mrem (γ), and 5 mrem (**thermal** neutrons). Which ONE of the following is your total dose?

a. 175 mrem
b. 155 mrem
c. 145 mrem
d. 135 mrem

Answer: B.02 d.
REF: Reactor Training Manual - *Ionizing Radiation*

Question B.003 (1.0 point, ¼ each) {3.0}
Match type of radiation (1 thru 4) with the proper penetrating power (a thru d)

a.	Gamma	1.	Stopped by thin sheet of paper
b.	Beta	2.	Stopped by thin sheet of metal
c.	Alpha	3.	Best shielded by light material
d.	Neutron	4.	Best shielded by dense material

Answer: B.03 a. = 4; b. = 2; c. = 1; d. = 3
REF: Reactor Training Manual - *Health Physics*

Section B Normal/Emergency Procedures & Radiological Controls

Question B.004 (1.0 point, ¼ each) {4.0}

10CFR50.54(x) states: *"A licensee may take reasonable action that departs from a license condition or a technical specification (contained in a license issued under this part) in an emergency when this action is immediately needed to protect the public health and safety and no action consistent with license conditions and technical specifications that can provide adequate or equivalent protection is immediately apparent."* Per 10CFR50.54(y), which one of the following is the minimum level of authorization for this action?

a. Reactor Operator licensed at the facility.

b. Senior Reactor Operator licensed at the facility.

c. Facility Manager (or equivalent at facility).

d. The U.S. Nuclear Regulatory Commission Project Manager

Answer: B.04 b.
REF: 10CFR50.54(y).

Question B.005 (1.0 point) {5.0}

In accordance with the Technical Specifications, which ONE situation below is NOT permissible when the reactor is operating?

a. scram time of a control rod = >1 second

b. depth of water above the top of the bottom grid plate = 18 feet

c. conductivity of bulk pool water = 5 micromhos/cm

d. reactivity insertion by a control rod = 0.12% delta k/k

Answer: B.05 a.
REF: Technical Specifications, Section 3.2.6

Question B.006 (1.0 point) {6.0}

"The maximum power level shall be no greater than 1.1 MW." This is an example of a:

a. safety limit.

b. limiting safety system setting.

c. limiting condition for operation.

d. surveillance requirement.

Answer: B.06 c.
REF: TS 3.1.1

Section B Normal/Emergency Procedures & Radiological Controls

Question B.007 (1.0 point) {7.0}
Which one of the following statements defines the Technical Specifications term "Channel Test?"

a. The adjustment of a channel such that its output corresponds with acceptable accuracy to known values of the parameter which the channel measures.

b. The qualitative verification of acceptable performance by observation of channel behavior .

c. The introduction of a signal into a channel for verification of the operability of the channel.

d. The combination of sensors, electronic circuits and output devices connected to measure and display the value of a parameter

Answer: B.07 c.
REF: TS 1.1.6

Question B.008 (1.0 point) {7.0}
As permitted by 10 CFR 50.59, the PSBR may:

a. Modify systems and change the Technical Specifications (TS) if the NRC is notified afterwards.

b. Perform new and little understood experiments when they are for research.

c. Determine the effects of modifications and their impact on TS.

d. Redefine the boundaries of accidents previously analyzed in the Safety Analysis Report (SAR).

Answer: B.08 c.
REF: 10 CFR 50.59

Question B.009 (1.0 point) {9.0}
A small radioactive source is to be stored in an accessible area of the reactor building. The source reads 2 R/hr at 1 foot. Assuming no shielding is to be used, a Radiation Area barrier would have to be erected from the source at least a distance of approximately:

a. 400 feet

b. 40 feet

c. 20 feet

d. 10 feet

Answer: B.09 c.
REF: $DR_1D_1^2 = DR_2D_2^2$

Section B Normal/Emergency Procedures & Radiological Controls

Question B.010 (1.0 point) {10.0}
Which ONE of the following would be classified as an OPERATIONAL EVENT?

a. Operation in violation of a safety limit.
b. Release of fission products from a fuel element.
c. Unanticipated reactivity change greater than $1.00 .
d. Reactor scram.

Answer: B.10 d.
REF: AP-4 C.1.a

Question B.011 (1.0 point) {11.0}
Which of the following is the most correct statement regarding the use of the **X-SCRAM Bypass (F1)**?

a. Performing Wide Range Monitor Checks in accordance with SOP-2 does not require express Facility Director's approval.

b. Each time X-Scram Bypass (F1) is to be used, the Reactor Operator must have the express Facility Director's approval.

c. If you are performing a CCP with the reactor at power which requires X-Scram Bypass (F1), the Reactor Operator must have the express Facility Director's approval before proceeding.

d. If you are handling highly radioactive samples by the pool deck during reactor power operations, X-Scram Bypass (F1) may be authorized by the Facility Director for up to 1 minute in order to preclude an inadvertent scram from an evacuation signal.

Answer: B.11 a
REF: PSBR SOP-1, Rev. 18

Question B.012 (1.0 point) {12.0}

A radioactive source generates a dose of 100 mr/hr at a distance of 10 feet. Using a two inch thick sheet of lead for shielding the reading drops to 50 mr/hr at a distance of 10 feet. What is the minimum number of sheets of the same lead shielding needed to drop the reading to less than 5 mr/hr at a distance of 10 feet?

a. 1

b. 3

c. 5

d. 7

Answer: B.12 c.
REF: Two inches = one-half thickness (T½). Using 5 half-thickness will drop the dose by a factor of $(½)^5$ = 1/32 100/32 = 3.13

Question B.013 (1.0 point) {13.0}

Which one of the following is the 10 CFR 20 definition of TOTAL EFFECTIVE DOSE EQUIVALENT (TEDE)?

a. The sum of the deep dose equivalent and the committed effective dose equivalent.

b. The dose that your whole body receives from sources outside the body.

c. The sum of the external deep dose and the organ dose.

d. The dose to a specific organ or tissue resulting from an intake of radioactive material

Answer: B.13 a.
REF: 10 CFR 20.1003 Definitions

Question B.014 (1.0 point) {14.0}

You have not performed the functions of an RO or SRO in the past 6 months. Per the Regulations, prior to resuming activities authorized by your license, how many hours must you complete in that function under the direction of an RO or SRO as appropriate?

a. 4

b. 6

c. 12

d. 40

Answer: B.14 b.
REF: 10CFR55.53(f)(2))

Section B Normal/Emergency Procedures & Radiological Controls

Question B.015 (1.0 point) {15.0}

Which ONE of the following is NOT true for reactor power calibration?

a. The objective is to verify the performance and operability of the power measuring channel.

b. The thermal power level channel calibration will assure that the reactor is to be operated at or below the licensed power levels.

c. The thermal power channel calibration shall be made on the linear power level monitoring channel biennially, not to exceed 30 months.

d. The percent power level monitor of the Power Range channel shall be used as the official indication to verify that the reactor is operated at or below the authorized power level.

Answer: B.15 d.
REF: T.S. 4.1.1 and SOP-1, II.j

Question B.016 (1.0 point) {16.0}

Which ONE of the following are the potential sources of airborne radioactive material release at the PSBR.

a. A loss of coolant accident, and the reactivity insertion accident.

b. A loss of coolant accident, and a rupture of one or more fuel elements.

c. The reactivity insertion accident, and leakage or rupture of an irradiated sample or experimental apparatus.

d. A rupture of one or more fuel elements, and leakage or rupture of an irradiated sample or experimental apparatus.

Answer: B.16 d.
REF: EP-5 V.c.1

Question B.017 (1.0 point) {17.0}

Which one of the following terms matches the definition of “The reactor building and all connected structures” ?

a. Emergency Planning Zone (EPZ).

b. Reactor Site Boundary.

c. Restricted Area.

d. Site Geographical Area.

Answer: B.17 a.
REF: EP-1, Definitions

Question B.018 (1.0 point) {18.0}

In the event of a bomb threat, the person receiving the threat should...

a. ask the person making the threat for his name and address.

b. call 911 after the call has ended.

c. immediately activate the Emergency Plan.

d. immediately evacuate the reactor building and proceed to the facility gate.

Answer: B.18 a.
REF: PSBR EP-8

Question B.019 (1.0 point) {19.0}

A release of airborne radioactive material where a person at the reactor site boundary is expected to receive a deep dose equivalent of 15 mrem over a 24 hour period is classified as:

a. Unusual Event

b. Alert

c. Site Area Emergency

d. General Emergency

Answer: B.19 a.
REF: EP-5 Section D.3

Question B.020 (1.0 point) {20.0}

In the event of an emergency involving an emergency evacuation, the Duty RO is responsible to:

a. be a member of the re-entry team and reporting to the Emergency Director.

b. be the acting Emergency Director until relieved by higher levels of facility management.

c. admit appropriate emergency support personnel to the facility to mitigate the consequences of the emergency.

d. open and take charge of the Emergency Support Center, distributing emergency equipment to appropriate support personnel.

Answer: B.20 a.
REF: EP-1.B.4

Section C Facility and Radiation Monitoring Systems

Question C.001 (1.0 point) {1.0}
Which ONE of the following is a condition under which air can be applied to the cylinder of the transient rod on the DCC-X?

a. Pulse mode and initial power up to 100 kw.
b. Transient rod drive is at the bottom end of travel position.
c. Square wave mode and initial power greater than 1 kw.
d. The counter clockwise limit switch is closed.

Answer: C.01 b.
REF: PSBR Training Manual, page 4-45.

Question C.002 (1.0 point) {2.0}
The Emergency Exhaust System is activated when:

a. the facility exhaust system is secured
b. the reactor bay has a positive pressure with respect to the atmosphere
c. a building evacuation is initiated
d. the pressure drop across the facility exhaust system filters doubles

Answer: C.02 c.
REF: PSBR Training Manual, Section 5-3-4

Question C.003 (1.0 point) {3.0}
Which one of the following is true for ALL control rods (i.e., the safety, the shim, the regulating and the transient rods)

a. A stroke of about 15 inches.
b. A length of about 43 inches.
c. A fuel follower of about 15 inches.
d. They contain graphite reflector sections.

Answer: C.03 a.
Reference: PSBR Training Manual, Section 3.5

Question C.004 (1.0 point) {4.0}

SCRAM logic is designed to meet the single failure criterion. Which one pair of parameters below are in the correct circuits?

	Scram Circuit #1	Scram Circuit #2
a.	Fuel temperature High	Fission Chamber Power High
b.	Manual Scram	Pulse Timer Scram
c.	Pulse Timer Scram	GIC Power High
d.	Keyswitch Off	Fuel Temperature High

Answer: C.04 c.
REF: PSBR Training Manual, Section 4.2.10.2

Question C.005 (1.0 point) {5.0}

Which one of the following is true for the rod drive interlocks?

a. The rod drive interlock logic is fail safe on loss of power since power is not required for the motor controller digital inputs to perform the inhibit function.

b. The rod drive pushbuttons provide normally closed contacts for interlock functions and normally open contacts for inputs to DCC-X.

c. The interlock validation in RSS and the use of redundant software interlocks for the demand velocity signal provide a diverse control rod withdrawal interlock.

d. If more than one rod pushbutton is pressed at one time, the logic blocks manual withdrawal of the last selected rod or rods and all rods in the automatic mode of control.

Answer: C.05 b.
REF: PSBR Training Manual, Section 4.20.7.2c

Question C.006 (1.0 point) {6.0}

When the ventilation system is in the emergency exhaust mode _____ .

a. air outside of the PSBR facility is pulled into the emergency exhaust system through a screened opening in the east wall of the reactor bay to dilute the filtered air that is ultimately released through the 18" PVC Emergency Exhaust Stack which terminates above the main Reactor Bay roof.

b. air outside of the PSBR facility is pulled into the emergency exhaust system and a DCC-X message "Emerg Ventilation Flow On" can be observed by the Reactor Operator which is the most positive indication that the system has flow.

c. filtered air is recirculated in the reactor bay to prevent the potential release of fission products to the environment.

d. filtered air is ultimately released through the 18" PVC Emergency Exhaust Stack which terminates above the main Reactor Bay roof.

Answer: C.06 d.
Reference: PSBR Training Manual, Chapter 5.3.4.3

Question C.007 (1.0 point) {7.0}

Which one of the following initiates a reactor operation inhibit by DCC-X?

a. Emergency exhaust system operating.

b. Reactor pool level below normal.

c. Radiation hazard from the neutron beam ports.

d. Fuel temperature is high.

Answer: C.07 c.
Reference: PSBR Training Manual, page 4-29

Question C.008 (1.0 point) {8.0}

In the Automatic Control mode, the controlling signal is:

a. reactor power as measured by the Power Range Monitor

b. reactor period as measured by the GIC

c. reactor power as measured by the Wide Range Monitor

d. reactor period as measured by the Power Range Monitor

Answer: C.08 c.
REF: PSBR Training Manual, Section **4.1.7**

Question C.009 (1.0 point) {9.0}

When the Automatic Mode Menu is displayed, rod mode "2" is selected. This means that the rods selected for regulation are the:

a. regulating rod and safety rod
b. regulating rod and shim rod
c. safety rod and shim rod
d. regulating rod and transient rod

Answer: C.09 b.
REF: PSBR Training Manual, Section 4.2.9.1

Question C.010 (1.0 point) {10.0}

In the PSBR Water Handling System, pool water conductivity is measured:

a. at the suction of the purification pump
b. downstream of the skimmer
c. between the filter and purification pump
d. at the inlet of the demineralizer

Answer: C.10 d.
REF: PSBR Training Manual, Section 5-2-3.

Question C.011 (1.0 point) {11.0}

Streaming of radiation from the central thimble is prevented by:

a. a graphite shield box over the top of the tube
b. the tube being filled with water
c. a boral plug inserted into the top of the tube
d. large radius bend in the tube

Answer: C.11 b.
REF: PSBR Training Manual, Section 5-4-6

Question C.012 (1.0 point) {12.0}

A reactor stepback is initiated by:

a. east or west bay monitor high radiation

b. east and west facility exhaust fans off

c. high fuel temperature

d. pulse timer timed out

Answer: C.12 c
REF: PSBR Training Manual, Section 4.2.9.1bi

Question C.013 (1.0 point) {13.0}

The purge gas for the Power Range Monitor is _.

a. CO_2

b. Argon

c. Nitrogen

d. Oxygen

Answer: C.13 a
Reference: PSBR Training Manual, Chapter 4, Section 4.1.14

Question C.014 (1.0 point) {14.0}

The _____is coupled to its drive by air pressure applied to its cylinder via a solenoid valve.

a. Safety rod

b. Shim rod

c. Regulating rod

d. Transient rod

Answer: C.14 d.
Reference: PSBR Training Manual, Chapter 4, Section 4.2.4

Question C.015 (1.0 point) {15.0}

Per **PSBR TS** under no conditions should any experiment or action be initiated which would allow _____to be introduced into the pool water. If __came in contact with the stainless steel fuel element cladding, it could possibly cause a failure of the cladding leading to a fission product release.

a. Nitrogen
b. Argon
c. Mercury
d. Chlorine

Answer: C.15 c.
Reference: PSBR Training Manual, Chapter 5, Section 5.1.4

Question C.016 (1.0 point) {16.0}

Which ONE of the following types of detector is used in the Reactor Bay East and West Monitors?

a. Geiger-Mueller tube
b. Scintillation detector
c. Ionization chamber
d. Proportional counter

Answer: C.16 a
REF: PSBR Training Manual, Section **4.1.12**

Question C.017 (1.0 point) {17.0}

The thermocouples in the instrumented fuel elements measure temperature at the:

a. interior surface of the cladding
b. center of the zirconium rod
c. outer surface of the fuel
d. interior of the fuel

Answer: C.17 d.
REF: PSBR Training Manual, Section 5.1.4

Question C.018 (1.0 point) {18.0}

Which one of the following would be an indication of a leak in the Pool Heat Exchanger?

a. Increased radioactivity in the pond water.

b. Decreased delta T across the Pool Heat Exchanger.

c. Excessive makeup to the pool.

d. Increased pool level.

Answer: C.18 d.
REF: PSBR Training Manual, Section 3.11

Question C.019 (1.0 point) {19.0}

Which one of the following describes an RSS operational interlock function while in the PULSE mode of operation?

a. Prevents manual withdrawal of more than one rod.

b. Prevents application of air to the transient rod if the drive is not fully down.

c. Prevents manual withdrawal of any rod.

d. Prevents outward movement of all rods except the transient rod.

Answer: C.19 d.
REF: PSBR Training Manual, Section 4.20.4.2

Question C.020 (1.0 point) {20.0}

The DCC-X bulk pool temperature alarms at ~100°F to ensure that:

a. there is an adequate heat sink for the full thermal power of the reactor.

b. the resin in the demineralizer is not damaged.

c. nucleate boiling does not occur on fuel element surfaces.

d. the expansion of pool water at higher temperatures does not reduce the moderating capability of the coolant.

Answer: C.20 b
REF: PSBR Training Manual, Section 3.9