July 6, 2007

Dr. C. Frederick Sears, Director
Radiation Science and Engineering Center
Breazeale Nuclear Reactor Building
Pennsylvania State University
University Park, PA 16802-2301

SUBJECT: INITIAL EXAMINATION REPORT 50-005/OL-07-01, PENNSYLVANIA STATE UNIVERSITY

Dear Dr. Sears:

During the week of June 4, 2007, the NRC administered an operator licensing examination at the Pennsylvania State University Breazeale Reactor. The examination was conducted according to NUREG-1478, "Non-Power Reactor Operator Licensing Examiner Standards," Revision 1. 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 10 CFR 2.390 of the Commission's 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 (the Public Electronic Reading Room) 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 Patrick Isaac at 301-415-1019.

Sincerely,

/RA/

Johnny Eads, Chief
Research and Test Reactors Branch B
Division of Policy and Rulemaking
Office of Nuclear Reactor Regulation

Docket No. 50-5

Enclosures: 1. Initial Examination Report No. 50-005/OL-07-01
2. Examination and answer key (RO/SRO)

cc w/enclosures:
Please see next page

cc:

Mr. Eric J. Boeldt, Manager of
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The Pennsylvania State University
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University Park, PA 16802-1504

Dr. Eva J. Pell
Vice President and Dean
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Director, Bureau of Radiation Protection
Department of Environmental Protection
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Harrisburg, PA 17105-8469

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

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**DISTRIBUTION:**
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**PACKAGE ACCESSION #: ML070720031**

| OFFICE | PRTB:CE | | IOLB:LA | | PRTB:BC | |
|---|---|---|---|---|---|---|
| NAME | PIsaac | | EBarnhill | | JEads | |
| DATE | 7/6/2007 | | 7/6/2007 | | 7/6/2007 | |

**OFFICIAL RECORD COPY**

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

REPORT NO.: 50-5/OL-07-01

FACILITY DOCKET NO.: 50-5

FACILITY LICENSE NO.: R-2

FACILITY: Pennsylvania State University Breazeale Reactor

EXAMINATION DATES: 06/04 - 05/2007

EXAMINERS: Patrick Isaac, Chief Examiner
Kevin M. Witt

SUBMITTED BY: _____ 06/22/2007
Patrick Isaac, Chief Examiner Date

SUMMARY:

During the week of June 04, 2007, the NRC administered Operator Licensing Examinations to four Senior Reactor Operator Instant (SROI) candidates. All the candidates passed the examinations.

ENCLOSURE 1

REPORT DETAILS

1. Examiners:

   Patrick Isaac, Chief Examiner
   Kevin M. Witt

2. Results:

| | RO PASS/FAIL | SRO PASS/FAIL | TOTAL PASS/FAIL |
|---|---|---|---|
| **Written** | **N/A** | **4/0** | **4/0** |
| **Operating Tests** | **N/A** | **4/0** | **4/0** |
| **Overall** | **N/A** | **4/0** | **4/0** |

3. Exit Meeting:

   There were no generic concerns raised by the examiners. The Chief Examiner thanked the Pennsylvania State University staff for their efforts in support of the examination and agreed to make the following changes to the written examination:

   Question A.15 - Accept both "b" and "d" as correct.

   Question B.8 - Accept both "b" and "c" as correct.

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

FACILITY: PENN STATE UNIVERSITY

REACTOR TYPE: TRIGA

DATE ADMINISTERED: 6/04/2007

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 paren-theses for each question. A 70% overall 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 |
| 20.00 | 33.3 | _____ | _____ | C. | PLANT AND RADIATION MONITORING SYSTEMS |
| FINAL GRADE | | _____ | _____ % TOTALS | | |

**ALL THE WORK DONE ON THIS EXAMINATION IS MY OWN. I HAVE NEITHER GIVEN NOR RECEIVED AID.**

_____
**CANDIDATE'S SIGNATURE**

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.

MULTIPLE CHOICE

001 a b c d ____

002 a b c d ____

003 a b c d ____

004 a b c d ____

005 a b c d ____

006 a b c d ____

007 a b c d ____

008 a b c d ____

009 a b c d ____

010 a b c d ____

011 a b c d ____

012 a b c d ____

013 a b c d ____

014 a b c d ____

015 a b c d ____

016 a b c d ____

017 a b c d ____

018 a b c d ____

019 a b c d ____

020 a b c d ____

(***** END OF CATEGORY A *****)

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.

MULTIPLE CHOICE

001 a b c d ___

002 a b c d ___

003 a ___ b ___ c ___ d ___

004 a b c d ___

005 a b c d ___

006 a b c d ___

007 a b c d ___

008 a b c d ___

009 a b c d ___

010 a b c d ___

011 a b c d ___

012 a b c d ___

013 a b c d ___

014 a b c d ___

015 a b c d ___

016 a b c d ___

017 a ___ b ___ c ___ d ___

018 a b c d ___

019 a b c d ___

020 a b c d ___

(***** END OF CATEGORY B *****)

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.

MULTIPLE CHOICE

001 a b c d ___

002 a b c d ___

003 a b c d ___

004 a b c d ___

005 a b c d ___

006 a b c d ___

007 a b c d ___

008 a b c d ___

009 a b c d ___

010 a b c d ___

011 a b c d ___

012 a b c d ___

013 a b c d ___

014 a b c d ___

015 a b c d ___

016 a b c d ___

017 a b c d ___

018 a b c d ___

019 a b c d ___

020 a b c d ___

(********** 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 not received or 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.

6. Fill in the date on the cover sheet of the examination (if necessary).

7. Print your name in the upper right-hand corner of the first page of each section of your answer sheets.

8. The point value for each question is indicated in parentheses after the question.

9. Partial credit will NOT be given.

10. If the intent of a question is unclear, ask questions of the examiner only.

11. When you are done and have turned in your examination, leave the examination area as defined by the examiner.

# EQUATION SHEET

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

$\dot{Q} = UA\, \Delta T$ $SCR = S/(1-Keff)$

$CR_1\,(1\text{-}Keff)_1 = CR_2\,(1\text{-}Keff)_2$

$$SUR = \frac{26.06\,(\lambda_{eff}\rho)}{(\beta - \rho)} \qquad M = \frac{(1\text{-}Keff)_0}{(1\text{-}Keff)_1}$$

$SUR = 26.06/\tau$ $M = 1/(1\text{-}Keff) = CR_1/CR_0$

$P = P_0\, 10^{SUR(t)}$ $SDM = (1\text{-}Keff)/Keff$

$P = P_0\, e^{(t/\tau)}$ $Pwr = \dot{W}_f\, m$

$$P = \frac{\beta(1-\rho)}{\beta-\rho}\, P_o \qquad \ell^* = 1 \times 10^{-5} \text{ seconds}$$

$\tau = (\ell^*/\rho) + [(\bar{\beta}-\rho)/\lambda_{eff}\rho]$ $\tau = \ell^*/(\rho-\bar{\beta})$

$\rho = (Keff-1)/Keff$ $\lambda_{eff} = 0.1 \text{ seconds}^{-1}$

$\rho = \Delta Keff/Keff$ $$T_{1/2} = \frac{0.693}{\lambda}$$

$DR_1 D_1^2 = DR_2 D_2^2$ $DR = DR_o e^{-\lambda t}$

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

1 Curie = $3.7 \times 10^{10}$ dps 1 kg = 2.21 lbm

1 hp = $2.54 \times 10^3$ BTU/hr 1 Mw = $3.41 \times 10^6$ BTU/hr

1 BTU = 778 ft-lbf $^\circ F = 9/5\,^\circ C + 32$

1 gal $H_2O \approx$ 8 lbm $^\circ C = 5/9\,(^\circ F - 32)$

## QUESTION A.1 [1.0 point]

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

## QUESTION A.2 [1.0 point]

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

## QUESTION A.3 [1.0 point]

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.

## QUESTION A.4 [1.0 point]

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..

## QUESTION A.5 [1.0 point]

In a subcritical reactor, K eff is increased from 0.861 to 0.946. Which ONE of the following is the amount of reactivity that was added to the reactor core?

a. 0.085 delta k/k

b. 0.104 delta k/k

c. 0.161 delta k/k

d. 0.218 delta k/k.

## QUESTION A.6 [1.0 point]

The table provided lists data taken during a core loading. Estimate the number of fuel elements needed to go critical.

a. 24

b. 27

c. 30

d. 38

| Count Rate | Number for Fuel Elements |
|---|---|
| 842 | 2 |
| 886 | 7 |
| 1052 | 12 |
| 1296 | 17 |
| 4210 | 22 |

## QUESTION A.7 [1.0 point]

During a startup you increase reactor power from 100 watts to 195 watts in a minute. Which ONE of the following is reactor period?

a. 30 seconds.

b. 60 seconds.

c. 90 seconds.

d. 120 seconds.

## QUESTION A.8 [1.0 point]

The reactor has just been started up and has been at 100% power for 3 hours. The Reactor Operator notes that several small control rod withdrawals are required to maintain power at 100%. Which of the following is the reason for the rod withdrawals?

a. Fuel temperatures are decreasing.

b. Xenon is building in to equilibrium concentration.

c. Pool water temperatures are decreasing.

d. Samarium is burning out from equilibrium concentration.

## QUESTION A.9 [1.0 point]

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.

## QUESTION A.10 [1.0 point]

Given the data in the table to the right, which ONE of the following is the closest to the half-life of the material?

a. 11 minutes

b. 22 minutes

c. 44 minutes

d. 51 minutes

| TIME | ACTIVITY |
|---|---|
| 0 minutes | 2400 cps |
| 10 minutes | 1757 cps |
| 20 minutes | 1286 cps |
| 30 minutes | 941 cps |
| 60 minutes | 369 cps |

## QUESTION A.11 [1.0 point]

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.

## QUESTION A.12 [1.0 point]

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.

## QUESTION A.13 [1.0 point]

The reactor has been at 100% power for several hours when a reactor scram occurs. All systems have operated as designed, no experiments have been changed, and no fuel has been removed from the reactor. Several hours after the reactor scram, indicated reactor power will stabilize due to:

a. continuing decay of the shortest-lived delayed neutron precursor.

b. the decay of nuclear instrumentation compensation voltage at low power levels.

c. reaching the nuclear instrumentation minimum detectable level.

d. the continuing subcritical multiplication of source neutrons.

## QUESTION A.14 [1.0 point]

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

## QUESTION A.15 [1.0 point]

During a reactor startup, the count rate is increasing linearly with time, with no rod motion. This means:

a. the reactor is subcritical and the count rate increase is due to the buildup of delayed neutron precursors

b. the reactor is critical and the count rate increase is due to Am-Be source neutrons

c. the reactor is subcritical and the count rate increase is due to Am-Be source neutrons

d. the reactor is critical and the count rate increase is due to the buildup of delayed neutron precursors

## QUESTION A.16 [1.0 point]

The reactor is operating at 100 KW. The reactor operator withdraws the Regulating Rod allowing power to increase. The operator then inserts the same rod to its original position, decreasing power. In comparison to the rod withdrawal, the period due to the rod insertion will be …

a. longer due to long lived delayed neutron precursors.

b. shorter due to long lived delayed neutron precursors.

c. same due to equal amounts of reactivity being added.

d. same due to equal reactivity rates from the rod.

## QUESTION A.17 [1.0 point]

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.

## QUESTION A.18 [1.0 point]

The term "Prompt Critical" refers to:

a. the instantaneous jump in power due to a rod withdrawal

b. a reactor which is supercritical using only prompt neutrons

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

d. a reactivity insertion which is less than Beta-effective

## QUESTION A.19 [1.0 point]

Identify the PRINCIPAL source of heat in the reactor after shutdown?

a. Stored energy from the reactor and core materials

b. Spontaneous fission within the core

c. Decay of fission products

d. Cosmic radiation causing fission

## QUESTION A.20 [1.0 point]

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

## QUESTION B.1 [1.0 point]

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"

## QUESTION B.2 [1.0 point]

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. 130 mrem

## QUESTION B.3 [1.0 point, ¼ each]

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 |

## QUESTION B.4 [1.0 point]

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

## QUESTION B.5 [1.0 point]

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

## QUESTION B.6 [1.0 point]

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 affects of modifications and their impact on TS.

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

## QUESTION B.7 [1.0 point]

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

a. The sum of the deep does 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.

## QUESTION B.8 [1.0 point]

Which ONE of the following does NOT require the direct supervision of a licensed Senior Reactor Operator?

a. recovery from an unplanned scram

b. relocation of an in-core experiment with a reactivity worth of $0.50

c. a reactor operator trainee during a normal startup

d. an unlicensed individual moving the reactor graphite reflectors

## QUESTION B.9 [1.0 point]

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

## QUESTION B.10 [1.0 point]

The Safety System channels required to be operable in all modes of operation are:

a. fuel element temperature scram, reactor high power scram, and manual scram

b. fuel element temperature scram and manual scram

c. manual scram and reactor high power scram

d. reactor high power scram, detector power supply scram, and fuel element temperature scram

## QUESTION B.11 [1.0 point]

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

## QUESTION B.12 [1.0 point]

Prior to insertion into a pneumatic transfer system, a rabbit sample must be inspected by:

a. the reactor operator

b. the Health Physics office

c. the experimenter

d. the duty senior reactor operator

## QUESTION B.13 [1.0 point]

In accordance with the Technical Specifications, which ONE situation below is permissible when the reactor is operating?:

a. The Emergency Exhaust System is inoperable for 72 hours for repairs

b. A single secured experiment with a reactivity worth of 2.31 % delta k/k

c. The reactivity insertion rate for standard control rods is 0.71% delta k/k per second

d. The reactor bay truck door is open for ten minutes to move equipment

## QUESTION B.14 [1.0 point]

Which ONE statement below describes the basis for the Safety Limit applicable to fuel temperature?

a. Excessive gas pressure may result in loss of fuel element cladding integrity

b. High fuel temperature combined with lack of adequate cooling could result in fuel melt

c. Excessive hydrogen produced as a result of the zirconium-water reaction is potentially explosive

d. High fuel temperature could result in clad melt

## QUESTION B.15 [1.0 point]

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

## QUESTION B.16 [1.0 point]

An Emergency Action Level is:

a. a condition which calls for immediate action, beyond the scope of normal operating procedures, to avoid an accident or to mitigate the consequences of one.

b. a class of accidents for which predetermined emergency measures should be taken or considered.

c. a procedure that details the implementation actions and methods required to achieve the objectives of the Emergency Plan.

d. a specific instrument reading or observation which may be used as a threshold for initiating appropriate emergency procedures.

## QUESTION B.17 [1.0 point, ¼ each]

Match the 10 CFR Part 55 requirements listed in Column A for an actively licensed operator with the correct time period from Column B. Column B answers may be used once, more than once, or not at all.

| Column A | Column B |
|---|---|
| a. License Expiration | 1. 1 year |
| b. Medical Examination | 2. 2 years |
| c. Requalification Written Examination | 3. 3 years |
| d. Requalification Operating Test | 4. 6 years |

## QUESTION B.18 [1.0 point]

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.

## QUESTION B.19 [1.0 point]

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

## QUESTION B.20 [1.0 point]

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.

## QUESTION C.1 [1.0 point]

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.

## QUESTION C.2 [1.0 point]

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

## QUESTION C.3 [1.0 point]

Carbon dioxide is used in the pneumatic transfer system instead of compressed air because:

a. it is more compressible

b. it does not retain moisture

c. it minimizes Ar-41 production

d. it minimizes N-16 production

## QUESTION C.4 [1.0 point]

The top grid plate in the reactor:

a. supports the weight of the fuel assemblies

b. aligns and supports the nuclear detectors

c. maintains lateral fuel alignment

d. serves as a reflector over the top of the core

## QUESTION C.5 [1.0 point]

A signal of notification to Penn State University Police Services is initiated by:

a. reactor bay truck door open

b. UPS battery low

c. emergency exhaust system initiation

d. DCC-Z watchdog trip

## QUESTION C.6 [1.0 point]

For a standard control rod, the drive up arrow is green, the drive down arrow is red, and rod bottom arrow is red. This indicates that:

a. the rod and drive are not in contact, the rod is full up and the drive is full down

b. the rod and drive are both full up

c. the rod and drive are both full down

d. the rod and drive are not in contact, the drive is full up and the rod is full down

## QUESTION C.7 [1.0 point]

All operational interlocks and safety trips required by technical specifications are performed by the:

a. Digital Control Computer (DCC-Z)

b. Digital Control Computer (DCC-X)

c. protection, control and monitoring system (PCMS)

d. reactor safety system (RSS)

## QUESTION C.8 [1.0 point]

Which ONE of the following is a control rod interlock?

a. above reactor power of 1 kW, the transient rod cannot be operated in the pulse mode

b. only one standard rod at a time can be moved in the pulse mode

c. control rods cannot be withdrawn unless the count rate is greater than 1 CPS in the manual mode

d. two control rods cannot be moved at the same time above 1 kW in the manual mode

## QUESTION C.9 [1.0 point]

The Wide Range power monitor uses a (an):

a. uncompensated ion chamber

b. compensated ion chamber

c. fission chamber

d. boron-trifluoride detector

## QUESTION C.10 [1.0 point]

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 |

## QUESTION C.11 [1.0 point]

Reclaimed water from the Liquid Waste Evaporator System is transferred to the reactor makeup by the:

a. makeup pump

b. processed water pump

c. distillate pump

d. hot water pump

## QUESTION C.12 [1.0 point]

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

## QUESTION C.13 [1.0 point]

For a standard control rod, the rod drive up arrow is red, the rod drive down arrow is red, and the rod drive magnet block is yellow. This indicates that:

a. the rod and drive are in contact, and are both full down

b. the rod and drive are in contact, and are both full up

c. the rod and drive are not in contact, and the rod and drive are somewhere between full up and full down

d. the rod and drive are in contact, and are somewhere between full up and full down

## QUESTION C.14 [1.0 point]

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

## QUESTION C.15 [1.0 point]

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

## QUESTION C.16 [1.0 point]
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

## QUESTION C.17 [1.0 point]
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

## QUESTION C.18 [1.0 point]
The purpose of the boral plate on top of the D2O tank is to:

a. reduce radiation escaping from the core

b. minimize production of gamma radiation resulting from neutron activation of the pool water

c. reduce gamma interactions with the pool wall

d. absorb reflected neutrons so that the outputs of the gamma and fission chambers are in agreement

## QUESTION C.19 [1.0 point]

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

## QUESTION C.20 [1.0 point]

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 Key**

A.1 c
REF: Reactor Training Manual, Page 2-16.

A.2 d
REF: PSBR Technical Specifications, Section 1.1.42.

A.3 d
REF: Reactor Training Manual - *Introduction To Nuclear Physics*

A.4. c
REF: Reactor Training Manual - *Reactivity Feedback*

A.5 b
REF: Reactor Training Manual - *Reactor Kinectics*

A.6 a
REF: Reactor Training Manual - *Subcritical Multiplication*

A.7 c
REF: $P = P_0 e^{t/\tau}$ —> $\tau = t/\ln(P/P_0)$ $\tau = 60/\ln(195/100) = 60/\ln(1.95) = 89.84 \approx 90$ sec.

A.8 b
REF: Reactor Training Manual - *Reactor Physics and Kinetics*

A.9 c
REF: Reactor Training Manual - *Neutron Life Cycle*

A.10 b
REF: Reactor Training Manual - *Reactivity*

A.11 c
REF: Glasstone, 1958, CHAP 5, LAMARSH, 1983, CHAP 2.8

A.12 b
REF: Glasstone, 1958, CHAP 14

A.13 d
REF: Reactor Training Manual - *Introduction to Nuclear Physics*

A.14 a
REF: Standard NRC Question

A.15 b, d
REF: Standard NRC Question

A.16 a
REF: Reactor training Manual - *Reactor Physics and Kinetics*

**Answer Key**

A.17 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

A.18. b
REF: Standard NRC Question

A.19 c
REF: Lamarsh, pgs 318 - 320

A.20. d
REF: Reactor Training Manual - *Fission Process*

**Answer Key**

B.1 c
REF: 10CFR20

B.2 d
REF: Reactor Training Manual - *Ionizing Radiation*

B.3 a, 4 b, 2 c, 1d, 3
REF: Reactor Training Manual - *Health Physics*

B.4 b
REF: 10CFR50.54(y).

B.5 a
REF: Technical Specifications, Section 3.2.6

B.6 c
REF: 10 CFR 50.59

B.7 a
REF: 10 CFR 20.1003 *Definitions*

B.8 b, c
REF: AP-1

B.9 c
REF:

$$\frac{DR_1}{{X_2}^2} = \frac{DR_2}{{X_1}^2} \qquad {X_2}^2 = \frac{DR_1}{DR_2} X^2 \quad X^2 = \frac{2000}{5} \times 1^2 = 400\, ft^2 \quad X = 20\, ft$$

B.10 b
REF: Technical Specifications, Section 3.2.4

B.11 d
REF: AP-4.B.3

B.12 d
REF: SOP-9.

B.13 b
REF: TS 3.7; 3.5; 3.4; 3.2.2

B.14 a
REF: TS 2.1

B.15 b
REF: 10CFR55.53(f)(2))

**Answer Key**

B.16 d
REF: PSBR Emergency Preparedness Plan, Section 5.0.

B.17 a, 4 b, 2 c, 2d, 1.
REF: AP-3, Operator and Senior Operator Requalification

B.18 d
REF: T.S. 4.1.1 and SOP-1, II.j

B.19 d
REF: EP-5

B.20 a
REF: EP-1, Definitions

**Answer Key**

C.1 b
REF: PSBR Training Manual, page 4-45.

C.2 c
REF: PSBR Training Manual, Page 3-23

C.3 c
REF: PSBR Training Manual, Page 3-30

C.4 c
REF: PSBR Training Manual, Page 3-1

C.5 b
REF: PSBR Training Manual, Page 4-30

C.6 b
REF: PSBR Training Manual, Page 6-5

C.7 d
REF: PSBR Training Manual, Page 4-15

C.8 a
REF: CCP-4

C.9 c
REF: PSBR Training Manual, Page 4-9

C.10 c
REF: PSBR Training Manual, Page 4-35

C.11 b
REF: PSBR Training Manual, Page 3-20

C.12 b
REF: PSBR Training Manual, Page 6-7

C.13 d
REF: PSBR Training Manual, Page 6-5

C.14 d
REF: PSBR Training Manual, Page 3-13

C.15 c
REF: PSBR Training Manual, Page 5-2

C.16 b
REF: PSBR Training Manual, Page 3-38

**Answer Key**

C.17 c
REF: PSBR Training Manual, Page 4-28

C.18 d
REF: PSBR Training Manual, Page 5-2

C.19 a
REF: PSBR Training Manual, Page 4-11

C.20 d
REF: PSBR Training Manual, Page 3-7