May 28, 2014

Dr. Ayman I. Hawari, Director
Nuclear Reactor Program
Department of Nuclear Engineering
North Carolina State University
Campus Box 7909
2500 Stinson Drive
Raleigh, NC 27695-7909

SUBJECT: EXAMINATION REPORT NO. 50-297/OL-14-01,
NORTH CAROLINA STATE UNIVERSITY

Dear Dr. Hawari:

During the week of April 28, 2014, the U.S. Nuclear Regulatory Commission (NRC) administered operator licensing examinations at your North Carolina State University Pulstar 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 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 Mr. Phillip T. Young at (301) 415-4094 or via electronic mail at phillip.young@nrc.gov.

Sincerely,

/RA/

Gregory T. Bowman, Chief
Research and Test Reactors Oversight Branch
Division of Policy and Rulemaking
Office of Nuclear Reactor Regulation

Docket No. 50-297

Enclosures:
1. Examination Report No. 50-297/OL-14-01
2. Written examination with facility comments

cc w/out enclosures: Please see next page

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ADAMS ACCESSION #: ML14128A524 **NRR-079**

OFFICE	PRTB:CE	IOLB:LA	PROB:
NAME	PYoung	CRevelle	GBowman
DATE	5/13 /2014	5/13/2014	5/ 28/2014

OFFICIAL RECORD COPY

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

REPORT NO.: 50-297/OL-14-01

FACILITY DOCKET NO.: 50-297

FACILITY LICENSE NO.: R-120

FACILITY: North Carolina State University Pulstar Reactor

EXAMINATION DATES: April 30, 2014

SUBMITTED BY: **/RA/** 05/13/2014
Phillip T. Young, Chief Examiner Date

SUMMARY:

During the week of April 28, 2014, the U.S. Nuclear Regulatory Commission (NRC) administered licensing examinations to three Reactor Operator (RO) applicants. The applicants passed all portions of the examination.

REPORT DETAILS

1. Examiners: Phillip T. Young, Chief Examiner, NRC

2. Results:

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

3. Exit Meeting:
Phillip T. Young
Andrew Cook, Reactor Operations Manager
The examiner thanked the facility for their assistance ensuring the exam administration went smoothly and their feedback on the written examination. The examiner thanked the facility for their comments on the written exam.

ENCLOSURE 1

FACILITY COMMENTS WITH NRC RESOLUTION

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NORTH CAROLINA STATE UNIVERSITY
NON-POWER REACTOR INITIAL LICENSE EXAMINATION
4/30/2014
TEST COMMENTS:

SECTION B

Question B.012

Comment:	The correct answer for evacuation would be: (a). Determine if reactor operations may continue
Reference:	NRP-OP105 Response to SCRAMS, Alarms and Abnormal Conditions, Immediate Actions
NRC Resolution:	Comment accepted. The answer as shown in the comment will be accepted as correct

Question B.013

Comment:	MCC#1 has been replaced with SB-1. The crane supply breaker is no longer normally locked in the “OFF” position. There are no correct answers.
NRC Resolution:	Comment accepted. The question is deleted from the examination

Question B.015

Comment:	The correct answer is (d)
Reference:	Emergency Plan Figure 4, Technical Specifications Figure 5.2-1
NRC Resolution:	Comment accepted. The answer as shown in the comment will be accepted as correct

SECTION C

Question C.002

Comment:	There is no correct answer.
NRC Resolution:	Comment accepted. The question is deleted from the examination

Question C.006

Comment:	There are two correct answers: (a) or (c)
Reference:	Heat Exchanger Boundary Breech
NRC Resolution:	Comment accepted. Both answers are accepted for this examination.

Question C.019

Comment:	There is no correct answer. The mixing valve has been replaced by a variable speed fan.
NRC Resolution:	Comment accepted. The question is deleted from the examination

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

FACILITY: NORTH CAROLINA STATE UNIVERSITY

REACTOR TYPE: PULSTAR

DATE ADMINISTERED: 4/30/2014

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 parentheses 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 CHARACTISTICS
19.0 ~~20.00~~	33.3	_____	_____	B. NORMAL AND EMERGENCY OPERATING PROCEDURES AND RADIOLOGICAL CONTROLS
18.0 ~~20.00~~	33.3	_____	_____	C. FACILITY AND RADIATION MONITORING SYSTEMS
57.0 ~~60.00~~		_____ **FINAL GRADE**		TOTALS

ALL THE 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 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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

$$I = I_{oe^{-\mu x}}$$

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

$$\mu_m = \frac{\mu}{\rho}$$

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

1 Curie = 3.7 x 10^{10} dis/sec
1 Horsepower = 2.54 x 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 x 10^6 BTU/hr
°F = 9/5 °C + 32
°C = 5/9 (°F - 32)
c_p = 1 cal/sec/gm/°C

1 inch=2.54 cm

Question: A.001 [1.0 point] {1.0}
A reactor pool contains 106, 000 gallons of water at 90 degrees F, and it heats up to 93 degrees F in two hours. Assuming no ambient losses, the calculated reactor power level is _____.

a. 93 kW.
b. 259 kW.
c. 389 kW.
d. 777 kW.

Answer: A.01 c.
Power = mcΔT/Δt , where: m=106,000 gallons x 8.34 degrees/hour.
Power = 1,326,060 Btu/hour; 3413 Btu/hour = 1 kW. Power = 1,326,060/3413 = 389 kW
Reference: NC State's Pulstar Reactor Trainee Notebook, Section 3.7

Question: A.002 [1.0 point] {2.0}
You are the reactor operator performing two pulsing operations. The first pulse had a reactivity worth of **$1.50** which resulted in a peak power of **250 MW**. If the second pulse had a reactivity worth of **$2.00**, what was the corresponding peak power?

Given: β_{eff} =0.0070
a. 375 MW
b. 750 MW
c. 1000 MW
d. 1200 MW

Answer: A.02 c
Δ$prompt = ρ - β where β= $1.00 of reactivity P_1=250 MW ρ_1=$0.50 $P_2=X_2$=$1.00
$(250\ MW)/(0.5)^2=(x)(1)^2$= 1000MW
Reference: Reactor Physics of Pulsing: Fuchs-Hansen Adiabatic Model
http://www.rcp.ijs.si/ric/pulse_operation-s.html

Question: A.003 [1.0 point] {3.0}
Which ONE of the following describes a property of a ***GOOD MODERATOR***?

a. It slows down fast neutrons to thermal energy levels via a small number of collisions.
b. It reduces gamma radiation to thermal energy levels via a small number of collisions.
c. It slows down fast neutrons to thermal energy levels via a large number of collisions.
d. It reduces gamma radiation to thermal energy levels via a large number of collisions.

Answer: A.03 a.
Reference: Standard NRC QUESTION.

Question: A.004 [1.0 point] {4.0}
The effective neutron multiplication factor, K_{eff}, is defined as:

a. absorption/(production + leakage)
b. (production + leakage)/absorption
c. (absorption + leakage)/production
d. production/(absorption + leakage)

Answer: A.04 d.
Reference: Pulstar Reactor Trainee Notebook, Section 1.5.2.

Question: A.005 [1.0 point] {5.0}
Why does the fuel temperature (Doppler) coefficient becomes less negative at higher fuel temperatures?

a. As reactor power increases, the rate of increase in the fuel temperature diminishes.
b. Neutrons penetrate deeper into the fuel, resulting in an increase in the fast fission factor.
c. The amount of self-shielding increases, resulting in less neutron absorption by the inner fuel.
d. The broadening of the resonance peaks diminishes per degree change in fuel temperature.

Answer: A.05 d.
Reference: FNRE pg. 146, 149 / Nuc. Trng. Man. pg. RX 6-8

Question: A.006 [1.0 point] {6.0}
A reactor is subcritical with a Keff of 0.955. A positive reactivity of 650 pcm is inserted into the core. At this point, the reactor is:

a. subcritical.
b. exactly critical.
c. supercritical.
d. prompt critical.

Answer: A.06 a.
Reference: Pulstar Reactor Trainee Notebook, Section 1.4.1.
When keff = 0.955, ρ = -0.0471 delta k/k; 650 pcm = +0.00650 delta k/k.
-0.0471 + 0.0065 delta k/k = -0.0406 delta k/k, therefore reactor is subcritical.

Question: A.007 [1.0 point, ¼ each] {7.0}
Match each term in column A with the correct definition in column B.

	Column A	Column B
a.	Prompt Neutron	1. A neutron in equilibrium with its surroundings.
b.	Fast Neutron	2. A neutron born directly from fission.
c.	Thermal Neutron	3. A neutron born due to decay of a fission product.
d.	Delayed Neutron	4. A neutron at an energy level greater than its surroundings.

Answer: A.07 a. = 2; b. = 4; c = 1; d = 3
Reference: Pulstar Reactor Trainee Notebook, Chapter 2, § 2.2 and Chapter 1, § 1.4.4 ¶¶ 5 and 7.

Question: A.008 [1.0 point] {8.0}
As a reactor continues to operate over time, for a constant power level, the thermal neutron flux:

a. decreases, due to the increase in fission product poisons.
b. increases, in order to compensate for fuel depletion.
c. decreases, because fuel is being depleted.
d. remains the same.

Answer: A.08 b.
Reference: Pulstar Reactor Trainee Notebook, Section 3.4.
Power = $\Sigma f \Phi th$ As Σf decreases due to fuel burnup, Φth must increase.

Question: A.009 [1.0 point] {9.0}
You are increasing reactor power on a steady +26 second period. How long does it take to increase power by a factor of 1000?

a. 60 seconds (1 minute)
b. 180 seconds (3 minutes)
c. 300 seconds (5 minutes)
d. 480 seconds (8 minutes)

Answer: A.09 b.
Reference: ln (P/P0) × period = time,
$\ln(1000) \times 26 = 6.908 \times 26 = 179.6 \approx 180$ seconds

Question: A.010 [1.0 point] {10.0}
Which ONE of the following describes the term "prompt jump?"

a. A reactor which is critical on prompt neutrons only.
b. A negative reactivity insertion which is less than βeff.
c. A reactor which is critical using both prompt and delayed neutrons.
d. The instantaneous change in the neutron population due to withdrawing a control rod.

Answer: A.10 d.
Reference: Pulstar Reactor Trainee Notebook, Section 2.2.

Question: A.011 [1.0 point] {11.0}
Inelastic scattering can be described as a process whereby a neutron collides with a nucleus and:

a. recoils with the same kinetic energy it had prior to the collision.
b. is absorbed by the nucleus, with the nucleus emitting a gamma ray.
c. recoils with a lower kinetic energy, with the nucleus emitting a gamma ray.
d. recoils with a higher kinetic energy, with the nucleus absorbing a gamma ray.

Answer: A.11 c.
Reference: Pulstar Reactor Trainee Notebook, Section 1.1.

Question: A.012 [1.0 point] {12.0}
Initially Nuclear Instrumentation is reading 30 CPS and the reactor has a Keff of 0.90. You add an experiment which causes the Nuclear Instrumentation reading to increase to 60 CPS. Which ONE of the following is the new Keff?

a. 0.91
b 0.925
c. 0.95
d. 0.975

Answer: A.12 c.
Reference: CR2/CR1 = (1 - Keff1)/(1 - Keff2)
60/30 = (1 - 0.900)/(1 - Keff2)
1 - Keff2 = ½ × 0.1 = 0.05 Keff2 = 1 - 0.05 = 0.95

Question: A.013 [1.0 point] {13.0}
Two critical reactors at low power are identical except that Reactor #1 has a beta fraction of 720 pcm and Reactor #2 has a beta fraction of 600 pcm. An equal amount of positive reactivity is inserted into both reactors. Which ONE of the following will be the response of Reactor 2 compared to Reactor 1?

a. The resulting power level will be lower.
b. The resulting power level will be higher.
c. The resulting startup rate will be faster.
d. The resulting startup rate will be slower.

Answer: A.13 c.
Reference: Pulstar Reactor Trainee Notebook, Section 2.3.

Question: A.014 [1.0 point] {14.0}
The reactor is operating in the automatic mode at 50% power. A problem in the secondary cooling system causes the primary coolant temperature to increase by 10 degrees F. Given that the moderator temperature coefficient is -4.0 pcm/deg. F and the differential rod worth of the regulating rod is 160 pcm/inch, the change in the position of the regulating rod will be:

a. two (2) inches in.
b. two (2) inches out.
c. one-quarter (0.25) inch in.
d. one-quarter (0.25) inch out.

Answer: A.14 d.
Reference: Pulstar Reactor Trainee Notebook, Section 2.7.1.
Since the coolant temperature increased, negative reactivity was added. Therefore, the rod must add positive reactivity, i.e. withdrawn. (10 deg. F)x(-4.0 pcm/deg. F) / (160 pcm/inch) = 0.25 inches.

Question: A.015 [1.0 point] {15.0}
During the minutes following a reactor scram, reactor power decreases on a negative 80second period (-1/3 DPM), corresponding to the half-life of the longest-lived delayed neutron precursors, which is approximately:

a. 20 seconds.
b. 40 seconds.
c. 55 seconds
d. 80 seconds.

Answer: A.15 c.
Reference: Pulstar Reactor Trainee Notebook, Section 2.4.

Question: A.016 [1.0 point] {16.0}
Which ONE of the following describes the response of the subcritical reactor to equal insertions of positive reactivity as the reactor approaches critical? Each reactivity insertion causes:

a. a SMALLER increase in the neutron flux, resulting in a LONGER time to reach equilibrium.
b. a LARGER increase in the neutron flux, resulting in a LONGER time to reach equilibrium.
c. a SMALLER increase in the neutron flux, resulting in a SHORTER time to reach equilibrium.
d. a LARGER increase in the neutron flux, resulting in a SHORTER time to reach equilibrium.

Answer: A.16 b.
Reference: Pulstar Reactor Trainee Notebook, Section 1.5.3.

Question: A.017 [1.0 point] {17.0}
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. Pool water temperature increase at 90% power.
d. Removal of an experiment containing cadmium.

Answer: A.17 d.
Reference: Insertion of a control rod inserts negative reactivity to balance the positive reactivity added when removing a neutron absorber. All other answers add negative reactivity.

Question: A.018 [1.0 point] {18.0}
Which ONE of the following is the approximate time period during which the MAXIMUM amount of Xenon-135 will be present in the core?

a. 40 to 50 hours after a startup to 100% power.
b. 10 to 12 hours after shutdown from 100% power.
c. 40 to 50 hours after a power increase from 50% to 100%.
d. 10 to 12 hours after a power decrease from 100% to 50%.

Answer: A.18 b.
Reference: Pulstar Reactor Trainee Notebook, Figure 2.11.

Question: A.019 [1.0 point] {19.0}
Which ONE of the following conditions describes a critical reactor?

a. Keff = 1; $\Delta k/k$ (ρ) = 1
b. Keff = 1; $\Delta k/k$ (ρ) = 0
c. Keff = 0; $\Delta k/k$ (ρ) = 1
d. Keff = 0; $\Delta k/k$ (ρ) = 0

Answer: A.19 b.
Reference:

Question: A.020 [1.0 point] {20.0}
Several processes occur that may increase or decrease the available number of neutrons. SELECT from the following the six-factor formula term that describes an INCREASE in the number of neutrons during the cycle.

a. Thermal utilization factor (f).
b. Resonance escape probability (p).
c. Fast non-leakage probability (□f).
d. Fast Fission factor (ε).

Answer: A.20 d.
Reference:

Question B.001 (1.0 point) {1.0}
Which of the following radiation detector types, does not have an output intensity (current or pulse height) proportional to the incident radiation energy; i.e., if the incident energy increases, will the out-put intensity increase?

a. Ion Chamber
b. GM
c. Proportional Counter
d. Scintillation

Answer: B.01 b.
Reference: NRC standard HP question

Question B.002 (1.0 point, ⅓ each) {2.0}
Match each of the Limiting Safety System Settings for Natural Convection Flow in Column A with the correct value in Column B.

Column A	Column B
a. Reactor Thermal Power.	1. 117°F
b. Reactor Coolant Inlet Temperature.	2. 1.4 MWt
c. Height of water above the top of the core.	3. 14 feet
	4. 250 kWt
	5. 120°F
	6. 14 feet, 2 inches
	7. 123°F
	8. 1.3 MWt
	9. 14 feet, 4 inches

Answer: B.02 a. =4; b. = 1; c. =6.
Reference: Technical Specifications, section 2.2.2.

Question B.003 (1.0 point) {3.0}
Which ONE of the following is the definition for “Annual Limit on Intake (ALI)”?

a. The concentration of a radio-nuclide in air which, if inhaled by an adult worker for a year, results in a total effective dose equivalent of 100 millirem.
b. 10CFR20 derived limit, based on a Committed Effective Dose Equivalent of 5 Rems whole body or 50 Rems to any individual organ, for the amount of radioactive material inhaled or ingested in a year by an adult worker.
c. The effluent concentration of a radio-nuclide in air which, if inhaled continuously over a year, would result in a total effective dose equivalent of 50 millirem for noble gases
d. Projected dose commitment values to individuals, that warrant protective action following a release of radioactive material.

Answer: B.03 b.
Reference: 10CFR20.1003

Question B.004 (1.0 point) {4.0}
With regard to "Response to Abnormal Reactivity Changes?" An unanticipated reactivity change of __?__ or more is considered a significant change.

a. 50 pcm
b. 100 pcm
c. 150 pcm
d. 200 pcm

Answer: B.04 b.
Reference: NRP-OP-105, pg. 11 of 16

Question B.005 (1.0 point) {5.0}
During which one of the following operations may the Over-the-Pool radiation monitor be bypassed for up to five (5) minutes?

a. Calibration response checks.
b. Removal of experiments from the reactor pool.
c. Immediately after starting the pneumatic blower system.
d. During return of pneumatic rabbit capsule from the core.

Answer: B.05 b.
Reference: Tech Spec Section 3.5. 2

Question B.006 (1.0 point) {6.0}
What is the minimum required operating crew with the reactor at 1.0 MW, steady state conditions? Indicate whether each individual must be AT THE FACILITY or MAY BE ON CALL.

a.	DSRO	1.	AT THE FACILITY
b.	RO	2.	MAY BE ON CALL
c.	ROA		
d.	RHP		

Answer: B.06 a. = 2; b. = 1; c. = 1; d. = 2
Reference: Tech. Spec. 6.1.2

Question B.007 (1.0 point) {7.0}
The CURIE content of a radioactive source is a measure of

a. the number of radioactive atoms in the source.
b. the amount of energy emitted per unit time by the source
c. the amount of damage to soft body tissue per unit time.
d. the number of nuclear disintegrations per unit time.

Answer: B.07 d.
Reference: Standard Health Physics Definition.

Question B.008 (1.0 point) {8.0}
Which one of the following are the Technical Specification limits for irradiated fuel storage?

a. K_{eff} <0.80 Δk/k
b. K_{eff} <0.85 Δk/k
c. K_{eff} <0.90 Δk/k
d. K_{eff} <0.95 Δk/k

Answer: B.08 c.
Reference: Tech Specs 5.3

Question B.009 (1.0 point) {9.0}
The Basement area ramp door and the Loading Dock Doors above the MER may be open for a maximum of ___ minutes while the reactor is operating. (Assume audible and visual idication IS available for the RO to verify door status.)

a. one
b. three
c. five
d. seven

Answer: B.09 c.
Reference: Training Manual 5.1.2. Confinement Structure Design.

Question B.010 (1.0 point, ¼ each) {10.0}
Identify whether each of the listed Emergency Classes are credible (CRED) or not credible (NOT) at the NCSU PULSTAR reactor. (Note: Emergency classes are listed in alphabetical order NOT in order of severity.)

a. Alert
b. General Emergency
c. Notification of Unusual Events
d. Site Area Emergency

Answer: B.10 a. = CRED; b. = NOT; c. = CRED; d. = NOT
Reference: Emergency Plan

Question B.011 (1.0 point, ⅓ each) {11.0}
Identify the PRIMARY source of each of the radioisotopes listed below as coming from irradiation of air (**A**) or water (**W**), or is a fission product (**FP**).

a. N^{16}
b. Ar^{41}
c. Xe^{135}

Answer: B.11 a. = W; b. = A; c. = FP
Reference: NCS Reactor Operating Procedures

Question B.012 (1.0 point) {12.0}
You hear the Evacuation alarms sounding and you note that the Over-the-Pool radiation monitor is in alarm. Which ONE of the following actions with respect to reactor operations must you perform?

a. Determine if reactor operations may continue.
b. Shutdown the reactor.
c. SCRAM the Reactor.
d. Nothing, the reactor automatically scrams on an evacuation alarm.

Answer: B.12 ~~c.~~ a. per comment
Reference: NRP-OP-105, Response to SCRAMS, Alarms and Abnormal Conditions

Question B.013 (1.0 point) {13.0}
Deleted per comment
~~Which ONE of the following disconnect switches on MCC #1 is NORMALLY locked in the "OFF" position?~~

~~a. Service Demineralizer Pump~~
~~b. Confinement Fan #2~~
~~c. Sump Pump~~
~~d. Crane control~~

~~Answer: B.13 d.~~
~~Reference: PULSTAR Operating Manual § 3.5.2 Part E step 5. Page 3-29.~~

Question B.014 (1.0 point) {14.0}
A radiation survey of an area reveals general radiation readings of 1 mrem/hr. A valve however, reads 10 mrem/hr at 30 cm. Assuming the valve may be considered a point source Per 10 CFR 20 the area must be posted as a …

a. Restricted Area
b. Radiation Area
c. High Radiation Area
d. Very High Radiation Area

Answer: B.14 b.
Reference: 10 CFR 20.

Question B.015 (1.0 point) {15.0}
The SITE BOUNDARY for the facility is …

a. The border that outlines the Reactor Building.
b. The border within a 50 m circle with the stack at the center.
c. The border within a 50 m circle with the reactor core at the center.
d. The border that includes the BEL, the area between Lampe and Broughton Drive and the Area between Stinson Drive and the North face of BEL.

Answer: B.15 ~~c.~~ d. per comment
Reference: Emergency Plan

Question B.016 (1.0 point) {16.0}
Per the Emergency Plan the maximum TEDE which may be authorized for life-saving actions or for the protection of large populations is not practicable is … (not voluntary, by someone who is NOT fully aware of the risks involved)

a. >25 rem
b. Up to 25 rem
c. Up to 10 rem
d. Up to 5 rem

Answer: B.16 d.
Reference: Emergency Plan

Question B.017 (1.0 point) {17.0}
Which ONE of the following is the correct definition of a CHANNEL CHECK?

a. The introduction of a signal into the channel for verification that it is operable.
b. The combination of sensor, line, amplifier, and output devices which are connected for the purposes of measuring the value of a parameter.
c. An adjustment of the channel such that its output corresponds with acceptable accuracy to known values of the parameter which the channel measures.
d. A qualitative verification of acceptable performance by observation of channel behavior. This verification, where possible, shall include comparison of the channel with other independent channels or systems measuring the same variable.

Answer: B.17 d.
Reference: Technical Specifications, Definitions

Question B.018 (1.0 point) {18.0}
Which ONE of the listed radio-isotopes produces the highest ionizing energy gamma?

a. H^3
b. N^{16}
c. Ar^{41}
d. U^{235}

Answer: B.18 b.
Reference: Chart of the Nuclides

Question B.019 (1.0 point) {19.0}
The Emergency Director (ED) must approve all emergency exposures in excess of …

a. 1 Rem
b. 5 Rem
c. 10 Rem
d. 25 Rem

Answer: B.19 b.
REF: Emergency Plan

Question B.020 (1.0 point) {20.0}
Which ONE of the following conditions is a violation of your requalification plan?

a. Your last medical examination was 26 months ago.
b. Last quarter you operated the reactor for six hours.
c. You last took a requalification operating test 13 months ago.
d. You last took a requalification written examination 17 months ago.

Answer: B.20 a.
Reference: Operator Requalification Program and 10 CFR 55.59

Question C.001 [1.0 point] {1.0}
Technical Specifications allow operation without the required differential pressure during investigation of the loss of the differential pressure for a period of time not to exceed…..

a. 20 minutes
b. 30 minutes
c. 45 minutes
d. 60 minutes

Answer: C.01 b.
Reference: T.S. 3.6 Confinement and Main HVAC Systems

Question C.002 [1.0 point] {2.0}
Deleted per facility comment.
~~The Main Exhaust Fan directly takes a suction on the following components except:~~

~~a. BP&TC Exhaust Fan~~
~~b. Reactor Bridge Glove Box~~
~~c. Control Room louvers~~
~~d. Reactor Bay Hood~~

~~Answer: C.02 c.~~
~~Reference: SAR Figure 6-1~~

Question C.003 [1.0 point, ¼ each] {3.0}
Match the core materials listed in column A with their primary purpose in column B.

Column A		Column B	
a.	Zircaloy	1.	Reflector
b.	Beryllium	2.	Cladding
c.	silver-indium-cadmium alloy	3.	Poison
d.	Graphite		

Answer: C.03 a. = 2; b. = 1; c. = 3; d. = 1
Reference: SAR

Question C.004 [1.0 point] {4.0}
On a loss of commercial power which ONE of the following components CANNOT receive power from the auxiliary generator?

a. Confinement Fan #1
b. Confinement Fan #2
c. VAMP Area Radiation Monitor
d. Control Room Distribution Panel

Answer: C.04 c.
Reference: SAR

Question C.005 [1.0 point] {5.0}
Which ONE of the following describes how the Auxiliary Generator supply breaker is closed following a loss of commercial power and the generator is started from the Control Console?

a. As the generator comes up in speed and voltage reaches 80% of rated it automatically closes the switch.
b. As the generator comes up in speed and voltage, the generator voltage works against the spring to close the switch.
c. As the generator comes up to rated speed a time delay times out applying power to the closing relay to close the switch
d. As the generator comes up to rated voltage a contact closes applying power to the closing relay to close the switch.

Answer: C.05 b.
Reference: Operations Manual Sect.6

Question C.006 [1.0 point] {6.0}
The primary to secondary heat exchanger develops a tube leak. Which ONE of the following conditions will result in a loss of reactor coolant to the secondary cooling system?

a.	Primary pump I/S	-	Secondary pump O/S	-	Reactor secured
b.	Primary pump I/S	-	Secondary pump I/S	-	Reactor operating at 1.0 MW
c.	Primary pump O/S	-	Secondary pump O/S	-	Reactor at 50 KW
d.	Primary pump O/S	-	Secondary pump I/S	-	Reactor at 125 KW

Answer: C.06 a. or c. per facility comment.
Reference: Operations Manual Sect.5

Question C.007 [1.0 point] {7.0}
Which ONE of the following statements concerning confinement fans is TRUE?

a. If confinement Fan #1 fails to start manually, Confinement Fan #2 will self-energize.
b. TWO confinement fans are required to achieve negative air pressure in the Reactor Building.
c. To start one of the confinement fans manually the main Heating and Ventilation system must be off.
d. Switch disconnect for Confinement Fan #1 must be opened in order to connect the Aux. Distribution panel to the Aux Generator.

Answer: C.07 c.
Reference: Operations Manual Sect.8

Question C.008 [1.0 point] {8.0}
Which ONE of the following will NOT be affected by a failure of the Linear Power channel High Voltage Power Supply (HVPS)?

a. Flow/Flapper scram enable
b. Control Rod Reverse Drive
c. Automatic Power Controller
d. Linear Channel Overpower SCRAM

Answer: C.08 a.
Reference: Operations Manual Sect.4

Question C.009 [1.0 point] {9.0}
Which one of the following conditions is indicated by the confinement fan damper-verification lights on the Radiation-Monitoring Panel when they are illuminated?

a. power is available to the controlled dampers
b. negative air pressure in the Reactor Building is achieve
c. the main H & V supply and exhaust dampers are fully open
d. the main H & V supply and exhaust dampers are fully closed

Answer: C.09 d.
Reference: SAR, 5.2. Confinement Initiation and Operations Manual Sect.5

Question C.010 [1.0 point] {10.0}
Which one of the following combination of Air Monitoring systems constitutes an off-line isokinetic sampling system?

a. Stack Gas Monitor & Particulate monitor
b. Auxiliary GM monitor & Reactor Bay Cam
c. Recirculation GM monitor & Reactor Bay Cam
d. Over the Pool monitor & Stack Particulate monitor

Answer: C.10 a.
Reference: SAR - 5.2.2. System Design

Question C.011 [1.0 point] {11.0}
Which one of the following monitors utilizes a gamma sensitive scintillation detector?

a. Waste Tank Monitor
b. Stack Particulate Monitor
c. Control Room Area Monitor
d. Personnel Hand and Feet Monitor

Answer: C.11 a.
Reference: SAR - 4.2.4. Liquid Radioactive Drain System

Question C.012 [1.0 point] {12.0}
Which one of the following monitors, when in an ALARM condition, DOES NOT cause an Evacuation?

a. West Reactor Bay Wall Monitor
b. Primary Demineralizer Monitor
c. Control Room Area Monitor
d. Auxiliary GM

Answer: C.12 b.
Reference: SAR - 10.2. Radiation Protection, 10.2.2.Installed Radiation Monitoring Instrumentation

Question C.013 [1.0 point] {13.0}
Which one of the following correctly describes how a Resistance Temperature Detector (RTD) failure would be indicated? If an RTD should fail,

a. because of a short, the temperature indication will go offscale in the low value direction.
b. because of a short, the temperature indication will go to the midpoint of the temperature scale.
c. in the open position, the temperature indication will go offscale in the low value direction.
d. in the open position, the temperature indication will go to the midpoint of the temperature scale.

Answer: C.13 a.
Reference: Generic Instrumentation Question

Question C.014 [1.0 point] {14.0}
Which ONE set of equations below describes the operation of the installed neutron source?

a. Pu -> U + alpha Be + alpha -> C + neutron
b. Pu -> Am + beta Be + beta -> Li + neutron
c. Pu -> U + alpha B + alpha -> N + neutron
d. Pu -> Am + beta B + beta -> Be + neutron

Answer: C.14 a.
Reference: NCSU SNM Inventory Record

Question C.015 [1.0 point] {15.0}
Select the control rod magnet current required to be used prior to fuel movements.

a. 40 mA
b. 60 mA
c. 80 mA
d. 100 mA

Answer: C.15 b.
Reference: NRP-OP-301 - Reactor Fuel Handling; APPENDIX A –

Question C.016 [1.0 point] {16.0}
Which ONE of the following is the purpose of the Nitrogen Purge System?

a. It provides a nitrogen purge gas to the Pneumatic Transfer System to reduce the formation of Ar-41.
b. It acts as a backup motive force in the Pneumatic Transfer system should the air/vacuum supply blower fail.
c. It acts with the BT&TC exhaust system to supply a continuous nitrogen gas blanket to the Beam Tubes to minimize Ar-41 formation.
d. It is used as a source of nitrogen gas for moisture removal and humidity control within the Beam Tubes while in use as a specimen chamber.

Answer: C.16 a.
Reference: SAR - 10.1. Radioactive Wastes

Question C.017 [1.0 point] {17.0}
Which of the following reactions is used for neutron detection in the startup channel detector?

a. Neutron + Nitrogen-16 ---> Nitrogen-17 + Gamma
b. Neutron + Uranium-235 ---> 2 Fission Fragment Ions
c. Neutron + Boron-10 ---> Lithium-7 Ion + Helium-4 Ion
d. Neutron + Fluorine-19 ---> Nitrogen-15 Ion + Helium-4 Ion

Answer: C.17 b.
Reference: SAR, 7.2.1. Source Range Channel

Question C.018 [1.0 point] {18.0}
If a complete loss of pool water were to occur with the reactor having been operating at 1 MWt power, which of the following would be the primary hazard or concern.

a. Keeping the reactor shutdown.
b. Core meltdown due to loss of cooling.
c. Clean up of the highly radioactive coolant water.
d. Vertical beam of radiation from the uncovered core.

Answer: C.18 d.
Reference: SAR, 13.2.1.3. Loss of Pool Water

Question C.019 [1.0 point] {19.0}
Deleted per facility comment.
~~Which ONE of the following statements describes how the three-way mixing valve is affected by a loss of control air?~~

~~a. The valve fails as is.~~
~~b. The valve fails to provide maximum flow to the cooling tower.~~
~~c. The valve is repositioned to provide maximum flow to the pump suction, thus bypassing the cooling tower.~~
~~d. The valve fails in mid-position. Half the flow is directed to the cooling tower and half to the pump suction.~~

~~Answer: C.19 b.~~
~~Reference: SAR, 4.2.2. Secondary System~~

Question C.020 [1.0 point] {20.0}
Which of the following describes how secondary system inventory is maintained?

a. Makeup is automatically initiated by cooling tower basin level.
b. Makeup is manually initiated on a low cooling tower basin level.
c. Makeup is automatically initiated by secondary pump suction pressure.
d. Chief of Reactor Maintenance (CRM) manually adds makeup on a predetermined schedule.

Answer: C.20 a.
Reference: SAR, Figure 4-1B, Secondary Coolant System