February 29, 2016

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-16-01, NORTH CAROLINA STATE UNIVERSITY

Dear Dr. Hawari:

During the week of February 1, 2016, the 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 (PARS) component of NRC's Agencywide Documents Access and Management System (ADAMS). ADAMS is accessible from the NRC Web site at http://www.nrc.gov/reading-rm/adams.html. The NRC is forwarding the individual grades to you in a separate letter which will not be released publicly. Should you have any questions concerning this examination, please contact Mr. Phillip T. Young at (301) 415-4094 or via e-mail Phillip.Young@nrc.gov.

Sincerely,

/RA/

Anthony J. Mendiola, Chief
Research and Test Reactors Oversight Branch
Division of Policy and Rule Making
Office of Nuclear Reactor Regulation

Docket No. 50-297

Enclosures: 1. Examination Report No. 50-297/OL-16-01
2. Written examination with facility comments

cc: without enclosures: See next page

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DATE	2/25/2016		2/24/2016		2/29/2016	

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Office of Intergovernmental Relations
116 West Jones Street
Raleigh, NC 27603

Dr. Kostadin Ivanov, Department Head
Department of Nuclear Engineering
North Carolina State University
Campus Box 7909
Raleigh, NC 27695-7909

W. Lee Cox, Section Chief
Department of Health and Human Services
Division of Health Service Regulation Radiation Protection Section
1645 Mail Service Center
Raleigh, NC 27699-1645

Dr. Louis Martin-Vega, Dean
College of Engineering
North Carolina State University
113 Page Hall
Campus Box 7901
Raleigh, NC 27695-7901

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

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

REPORT NO.: 50-297/OL-16-01

FACILITY DOCKET NO.: 50-297

FACILITY LICENSE NO.: R-120

FACILITY: North Carolina State University Pulstar Reactor

EXAMINATION DATES: February 1 - 3, 2016

SUBMITTED BY: ***/RA Patrick Isaac Acting for/*** 2/25/2016
Phillip T. Young, Chief Examiner Date

SUMMARY:

During the week of February 1, 2016 the NRC administered licensing examinations to three Reactor Operator (RO) applicants. The applicants passed all portions of the examination.

REPORT DETAILS

1. Examiner: 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
Greg Gibson, NCSU, Chief Reactor Operator
Kerry Kincaid, NCSU, Chief of Reactor Maintenance

The examiner thanked the facility for their assistance and feedback on the written examination.

ENCLOSURE 1

Facility Comments with NRC Resolution.

Question: A.008

Comment: The correct answer is a.

NRC Resolution: Comment accepted. Correct answer for A.008 is changed from (c.) to (a.).

Question: B.016

Comment: The answer key states the correct answer is d. per Technical Specifications 3.2.d Bases,
However the correct answer is b. per Technical Specifications 3.2.d Bases paragraph 4.

NRC Resolution: Comment accepted. Correct answer for B.016 is changed from (d.) to (b.).

Question: C.006

Comment: The question states “Primary coolant flow rate is measured at an orifice installed:”, at NCSU we use an annubar device to create the pressure drop not an orifice plate. This does not change the correct answer.

NRC Resolution: Comment accepted. The staff will change the question for future reference.

Question: C.011

Comment: The answer key states the correct answer is a. per SAR 4.2.1 Reactor Fuel. However the correct answer is d. per SAR 4.2.1 Reactor Fuel, paragraph 3 sentence 3.

NRC Resolution: Comment accepted. Correct answer for C.011 is changed from (a.) to (d.).

Question: C.017

Comment: The answer key states the correct answer is c. per the reference SAR 4.2.1 Reactor Fuel, however the both answer c. and d. are correct per the reference SAR 7.3.3.

NRC Resolution: Comment accepted. For question C.017, both (c.) and (d.) are accepted as correct.

ENCLOSURE 2

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

FACILITY: NORTH CAROLINA STATE UNIVERSITY

REACTOR TYPE: PULSTAR

DATE ADMINISTERED: 2/1/2016

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	32.8	_____	_____	A. REACTOR THEORY, THERMODYNAMICS, AND FACILITY OPERATING CHARACTISTICS
20.00	32.8	_____	_____	B. NORMAL AND EMERGENCY OPERATING PROCEDURES AND RADIOLOGICAL CONTROLS
21.00	34.4	_____	_____	C. FACILITY AND RADIATION MONITORING SYSTEMS
61.00		_____ **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

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

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

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

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

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

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

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

$$CR_1 (1 - K_{eff_1}) = CR_2 (1 - K_{eff_2}) \quad CR_1 (-\rho_1) = CR_2 (-\rho_2)$$

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

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

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

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

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

$$T = \frac{\lambda^*}{\rho - \bar{\beta}}$$

$$T = \frac{\lambda^*}{\rho} + \left[\frac{\bar{\beta} - \rho}{\lambda_{eff} \rho + \beta} \right]$$

$$T_{\frac{1}{2}} = \frac{0.693}{\lambda} \quad \Delta\rho = \frac{K_{eff_2} - K_{eff_1}}{K_{eff_1} K_{eff_2}}$$

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

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

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

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

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

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

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

Section A: Reactor Theory, Thermodynamics, and Fac. Operating Characteristics

Question A.001 (1 point) {1.0}

Given the following Core Reactivity Data during startup:

Control Rod	Total Rod Worth (pcm)	Rod Worth removed at 5 watts critical (pcm)
Rod # 1	2000	1500
Rod # 2	3000	2000
Rod # 3	4000	3500
Total	9000	7000

Assuming that all control rods are scrammable, the TECHNICAL SPECIFICATION MINIMUM Shutdown Margin for this core is:

a. 2000 pcm
b. 3000 pcm
c. 4000 pcm
d. 7000 pcm

Answer: A.01 b.

Reference: Tech Spec Minimum SDM =

SDM – highest control rod worth 7000 pcm – 4000 pcm = 3000 pcm

Or Total rod worth – excess reactivity – highest control rod worth 9000 pcm – 2000 pcm – 4000 pcm = 3000 pcm

Question A.002 (1 point) {2.0}

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.02 b.

Reference: Pulstar Reactor Trainee Notebook, Section 1.5.3.

Question A.003 (1 point) {3.0}

The resonance escape probability is the probability that a fission neutron will escape capture in resonances as it slows down to thermal energies. As the moderator temperature increases, the resonance escape probability:

a. increases, since the moderator becomes less dense.
b. increases, since the moderator-to-fuel ratio increases.
c. decreases, since the time required for a neutron to reach thermal energy increases.
d. remains constant, since the effect of moderator temperature change is relatively small.

Answer: A.03 c.

Reference: Pulstar Reactor Trainee Notebook, Section 2.7.1.

Section A: Reactor Theory, Thermodynamics, and Fac. Operating Characteristics

Question A.004 (1 point) {4.0}
Which one of the following is the definition for INTEGRAL ROD WORTH?
Integral Rod Worth is defined as the reactivity…..
a. due to control rod position.
b. change per unit of rod motion.
c. due to the difference in a control rods position.
d. still available for shutdown after control rod withdrawal.
Answer: A.04 a.
Reference: Nuclear Energy Training Module 3 Section 7 page 7.5-1

Question A.005 (1 point) {5.0}
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.05 c.
Reference: NC State's Pulstar Reactor Trainee Notebook, Section 3.7
Power = $mc\Delta T/\Delta t$, 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

Question A.006 (1 point) {6.0}
Few minutes following a reactor scram of 500 kW, the reactor period has stabilized and the power level is decreasing at a CONSTANT rate. What is the power level one minute later from 1 kW?
a. 0.2 kW
b. 0.5 kW
c. 0.8 kW
d. 2.1 kW
Answer: A.06 b
Reference: P = P0 e-t/T =
1 kW * e(60sec/-80sec) = 1 kW * e-0.75 = 0.472 * 1 kW = 0.47 kW

Section A: Reactor Theory, Thermodynamics, and Fac. Operating Characteristics

Question A.007 (1 point) {7.0}
A 1/M curve is being generated as fuel is loaded into the core. After some fuel elements have been loaded, the count rate existing at that time is taken to be the new initial count rate, C_o. Additional elements are then loaded and the inverse count rate ratio continues to decrease. As a result of changing the initial count rate:
a. predicted criticality will occur with the same number of elements loaded as if the initial count rate had not been changed.
b. predicted criticality will occur earlier (i.e., with fewer elements loaded).
c. predicted criticality will occur later (i.e., with more elements loaded).
d. criticality will be completely unpredictable.
Answer: A. 07 a.
Reference: Pulstar Reactor Trainee Notebook, Section 1.5.4.

Question A.008 (1 point) {8.0}
The following shows part of a decay chain for the radioactive element Radon (Rn). This decay chain is a good example of ___ decay.

$$^{222}_{86}Rn \xrightarrow{3.8\ \mathrm{d}} {}^{218}_{84}Po$$

a. Alpha
b. Beta
c. Gamma
d. Neutron
Answer: A.08 ~~c.~~ Answer is a. per facility comment
Reference: DOE Fundamentals Handbook *Nuclear Physics and Reactor Theory Vol. 2*

Question A.009 (1 point) {9.0}
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.09 a.
Reference: Standard NRC QUESTION.

Question A.010 (1 point) {10.0}
Which ONE of the following is a number of neutrons in the Uranium-235 nucleus (92U235)?
a. 92
b. 143
c. 235
d. The U-235 doesn't have a constant number of neutrons, it fluctuates between 95 and 140
Answer: A.10 b.
Reference: Nuclides and Isotopes N = A – Z 235-92 = 143

Section A: Reactor Theory, Thermodynamics, and Fac. Operating Characteristics

Question A.011 (1 point) {11.0}
Which of the following statements best characterizes Natural Circulation?
a. The driving force is a difference in density.
b. Heat transfer is more efficient as the heat source decays.
c. Heat transfer is more efficient if steam is mixed with water.
d. The elevation of the heat source must be above that of the heat sink.
Answer: A.11 a.
Reference: General Physics, HT&FF, pp. 355 - 358

Question A.012 (1 point) {12.0}
During a reactor startup, criticality occurred at a lower rod height than the last startup. Which ONE of the following reasons could be the cause?
a. Xe^{135} peaked.
b. Moderator temperature increased.
c. Adding an experiment with positive reactivity.
d. Maintenance on the control rods resulted in a slightly faster rod speed.
Answer: A.12 c.
Reference: Standard NRC Question

Question A.013 (1 point) {13.0}
Given a critical nuclear reactor operating below the point of adding heat (POAH), what reactivity effects are associated with reaching the POAH?
a. There are no reactivity effects because the reactor is critical.
b. The increase in fuel temperature will begin to create a positive reactivity effect.
c. The decrease in fuel temperature will begin to create a negative reactivity effect.
d. The increase in fuel temperature will begin to create a negative reactivity effect.
Answer: A.13 d.
Reference: DOE Fundamentals Handbook *Nuclear Physics and Reactor Theory Vol. 2*

Question A.014 (1 point) {14.0}
Given the following Primary System Parameters.
Reactor Pool Volume 14,250 gals
Reactor Pool Temperature 104º F
Reactor Power Level 1 MW
Which one of the following is the amount of time that is available before the reactor has to be scrammed, at 118 F pool temperature, when primary coolant flow is lost?
a. 15 minutes
b. 22 minutes
c. 29 minutes
d. 36 minutes
Answer: A.014 c.
Reference: Nuclear Energy Training, Module 4, Plant Performance Section 2

Section A: Reactor Theory, Thermodynamics, and Fac. Operating Characteristics

Question A.015 (1 point) {15.0}
Given the following data, which ONE of the following is the closest to the half-life of the material?

TIME	ACTIVITY
0	2400 cps
10 min.	1757 cps
20 min.	1286 cps
30 min.	941 cps
60 min.	369 cps

a. 11 minutes
b. 22 minutes
c. 44 minutes
d. 51 minutes
Answer: A.15 b.
Reference: $I = I_0 e^{-t/\tau}$ $Ln(369/2400) = 60min/\tau$ $\tau = 60min/[ln(369/2400)] = 32.044\ min^{-1}$.
$t_2 = ln(2)\ H\tau = -22.211$

Question A.016 (1 point) {16.0}
Which one of the following most correctly completes the following as the reason for having an installed neutron source within the core?
A startup without an installed neutron source...
a. could result in a very short period due to the reactor going critical before neutron population built up high enough to be read on nuclear instrumentation.
b. is impossible as there would be no neutrons available to start up the reactor.
c. would be very slow due to the long time to build up neutron population from so low a level.
d. can be compensated for by adjusting the compensating voltage on the source range detector.
Answer: A.16 a.
Reference: DOE Fundamentals Handbook *Nuclear Physics and Reactor Theory Vol. 2*

Question A.017 (1 point) {17.0}
Convert 1000 pcm to %Δk/k.
a. 0.1%
b. 1.0%
c. 10.0%
d. 100%
Answer: A.17 b.
Reference: Pulstar Training Manual
1.2.16 pcm: A unit of reactivity that is the abbreviation for "percent millirho" and is equal to 10-5 Δk/k reactivity. For example, 1000 pcm is equal to 1.0% Δk/k.

Section A: Reactor Theory, Thermodynamics, and Fac. Operating Characteristics

Question A.018 (1 point) {18.0}

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.18 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.019 (1 point) {19.0}

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.19 b.
Reference: Pulstar Reactor Trainee Notebook, Section 3.4.
Power = $\Sigma_f \Phi_{th}$ As Σ_f decreases due to fuel burnup, Φ_{th} must increase.

Question A.020 (1 point) {20.0}

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.20 c.
Reference: Pulstar Reactor Trainee Notebook, Section 1.1.

(*** End of Section A ***)

Question B.001 (1 point) {1.0}
Which one of the following Emergency Classes is being described?
"Events are in process or have occurred which involve an actual or potential substantial degradation of the level of safety of the reactor."
a. Notification of Unusual Events
b. Alert
c. Site Area Emergency
d. General Emergency
Answer: B.01 b.
Reference: Emergency Procedure 4 Rev. 6 - 5.1 Emergency Classification Criteria (2)(b)

Question B.002 (1 point) {2.0}
Your Annual Limit (Occupational Dose Limit for an adult) for Total Effective Dose Equivalent is …
a. 1.25 rems
b. 5.0 rems
c. 15.0 rems
d. 50 rems
Answer: B.02 b.
Reference: 10CFR20.2001.a(1)

Question B.003 (1 point) {3.0}
Which of the following is TRUE regarding the reactivity limitation on a movable experiment at the NC State PULSTAR reactor?
a. 300 pcm or 100 pcm/sec, whichever is more limiting
b. 500 pcm or 200 pcm/sec, whichever is more limiting
c. 730 pcm or 100 pcm/sec, whichever is more limiting
d. 1000 pcm
Answer: B.03 a.
Reference: OP-104, Reactor Experiments Rev. 3 - 2.1. Reactivity Limitations

Question B.004 (1 point) {4.0}
The Total Effective Dose Equivalent is equal to the …
a. sum of external and internal dose.
b. dose equivalent at a tissue depth of 1 cm.
c. dose equivalent to organs or tissues
d. sum of dose multiplied by weighting factors.
Answer: B.04 a.
Reference: 10 CFR 20

Question B.005 (1 point) {5.0}
During refueling operations the procedure states "All fuel additions shall be made with the rods "cocked"." Which one of the following will correctly complete the definition of a "cocked" rod? The rods positioned at some position at least __?__ below the estimated critical position to ensure the reactor shall remain subcritical upon fuel loading and concurrently a position that provides at least __?__ shutdown capability by rod insertion.
a. 600 pcm, 200 pcm
b. 500 pcm, 300 pcm
c. 400 pcm, 400 pcm
d. 300 pcm, 500 pcm
Answer: B.05 c.
Reference: NRP-OP-301, Reactor Fuel Handling Rev. 2 - 1.2. Definitions

Question B.006 (1 point) {6.0}
Which ONE of the following statements describe a "Radiation Area"?
a. Any area, accessible to personnel, in which there exists radiation at such levels that a major portion of the body could receive in excess of 100 mr/hr.
b. Any area, accessible to personnel, in which there exists radiation at such levels that a major portion of the body could receive in 5 consecutive days a dose in excess of 100 mr.
c. Any area, accessible to personnel, in which there exists radiation in excess of 25 percent of the amounts specified in Appendix B, Table I, Column I of 10 CFR 20.
d. Any accessible area, controlled by the licensee, where an individual could receive a dose in excess of 5 mr/hr.
Answer: B.06 d.
Reference: HP 1 Radiation Protection Program Rev 8 – 4.6.5

Question B.007 (1 point) {7.0}
Fill in the blank: According to Technical Specifications, the “designated Senior Operator (DSRO) is considered readily available on call, meaning: ...is capable of getting to the reactor facility within a reasonable time under normal conditions e.g., _____ minutes.
a. 15
b. 30
c. 45
d. 60
Answer: B.07 b.
Reference: Technical Specification 6.1.3.c

Question B.008 (1 point) {8.0}
Which ONE of the materials listed is required to doubly encapsulated prior to irradiation per Technical Specifications?
a. Explosive
b. Corrosive
c. Fueled
d. Cryogenic
Answer: B.08 b.
Reference: Technical Specification 3.7.a

Question B.009 (1 point) {9.0}

The standard ANSI/ANS 15.16 defines four Emergency Action Levels (EAL). Which ONE of the listed EALs is the most severe CREDIBLE accident which could occur at your reactor? (Note: EALs are listed in alphabetical order, NOT necessarily in order of severity.)

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

Answer: B.09 a.
Reference: Emergency Procedure 4 Rev. 6 - Emergency Classification, Note

Question B.010 (1 point) {10.0}

Which of the following is NOT required to review and sign a "RWP" before work can begin?

a. Person in charge of work
b. Reactor Health Physicist
c. Chief of Reactor Maintenance
d. Reactor Operations Manager

Answer: B.10 c.
Reference: HP-8 Radiation Work Permit, 4.2 Issuance of RWP

Question B.011 (1 points, 0.25 points each) {11.0}

Match the color pens for the log entries in Column A with the correct description of the entry in Column B.

Column A	Column B
a. Black	1. Reactor Secured
b. Blue	2. Unscheduled SCRAM/SHUTDOWN
c. Red	3. Routine entries
d. Green	4. Clear a SCRAM
	5. Not Used

Answer: B.11 a. = 3; b. = 5; c. = 2; d. = 4
Reference: OP103, Reactor Operation Rev. 3 – 3.1.3

Question B.012 (1 point) {12.0}

In the event of a student who sustains a life-threatening head injury with contamination, which treatment facility will this individual be transported to in accordance with the NC State Pulstar Reactor E-Plan?

a. NC State Student Health Center
b. Rex Hospital
c. Duke Raleigh Hospital
d. Holly Hill Hospital

Answer: B.12 b.
Reference: Emergency Procedure 4 Rev. - Section 3.3.1

Question B.013 (1 point) {13.0}
The Operations Boundary consists of:
a. the area within the Burlington Engineering Laboratory.
b. the area within the Pulstar Reactor Building and the South Wing.
c. the area within the Pulstar Reactor Building, Control Room and Primary Piping Vault.
d. the area within the Administration and Laboratory Building, and the Reactor Building.
Answer: B.13 c.
Reference: Emergency Plan Rev 9, The border that outlines the Reactor Building (Fig. 4)

Question B.014 (1 point, 0.25 points each) {14.0}
Identify each of the listed requirements as a Safety Limit (SL) a Limiting Safety System Setting (LSSS) or a Limiting Condition for Operation (LCO).
a. Maximum of 25 fuel assemblies.
b. Minimum height of water above the core of 14 feet, 2 inches.
c. The True value of reactor coolant inlet temperature shall not be greater than 120°F.
d. N^{16} Power Measuring channel is operable when power >500kW.
Answer: B.14 a. = LCO; b. = LSSS; c. = SL; d. = LCO
Reference: Technical Specifications 2.1.c , 2.2, 3.1 and 3.4

Question B.015 (1 point) {15.0}
If it is true that a ½ thickness for gammas in water is about 12 inches, then the 20 feet of water between the core and the top of the pool the radiation intensity due to gammas will have decreased by a factor of approximately …
a. 40
b. 400
c. 1,000
d. 1,000,000
Answer: B.15 d.
Reference: 2^{20} = 1,048,576 distractors: a = 2 ×20; b= 20^2, c = bogus

Question B.016 (1 point) {16.0}
Technical Specifications state "The rate of reactivity insertion of the control rods is not greater than 100 pcm per second (critical region only)." Which of the following is the bases for this limit? The maximum rate of reactivity insertion by the control rods which is allowed by Specification 3.2.d assures the Safety Limit will not be exceeded during:
a. a rod ejection accident in the steady state mode.
b. a startup accident due to a continuous linear reactivity insertion.
c. the flow reversal which occurs upon loss of forced convection coolant flow.
d. an accidental withdrawal of a 0.3% delta k/k experiment in the pneumatic rabbit.
Answer: B.16 ~~d.~~ Answer is b. per facility comment
Reference: Technical Specification - 3.2.d Bases

Question B.017 (1 point) {17.0}
An individual receives 100 mRem of Beta (ß), 25 mRem of gamma (γ), and 5 mRem of neutron radiation. What is his/her total dose?
a. 275 mRem
b. 205 mRem
c. 175 mRem
d. 130 mRem
Answer: B.17 d.
Reference: 10 CFR 20.4 A rem is a rem is a rem

Question B.018 (1 point) {18.0}
During which of the following Start-up/Shutdown evolutions, described in OP-101, could you expect the stated reactor response to occur. "However, if the power continues to rise at a steady exponential rate (stable positive period), the reactor is supercritical."
a. KEY-ON
b. FAST RECOVERY
c. SHUTDOWN – KEY-OFF
d. FORCED CONVECTION
e. NATURAL CIRCULATION
Answer: B.18 b.
Reference: OP101, Reactor Startup and Shutdown Rev 9, Page 10,
SECTION - 5. REACTOR STARTUP – FAST RECOVERY

Question B.019 (1 point) {19.0}
OP-101, Reactor Startup and Shutdown states the following "…a "benchmark" rod gang position is computed for a specified core configuration and set of control rod values. This value will be such that if the ACP results in the control rod gang being withdrawn beyond the "benchmark", then the cold, clean SDM will be > _____ and may be logged as such without computation." What is the predetermined value for SDM that may be logged?
a. >500 pcm
b. >650 pcm
c. >800 pcm
d. >950 pcm
Answer: B.19 c.
Reference: OP101, Reactor Startup and Shutdown Rev 9, Page 13,
Section - 8. Shutdown Margin (SDM) Verfication

Question B.20 (1 point) {20.0}
According to the Technical Specifications, if one filter train in the ventilation system is down for maintenance, the other filter train must be verified operable every …
a. 8 hours
b. 12 hours
c. 24 hours
d. 48 hours
Answer: B.20 c.
Reference: Technical Specifications, Section 3.6

(*** End of Section B ***)

Section C: Facility and Radiation Monitoring Systems

Question C.001 (1 point) {1.0}
Which ONE of the following load cannot be supplied by the Auxiliary Distribution panel?
a. Primary pump motor
b. Confinement Fan #1
c. Confinement Fan #2
d. Reactor Console
Answer: C.001 a.
Reference: SAR Figure 8-1 – Electrical Distribution System

Question C.002 (1 point) {2.0}
Which ONE of the following actions does not occur upon the receipt of a Confinement signal?
a. Control Room HVAC off
b. BT&TC exhaust fan off (and damper)
c. Confinement Fan #2 starts (and damper opens)
d. Main H&V system off (supply & exhaust fans and dampers)
Answer: C.02 c.
Reference: NRP-OP-101, Reactor Startup and Shutdown Rev. 9
Appendix B – Startup Checklist Instructions

Question C.003 (1 point) {3.0}
Which ONE of the following statements is TRUE?
a. The Emergency Reactor Air is supplied by the BEL air compressor.
b. An orifice reduces city water pressure to 20 psig for use in the Service Water System.
c. The purification system uses non-regenerable nuclear grade resin to control primary system pH.
d. The Reactor Bay Raw Water system is used to directly supply water for beam tube annulus recirculation.
Answer: C.03 c.
Reference: SAR, 5.4. Primary Coolant Cleanup System

Question C.004 (1 point) {4.0}
What type of detector does the N-16 channel use?
a. SEMIRAD burst
b. Compensated ion chamber
c. Uranium lined, fission chamber
d. Gas filled gamma sensitive ionization chamber
Answer: C.04 d.
Reference: SAR, 7.4.3.5. N-16 Channel

Section C: Facility and Radiation Monitoring Systems

Question C.005 (1 point) {5.0}

Which ONE of the following events will occur due to a loss of the Reactor Air Supply while the reactor is operating at 100% power?

a. The shim rod will drift down into the core.
b. An Abnormal Pool Level alarm will annunciate due to a high pool level indication.
c. Red LOW POOL LEVEL SCRAM annunciator light comes on. A LOW POOL LEVEL SCRAM occurs.
d. A Low Primary Flow condition will be sensed and the flapper valve will open, causing a Flapper Open scram.

Answer: C.05 c.
Reference: NRP-OP-101, Reactor Startup and Shutdown Rev. 9
Appendix B – Startup Checklist Instructions

Question C.006 (1 point) {6.0} Facility comment

Primary coolant system flow rate is measured at an annubar device ~~orifice~~ installed:

a. prior to the suction of the primary coolant pump.
b. after the discharge of the primary coolant pump.
c. prior to the inlet of the heat exchanger.
d. after the outlet of the heat exchanger.

Answer: C.06 a.
Reference: SAR, 7.4.4. Non-Nuclear Instrumentation and
Figure 5-1A Primary Coolant System

Question C.007 (1 point) {7.0}

How is the radiation level associated with N-16 controlled during reactor operations with natural convection flow?

a. Baffling in the N-16 delay tank
b. Maintaining pool level above the Limiting Safety System Setting of 14 feet 2 inches
c. The N-16 diffuser pump
d. Placing both trains of the confinement ventilation filter system in service

Answer: B.07 b.
Reference: SAR 11.1.1.1. Airborne Radiation Sources

Question C.008 (1 point) {8.0}

Which of the following is **NOT** a method for controlling radiation levels at the NC State Pulstar reactor?

a. Argon purge of the Pneumatic Rabbit System when not in use.
b. Installing shield plugs in the valve pit adjacent to the biological shield.
c. Draining liquid waste from the Reactor building to the sump in the floor of the Mechanical Equipment Room (MER).
d. Maintaining the PULSTAR Reactor Building at a negative d/p such that effluent release is through the ventilation stack.

Answer: B.08 a.
Reference: SAR 11.1.1.1. Airborne Radiation Sources

Section C: Facility and Radiation Monitoring Systems

Question C.008 (1 point) {8.0}
The NCSU reactor cladding is made of …
a. aluminum
b. silver-indium-cadmium alloy
c. stainless steel
d. zirconium alloy
Answer: C.08 d.
Reference: SAR

Question C.009 (1 point) {9.0}
Which one of the following is the Startup Neutron Source utilized at the NC State Pulstar reactor?
a. Plutonium - beryllium
b. Antimony - beryllium
c. Polonium - beryllium
d. Americium - beryllium
Answer: C.09 a.
Reference: SAR, Table 1-1

Question C.010 (1 point) {10.0}
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.10 b.
Reference: SAR, 8.2. Emergency Electrical Power Systems

Question C.011 (1 point) {11.0}
When a fuel assembly is inserted into the core, misalignment is prevented by:
a. proper orientation of the upper end fitting.
b. proper orientation of openings on the sides of the assembly.
c. proper orientation of the bail between the side plates at the top of the assembly.
d. proper orientation of two holes on the lower end fitting which mate with a pin on the grid plate.
Answer: C.11 ~~c.~~ Answer is d. per facility comment
Reference: SAR, 4.2.1. Reactor Fuel

Section C: Facility and Radiation Monitoring Systems

Question C.012 (1 point) {12.0}
Which ONE of the following statements is true?
a. The primary pump must be operating for the secondary pump to operate.
b. The secondary pump must be operating for the primary pump to operate.
c. The secondary pump must be operating for the cooling tower fans to operate.
d. The cooling tower fans must be operating for the secondary pump to operate.
Answer: C.12 c.
Reference: SAR, 5.3. Secondary Coolant System

Question C.013 (1 point) {13.0}
When the Confinement Mode is initiated, the order for the flow path for the discharged air is through the:
a. HEPA filter, charcoal absorber, confinement fan and stack.
b. confinement fan, HEPA filter, charcoal absorber and stack.
c. pre-filter, main filter, confinement fan, and stack.
d. HEPA filter, confinement fan, charcoal absorber and stack.
Answer: C.13 a.
Reference: SAR, 6.2.1. Confinement System

Question C.014 (1 point) {14.0}
Temperatures in the primary coolant system are measured at six locations using a:
a. thermometer.
b. thermocouple.
c. bimetallic temperature detector.
d. resistance temperature detector.
Answer: C.14 d.
Reference: SAR, 5.2. Primary Coolant System

Question C.015 (1 point) {15.0}
The operation of the cooling tower fans is controlled by:
a. the temperature of secondary water in the pump suction header.
b. the temperature of primary water exiting the heat exchanger.
c. the temperature of secondary water leaving the heat exchanger.
d. the outside air temperature.
Answer: C.15 b.
Reference: SAR, 5.3. Secondary Coolant System

Section C: Facility and Radiation Monitoring Systems

Question C.016 (1 point, 0.25 points each) {16.0}

Match the nuclear instrumentation actions listed in Column A with the detector types listed in Column B. Column B answers may be used once, more than once, or not at all.

Column A	Column B
a. Supplies input to Automatic Channel.	1. Fission Chamber.
b. Low count rate rod withdrawal inhibit.	2. Uncompensated Ion Chamber.
c. Supplies signal for Reverse drive.	3. GM tube.
d. Supplies input to safety power meter.	4. Compensated Ion Chamber.

Answer: C.16 a. = 4; b =1; c. = 4 d. = 2.
Reference: SAR, Figure 7-2.

Question C.017 (1 point) {17.0}

Which ONE of the following conditions (events) will **NOT** cause a Reverse Drive?

a. Ganged Insert" switch in the IN position
b. Loss of magnet power with the Reactor Keyswitch "ON"
c. Linear Power channel at 80%
d. Startup channel at greater than 5×10^3 cps

Answer: C.17 c.
Reference: SAR

Question C.018 (1 point) {18.0}

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.18 a.
Reference: SAR, 6.2.1. Confinement System

Question C.019 (1 point) {19.0}

Which ONE of the following is **NOT** an automatic primary coolant system SCRAM while operating in the Forced Convection mode?

a. Low primary flow, less than 475 gpm when power is greater than 200 kW.
b. Flapper open, power greater than 250 kW.
c. Low water level, 36 inches below normal.
d. High pool temperature, 114^{o}F.

Answer: C.19 d.
Reference: SAR, Figure 7.3 – Typical SCRAM/Alarm Control Circuit

Section C: Facility and Radiation Monitoring Systems

Question C.20 (1 point) {20.0}
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.20 a.
Reference: SAR, Figure 7.3 – Typical SCRAM/Alarm Control Circuit

(*** End of Examination ***)