March 21, 2016

Dr. Cameron Goodwin, Director
Rhode Island Atomic Energy Commission
Rhode Island Nuclear Science Center
16 Reactor Road
Narragansett, RI 02882-1165

SUBJECT: EXAMINATION REPORT NO. 50-193/OL-16-01, RHODE ISLAND NUCLEAR SCIENCE CENTER

Dear Dr. Goodwin:

During the week of February 22, 2016, the U.S. Nuclear Regulatory Commission (NRC) administered an operator licensing examination at your Rhode Island Nuclear Science Center 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 you and those members of your staff identified in the enclosed report at the conclusion of the examination.

In accordance with Title 10 of the *Code of Federal Regulations,* Section 2.390, a copy of this letter and the enclosures will be available electronically for public inspection in the NRC Public Document Room or from the Publicly Available Records (PARS) component of NRC's Agencywide Documents Access and Management System (ADAMS). ADAMS is accessible from the NRC Web site at http://www.nrc.gov/reading-rm/adams.html. The NRC is forwarding the individual grades to you in a separate letter which will not be released publicly. Should you have any questions concerning this examination, please contact Ms. Michele DeSouza at (301) 415-1169 or via e-mail, Michele.DeSouza@nrc.gov.

Sincerely,

/RA/

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

Docket No. 50-193

Enclosures: 1. Examination Report No. 50-193/OL-16-01
2. Written examination

cc: w/o enclosures: See next page

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DISTRIBUTION w/ enclosures
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ADAMS ACCESSION #: ML16073A003 **TEMPLATE #:NRR-079**

OFFICE	NRR/DPR/PROB/CE		NRR/DPR/PROB/OLA		NRR/DPR/PROB/BC	
NAME	MDeSouza		CRevelle		AMendiola	
DATE	03/14/2016		03/14/2016		03/21/2016	

OFFICIAL RECORD COPY

cc:

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Providence, RI 02903

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Providence, RI 02908-5097

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.: 50-193/OL-16-01

FACILITY DOCKET NO.: 50-193

FACILITY LICENSE NO.: R-95

FACILITY: Rhode Island Nuclear Science Center Reactor

EXAMINATION DATE: February 24, 2015

SUBMITTED BY: _____/RA/_____ __03/14/2016_____
Michele DeSouza, Chief Examiner Date

SUMMARY:
During the week of February 22, 2016, the NRC administered an operator licensing examination to one Reactor Operator (RO) candidate. The Reactor Operator candidate passed all applicable portions of the examination.

REPORT DETAILS

1. Examiner: Michele DeSouza, Chief Examiner, NRC

2. Results:

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

3. Exit Meeting:
Michele C. DeSouza, Chief Examiner, NRC
Dr. Cameron Goodwin, Director, RINSC
Michael J. Davis, Reactor Manager, RINSC
Paul Martin, Training Supervisor, RINSC

Upon completion of the examination, the NRC Examiner met with facility staff representatives to discuss the results. At the conclusion of the meeting, the NRC examiner thanked the facility for their support in the administration of the examination.

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

FACILITY: Rhode Island Nuclear Science Center Reactor

REACTOR TYPE: POOL

DATE ADMINISTERED: 02/24/2016

CANDIDATE: _____

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

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

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

_____
Candidate's Signature

ENCLOSURE 2

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

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.

A01 a b c d ___

A02 a b c d ___

A03 a ___ b ___ c ___ d ___ (0.25 each)

A04 a b c d ___

A05 a b c d ___

A06 a b c d ___

A07 a b c d ___

A08 a b c d ___

A09 a b c d ___

A10 a b c d ___

A11 a b c d ___

A12 a b c d ___

A13 a b c d ___

A14 a b c d ___

A15 a b c d ___

A16 a b c d ___

A17 a b c d ___

A18 a b c d ___

A19 a b c d ___

A20 a b c d ___

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

Category B – Normal/Emergency Operating Procedures and Radiological Controls

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.

B01 a b c d ___

B02 a b c d ___

B03 a b c d ___

B04 a b c d ___

B05 a b c d ___

B06 a b c d ___

B07 a b c d ___

B08 a b c d ___

B09 a ____ b ____ c ____ d ____ (0.25 each)

B10 a b c d ___

B11 a b c d ___

B12 a b c d ___

B13 a b c d ___

B14 a b c d ___

B15 a b c d ___

B16 a b c d ___

B17 a ___ b ___ c ___ d ___ (0.25 each)

B18 a b c d ___

B19 a b c d ___

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

Category C – Facility and Radiation Monitoring Systems

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.

C01 a b c d ___

C02 a b c d ___

C03 a b c d ___

C04 a b c d ___

C05 a b c d ___

C06 a b c d ___

C07 a b c d ___

C08 a b c d ___

C09 a b c d ___

C10 a ___ b ___ c ___ d ___ (0.25 each)

C11 a b c d ___

C12 a ___ b ___ c ___ (0.33 each)

C13 a b c d ___

C14 a b c d ___

C15 a b c d ___

C16 a b c d ___

C17 a b c d ___

C18 a b c d ___

C19 a b c d ___

C20 a b c d ___

(***** END OF CATEGORY C *****)
(********** 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 neither received nor given assistance in completing the examination. This must be done after you complete the examination.

3. Restroom trips are to be limited and only one candidate at a time may leave. You must avoid all contacts with anyone outside the examination room to avoid even the appearance or possibility of cheating.

4. Use black ink or dark pencil only to facilitate legible reproductions.

5. Print your name in the blank provided in the upper right-hand corner of the examination cover sheet and each Answer sheet.

6. Mark your Answers on the Answer sheet provided. USE ONLY THE PAPER PROVIDED AND DO NOT WRITE ON THE BACK SIDE OF THE PAGE.

7. The point value for each question is indicated in [brackets] after the question.

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

9. When turning in your examination, assemble the completed examination with examination questions, examination aids and Answer sheets. In addition turn in all scrap paper.

10. Ensure all information you wish to have evaluated as part of your Answer is on your Answer sheet. Scrap paper will be disposed of immediately following the examination.

11. To pass the examination you must achieve a grade of 70 percent or greater in each category.

12. There is a time limit of three (3) hours for completion of the examination.

EQUATION SHEET

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

$$P_{\max} = \frac{(\beta - \rho)^2}{(2\alpha\lambda)}$$

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

1 Curie = 3.7 x 10^{10} dis/sec **1 kg = 2.21 lb**

1 Horsepower = 2.54 x 10^3 BTU/hr **1 Mw = 3.41 x 10^6 BTU/hr**

1 BTU = 778 ft-lb **°F = 9/5 °C + 32**

1 gal (H_2O) ≈ 8 lb **°C = 5/9 (°F - 32)**

c_P = 1.0 BTU/hr/lb/°F **c_p = 1 cal/sec/gm/°C**

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

QUESTION A.01 [1.0 point]
Which ONE of the following is a correct statement of how delayed neutrons enhance the ability to control reactor power?

a. Prompt neutrons can cause fissions in both U-235 and U-238 and delayed neutrons can only cause fissions in U-235

b. Delayed neutrons are born at higher energy levels than prompt neutrons

c. The average number of delayed neutrons produced per fission is higher than the average number of prompt neutrons

d. Delayed neutrons increase the average neutron lifetime that allows a reactor to be controlled

QUESTION A.02 [1.0 point]
Which ONE of the following is the **MAJOR** source of energy released during fission?

a. Fission fragments

b. Fission product decay

c. Prompt gamma rays

d. Fission neutrons (kinetic energy)

QUESTION A.03 [1.0 point, 0.25 each]
Match the following Neutron Interactions in Column A with the appropriate definition in Column B (each used only once)

Column A	Column B
a. Fission	1. Neutron enters nucleus, forms a compound nucleus, then decays by gamma emission
b. Radiative capture	2. Particle enters nucleus, forms a compound nucleus and is excited enough to eject a new particle with incident neutron remaining in nucleus
c. Scattering	3. Nucleus absorbs neutron and splits into two similarly sized parts
d. Particle ejection	4. Nucleus is struck by a neutron and emits a single neutron

QUESTION A.04 [1.0 point]
Two common FISSION PRODUCTS that have especially large neutron cross sections and play a significant role in reactor physics are Sm-149 and _____.

a. Nitrogen-16

b. Argon-41

c. Iodine-131

d. Xenon -135

QUESTION A.05 [1.0 point]
Which factors of the six factor formula are affected by an INCREASE in core temperature and how are they affected?

a. $\downarrow Lf$, $\downarrow$p, $\uparrow f$

b. $\uparrow \varepsilon$, $\uparrow L_f$, $\downarrow L_t$, $\uparrow$p

c. $\uparrow \varepsilon$, $\downarrow Lf$, $\downarrow L_t$, $\downarrow$p, $\uparrow \eta$, $\uparrow f$

d. $\uparrow \varepsilon$, $\uparrow L_f$, $\downarrow L_t$, $\downarrow$p, $\uparrow \eta$, $\uparrow f$

QUESTION A.06 [1.0 point]
Given a source strength of 150 neutrons per second (N/sec) and a multiplication factor of 0.7, which ONE of the following is the expected stable neutron count rate?

a. 150 N/sec

b. 250 N/sec

c. 400 N/sec

d. 500 N/sec

QUESTION A.07 [1.0 point]
What is β?

a. The fractional change in neutron population per generation

b. The fraction of all fission neutrons that are born as delayed neutrons

c. The time required for the reactor to change by power by a factor of e

d. The fraction of all delayed neutrons that reach thermal energy

QUESTION A.08 [1.0 point]
How high will the reactor power get given the lowest of the reactor high power scrams set point is 110%, the scram delay time is 0.5 seconds, the reactor is operating at 100% power prior to the scram, and the reactor period is positive 20 second?

a. 113%

b. 115%

c. 120%

d. 220%

QUESTION A.09 [1.0 point]
Which ONE of the following is the reason for an external neutron source for reactor startup? A startup without an external neutron source _____.

a. Is impossible as no neutrons would be available to start up the reactor

b. Can be compensated for by adjusting the compensating voltage on the source range detector

c. Could result in a very short period due to the reactor going critical before the neutron population is built up high enough to be read on nuclear instrumentation

d. Would be very slow due to the long time to build up the neutron population from such a low level

QUESTION A.10 [1.0 point]
During the time following a reactor scram, reactor power decreases on an 80 second period, which corresponds 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

QUESTION A.11 [1.0 point]
A subcritical reactor, k_{eff} is increased from 0.914 to 0.965. Which ONE of the following is the amount of reactivity that was added to the core?

a. 3.64%Δk/k

b. 4.38%Δk/k

c. 5.78%Δk/k

d. 6.57%Δk/k

QUESTION A.12 [1.0 point]
The reactor is on a CONSTANT positive period. Which ONE of the following power changes will take the SHORTEST time to complete?

a. From 100 kW to 150 kW

b. From 10 kW to 20 kW

c. From 10 W to 30 W

d. From 1 W to 5 W

QUESTION A.13 [1.0 point]
What is the condition of the reactor when $k = \frac{1}{1-\beta}$? (Note: β not β_{eff})

a. Subcritical

b. Critical

c. Super critical

d. Prompt critical

QUESTION A.14 [1.0 point]
The following shows part of a decay chain for the radioactive element Pa-234:
$_{91}Pa^{234} \rightarrow {}_{92}U^{234}$
This decay chain is an example of _____ decay.

a. Alpha

b. Beta

c. Gamma

d. Neutron

QUESTION A.15 [1.0 point]
Which ONE of the following isotopes will readily absorb neutrons when it interacts with neutrons?

a. Hydrogen-1

b. Oxygen-16

c. Boron-10

d. Uranium-235

QUESTION A.16 [1.0 point]
Which ONE of the following best describes the difference between reflectors and moderators?

a. Reflectors decrease thermal leakage while moderators increase fast leakage

b. Reflectors thermalize neutrons while moderators decrease core leakage

c. Reflectors decrease core leakage while moderators thermalize neutrons

d. Reflectors shield against neutrons while moderators decrease core leakage

QUESTION A.17 [1.0 point]
Which ONE of the following parameters is MOST significant in determining the differential rod worth of a control rod?

a. Fuel temperature

b. Flux shape

c. Reactor power

d. Rod speed

QUESTION A.18 [1.0 point]
Which ONE of the following conditions would INCREASE the shutdown margin of a reactor?

a. Inserting an experiment adding positive reactivity

b. Depletion of Uranium fuel

c. Depletion of a burnable poison

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

QUESTION A.19 [1.0 point]
Which ONE of the following statements correctly describes thermal neutrons?

a. A neutron that experiences an increase in energy levels after collisions with larger atoms of the moderator

b. A neutron that experiences a linear decrease in energy as the temperature of the moderator increases

c. A neutron that experiences no net change in energy after several collisions with atoms of the moderator

d. A neutron at resonant epithermal energy levels that causes fissions to occur in U-238

QUESTION A.20 [1.0 point]
Reactor is critical. What would be the corresponding k_{eff} when adding negative 0.05 $\Delta k/k$?

a. 0.9951

b. 0.9524

c. 0.9750

d. 1.0526

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

Category B: Normal/Emergency Operating Procedures and Radiological Controls

QUESTION B.01 [1.0 point]
Which ONE of the following conditions is a violation of RINSC Technical Specifications, reactor primary pool water?

a. Conductivity of the pool water is 2 micromhos/cm

b. Resistivity of the pool water is 400K ohms/cm

c. Pool water gross radioactivity 500 cpm

d. Pool water pH is 5.9

QUESTION B.02 [1.0 point]
In accordance with RINSC emergency plan, a fire that may affect any reactor safety systems is an example of what type of classification?

a. General emergency

b. Site emergency

c. Alert

d. Unusual event

QUESTION B.03 [1.0 point]
Which ONE of the following is the definition for "Annual Limit on Intake"?

a. The concentration of a radionuclide in air which, if inhaled by an adult worker for a year, results in a total effective dose equivalent of 100 mrem

b. The effluent concentration of a radionuclide in air which, if inhaled continuously over a year, would result in a total effective dose equivalent of 50 mrem for noble gases

c. 10CFR20 derived limit, based on a Committed Effective Dose Equivalent of 5 rem 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

d. Projected dose commitment to individuals that warrant protective action following a release of radioactive material

QUESTION B.04 [1.0 point]
Which ONE of the following is **NOT** a responsibility of the RO?

a. Review and audit of safety aspects of reactor facility operations

b. Control room observation when core reactivity may be affected

c. Participation in requalification program

d. Preparation of logs and records of reactor operations

QUESTION B.05 [1.0 point]

Per RINSC Technical Specifications, what is the MAXIMUM insertion rates of individual control rods and regulating blades?

a. 0.02 Δk/k per second

b. 0.005 Δk/k per second

c. 0.0002 Δk/k per second

d. 0.005 Δk/k per second

QUESTION B.06 [1.0 point]

The boundary defined as “the reactor building and basement area” is _____.

a. Emergency planning zone boundary

b. Reconvening boundary

c. Site area boundary

d. Hazardous material boundary

QUESTION B.07 [1.0 point]

How long will it take a 50 Curie source, with a half-life of 5.26 years, to decay to 2 Curie?

a. 10.5 Years

b. 15.5 Years

c. 24.5 Years

d. 35.5 Years

QUESTION B.08 [1.0 point]

What is the lowest level of authorization necessary for determining whether a new experiment fits the limitations of a previously approved experiment?

a. RO

b. SRO

c. Associate Director Operations

d. Director of Operations

QUESTION B.09 [1.0 point, 0.25 each]
Identify each of the following surveillances as a channel check (CHECK), a channel test (TEST), or a channel calibration (CAL). Write the correct answer on your answer sheet next to the space given for each example listed below

a. During performance of the daily checklist, you compare the readings of radiation area monitor one and radiation monitor two

b. During performance of the daily checklist, you press the scram button to verify a scram on the safety system channel

c. Adjustment of the wide range monitor channel in accordance with recent data collected during a reactor power calibration

d. You expose a 2 mCi check source to the continuous air monitor detector to verify that its output is operable

QUESTION B.10 [1.0 point]
10 CFR 20 limits the annual occupational exposure to the WHOLE BODY of an individual to:

a. 5 rem

b. 15 rem

c. 50 rem

d. 100 rem

QUESTION B.11 [1.0 point]
"The MINIMUM height of the water above the top of the core shall be 23.7 feet." This is an example of:

a. Safety Limit

b. Limiting Safety System Setting

c. Limiting Conditions for Operation

d. Safety Operational Limit

QUESTION B.12 [1.0 point]
Calculate an individual's total whole body dose given the individual received the following doses: 5 mrad of alpha, 10 mrad of gamma, and 10mrad of neutron (unknown energy)

a. 190 mrem

b. 200 mrem

c. 210 mrem

d. 220 mrem

QUESTION B.13 [1.0 point]
You are standing three feet from a radiation source receiving 250 mR/hr. What is your dose rate at 9 feet away from the source?

a. 24 mR/hr

b. 28 mR/hr

c. 32 mR/hr

d. 36 mR/hr

QUESTION B.14 [1.0 point]
Based on the RINSC Requalification Plan, each operator must perform the functions of a licensed operator to maintain an "active" operator's license a MINIMUM of _____.

a. 24 hours per year

b. 8 hours per quarter

c. 4 hours per month

d. 4 hours per quarter

QUESTION B. 15 [1.0 point]
During performance of a power calibration, indicated power differed from calculated power by 15 kWatts. Which ONE of the following actions is required for the linear and percent power channels?

a. No adjustment is necessary

b. Adjust the compensating voltages on the detectors

c. Adjust the detector high voltages on the detectors

d. Adjust the detector heights

QUESTION B.16 [1.0 point]
What emergency classification is identified if an individual receives a DDE of 15 mrem over a 24 hour period at the reactor site boundary?

a. General emergency

b. Site emergency

c. Alert

d. Unusual event

QUESTION B.17 [1.0 point, 0.25 each]
Match the appropriate radiation unit in Column A with its definition in Column B.

Column A	Column B
a. Curie	1. Equal to absorbed dose of 100 ergs/gram
b. Roentgen	2. Amount of radioactive material decaying at a rate of 3.7×10^{10}
c. RAD	3. Amount of x-ray or gamma ray leading to the absorption of 88 ergs/gram in air
d. Dose Equivalent	4. Equal to absorbed dose in RAD times quality factor

QUESTION B.18 [1.0 point]
Which ONE of the following materials shall NOT be irradiated in the reactor core?

a. Any corrosive material

b. Any explosive material

c. Any movable experiment

d. Any fissionable material

QUESTION B.19 [1.0 point]
Which ONE of the following is the radiation dose limit for the public in an unrestricted area?

a. No limit

b. 2 rem in a year

c. 2 rem in any one hour

d. 2 mrem in any one hour

QUESTION B.20 [1.0 point]

A two curie source emits a 2MeV gamma 100% of the time. The source will be placed in the reactor storage building. How far from the source should a high radiation area sign be posted?

a. Not required

b. 10.5 feet

c. 12.5 feet

d. 15.5 feet

(***** End of Category B *****)

Category C: Facility and Radiation Monitoring Systems

QUESTION C.01 [1.0 point]
What instrumentation region associated with "the voltage is such that every primary ion produces an avalanche of secondary ions"? This region also cannot differentiate between types of radiation.

a. Region I, Recombination

b. Region II, Ionization

c. Region III, Proportional

d. Region V, Geiger-Mueller

QUESTION C.02 [1.0 point]
Which ONE of the following pump actions will reduce the buildup of N-16 at the pool surface? (Note: reactor is at full power).

a. Turn purification system ON, increase heat transfer rate due to increased mixing within the core

b. Turn primary pumps ON, increase transport time for N^{16} to reach the surface of the pool

c. Turn purification system ON, breakup O^{16} bubbles in pool, thereby decreasing production of N^{16}

d. Turn primary pumps OFF, decrease the activation rate of O^{16} to N^{16} due to reduced time in the core

QUESTION C.03 [1.0 point]
When an evacuation system test is performed which ONE of the following should automatically occur?

a. Differential pressure across confinement should be at least 0.5 inches of water

b. Dilution blower is energized and pushes air into the lab

c. Stack monitoring sample valve stays in the normal position

d. Emergency exhaust air blower is shut down

QUESTION C.04 [1.0 point]
A heat exchanger leak can be determined by which ONE of the following methods?

a. Secondary pH decrease due to the transfer of the water to the primary

b. Pool level decrease due to leakage from heat exchanger

c. Routine radioactive sampling

d. Primary flow rate increase from the leak

QUESTION C.05 [1.0 point]
RINSC Technical Specifications requires fuel elements be stored in a safe array where the MAXIMUM k_{eff} is _____.

a. 0.6

b. 0.7

c. 0.8

d. 0.9

QUESTION C.06 [1.0 point]
Which ONE of the following materials is the regulating blade fabricated from?

a. Aluminum

b. Boron

c. Cadmium

d. Stainless Steel

QUESTION C.07 [1.0 point]
Which ONE of the following will initiate a reactor scram?

a. Log count rate < 3 cps

b. Reactor coolant inlet temperature 110°C, forced convection above 0.1MW

c. Reactor coolant outlet temperature 122 °C, forced convection above 0.1MW

d. Reactor bridge radiation monitor 2.5 x normal reading

QUESTION C.08 [1.0 point]
Which channel receives the signal as a result of a period scram?

a. Wide range channel 1

b. Wide range linear channel 2

c. Wide range log channel

d. None, period does not produce a scram

QUESTION C.09 [1.0 point]
Which ONE of the following parameters is NOT measured in the secondary cooling system?

a. Conductivity

b. Flow rate

c. pH

d. Radioactivity

QUESTION C.10 [1.0 point, 0.25 each]
Match the readings listed in Column A with their respective AUTOMATIC responses listed in Column B. Assume the reactor is at 2MW (Answers may be used more than once or not at all)

Column A	Column B
a. Log Count Rate = 2 cps	1. Indication only
b. Open the gate to the heat exchanger	2. Control rod withdrawal prohibit
c. Move the bridge toward the low power section of the pool	3. Reactor scram
d. Primary coolant outlet temp = 121 ºF	

QUESTION C.11 [1.0 point]
RINSC Technical Specification requires the regulating rod reactivity not exceed _____.

a. 0.6% Δk/k

b. 0.7% Δk/k

c. 0.8% Δk/k

d. 0.9 % Δk/k

QUESTION C.12 [1.0 point, 0.33 each]
Match the emergency exhaust system filter in Column A with its purpose in Column B

Column A	Column B
a. Roughing filter	1. High efficiency for removing fission gases
b. HEPA filter	2. Filter atmospheric dust
c. Activated charcoal filter	3. High efficiency for removing particulate radiation

QUESTION C.13 [1.0 point]
RINSC TP-03 lists four methods that can be used to determine control rod reactivity worth. When using the positive period method which ONE of the following parameters is used?

a. Pool level vs. coolant level

b. Reactivity vs. rod height

c. Temperature vs. period

d. Count rate vs. k-effective

QUESTION C.14 [1.0 point]
Which ONE of the following control blade assembly components provides the 'stop' signal to the drive assembly at either end of blade travel?

a. Motor limit switch

b. Drive shaft worm gear

c. Electromagnetic clutch

d. Helical potentiometer

QUESTION C.15 [1.0 point]

Category C: Facility and Radiation Monitoring Systems

Which region of the pulse size versus applied voltage characteristic curve does a fission chamber operate?

a. Proportional

b. Limited proportional

c. Geiger-Mueller

d. Ion chamber

QUESTION C.16 [1.0 point]
Per RINSC TS, what MAXIMUM reactor coolant outlet water temperature would result in an alarm? (Note: Reactor operating in forced convection mode above 0.1MW)

a. 95^{o}F

b. 100^{o}F

c. 110^{o}F

d. 120^{o}F

QUESTION C.17 [1.0 point]
Which ONE of the following will result in a shim safety blade withdrawal interlock?

a. Reactor period 45 seconds

b. High flux 105%

c. Startup channel <3 cps

d. Source range signal/noise ratio of 2

QUESTION C.18 [1.0 point]
Which ONE of the following conditions will automatically scram the operating reactor?

a. Log count rate <3 cps

b. 102% reactor power

c. Fuel safe radiation monitor 2mR/hr

d. Loss of high voltage to the percent power channel

QUESTION C.19 [1.0 point]

Category C: Facility and Radiation Monitoring Systems

Which ONE of the following is the 'single, largest source of radiation exposure to facility personnel'?

a. Approved experiments

b. Antimony-Beryllium neutron source

c. Shim safety rod inspections

d. Demineralizer change out

QUESTION C.20 [1.0 point]
In the transport of samples the pneumatic transfer system uses _____ that results in the production of _____.

a. CO_2, N^{16}

b. CO_2, Ar^{41}

c. Air, Ar^{41}

d. D_2O, N^{16}

(***** END OF CATEGORY C *****)
((***** END OF EXAM *****))

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

A.01
Answer: d
Reference: Burn, *Introduction to Nuclear Reactor Operations,* Section 3.3.2, Page 3-7

A.02
Answer: a
Reference: Burn*, Introduction to Nuclear Reactor Operations*, Table 3.2, Page 3-5b
ρ=(k-1)/k-0.05→1=k-(-0.05k)=k(1+0.05)→k=1/1.05 =0.9524

A.03
Answer: a 3 b 1 c 4 d 2
Reference: DOE Fundamentals Handbook *Nuclear Physics and Reactor Theory*, Volume 1, Module 1, Page 43-46

A.04
Answer: d
Reference: Burn, *Introduction to Nuclear Reactor Operations*, Section 8.1, Page 8-1

A.05
Answer: a
Reference: DOE Fundamentals Handbook *Nuclear Physics and Reactor Theory*, Volume 2, Module 1

A.06
Answer: d
Reference: CR=S/(1-k)→150/(1-0.7) = 500 N/sec

A.07
Answer: b
Reference: DOE Fundamentals Handbook *Nuclear Physics and Reactor Theory*, Volume 2, Module 4

A.08
Answer: a
Reference: P/P_o = 110%, T = 20 seconds, t = 0.5, P/P_o = 110 e^0.5/20 = 112.78%

A.09
Answer: c
Reference: Burn, *Introduction to Nuclear Reactor Operations*, Section 5.2.2, Pages 5-2 - 5-4

A.10
Answer: c
Reference: LaMarsh, *Introduction to Nuclear Engineering*, Page 88
Group 1 is longest lived neutron precursor for thermal fission in U-235 with a half-life of 55.72 seconds

A.11
Answer: c
Reference: Burn, *Introduction to Nuclear Reactor Operations*, Section 3.3.4, Page 3-20&21
$\Delta\rho=(k_{eff2}-k_{eff1})/(k_{eff1}*k_{eff2})$ = (0.965-0.914)/(0.965*0.914) = 0.0578Δk/k=5.78%Δk/k

A.12
Answer: a
Reference: $P=P_oe^{t/T}\rightarrow t=T*\ln(P/P_o)$ assume constant period=1
The smallest ratio of P/P_o is the shortest time to complete

A.13
Answer: c
Reference: LaMarsh, *Introduction to Nuclear Engineering*, Page 340-341
(1-B)k=1 manipulated reads k=1/(1-B)

A.14
Answer: b
Reference: Chart of the Nuclides

A.15
Answer: c
Reference: Burn, *Introduction to Nuclear Reactor Operations*, Section 2.5.1, Pages 2-38-43

A.16
Answer: c
Reference: Burn, *Introduction to Nuclear Reactor Operations,* Section 5.4

A.17
Answer: b
Reference: Burn, *Introduction to Nuclear Reactor Operations*, Section 7.2

A.18
Answer: b
Reference: Burn, *Introduction to Nuclear Reactor Operations*, Section 6.2.3

A.19
Answer: c
Reference: DOE Fundamentals Handbook *Nuclear Physics and Reactor Theory*, Volume 1, Module 2

A.20
Answer: b

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

Reference: $\rho=(k-1)/k-0.05 \rightarrow 1=k-(-0.05k)=k(1+0.05) \rightarrow k=1/1.05 =0.9524$

Category B: Normal/Emergency Operating Procedures and Radiological Controls

B.1
Answer: b
Reference: RINSC TS 3.3(a)2 and RINSC MP-03

B.2
Answer: c
Reference: RINSC, EP 4.2.5

B.3
Answer: c
Reference: 10CFR20.1003

B.4
Answer: a
Reference: RINSC TS 6.3

B.5
Answer: c
Reference: RINSC TS 3.2.4

B.6
Answer: a
Reference: RINSC EP 2.14

B.7
Answer: c
Reference: $T\ A = A_{\circ} * e^{-\lambda t}$
$2Ci = 50Ci * e^{-\lambda(t)}$
Ln(2/50) = -ln2/5.27 yr*(t) --> -3.2189/-0.1315 →
solve for t: 24.47 years

B.8
Answer: b
Reference: RINSC XP-02 V.B.1.A.

B.9
Answer: a (check), b (test), c (cal) , d (test)
Reference: RINSC TS definitions, Table 3-1 and RINSC CP-04

B.10
Answer: a
Reference: 10 CFR 20.1201

B.11
Answer: b
Reference: RINSC TS 2.2.1

B.12
Answer: c
Reference: 5mrad Alpha x 20=100mrem, 10mrad Gamma x 1=10mrem, 10mrad neutron x 10 = 100mrem →100mrem+10mrem+100mrem= 210mrem

B.13
Answer: b
Reference: $I_1D_1^2=I_2D_2^2 \rightarrow$ 250mR/hr@$(3ft)^2=I_2$@$(9ft)^2 \rightarrow$28mR/hr

B.14
Answer: d
Reference: 10CFR55.59, RINSC Op Proc AP-02

B.15
Answer: a
Reference: NRC previous exam, 2012

B.16
Answer: d
Reference: RINSC EP 4.2

B.17
Answer: a (2), b(3), c(1), d(4)
Reference: 10CFR20.1003, 1004, & 1005

B.18
Answer: b
Reference: RINSC TS 3.8

B.19
Answer: d
Reference: 10CFR20.1301(a)(2)

B.20
Answer: d
Reference: I=6CEn=R/hr@ft.$\rightarrow$2Ci x 2Mev x 100% = 24 R/hr@ $(1ft)^2$ = 24 R/hr = 0.1 R/hr@ $D^2 = \sqrt{240}$ R/hr = 15.5 ft.

Category C: Facility and Radiation Monitoring Systems

C.01
Answer: d
Reference: NRC standard question

C.02
Answer: b
Reference: RINSC SAR 5.6

C.03
Answer: a
Reference: RINSC TS 4.4, 4.5, 4.6 and RINSC MP-10

C.04
Answer: c
Reference: RINSC TS 3.3

C.05
Answer: c
Reference: RINSC TS 5.5

C.06
Answer: d
Reference: RINSC SAR Section 1.2.2

C.07
Answer: c
Reference: RINSC TS Table 3.1 & 3.2

C.08
Answer: c
Reference: RINSC SAR 7.2.9, Figure 7-3 & 7-4

C.09
Answer: a
Reference: RINSC TS 4.3.b

C.10
Answer: a (2), b (1), c (3), d (3)
Reference: RINSC TS 3.2, Table 3.1, & Table 3.2

C.11
Answer: a
Reference: RINSC TS 3.1.6 and TP-03

C.12
Answer: a(2), b(3), c(1)
Reference: RINSC MP-03

C.13
Answer: b
Reference: RINSC TP-03

Category C: Facility and Radiation Monitoring Systems

C.14
Answer: a
Reference: RINSC NRC previous exam, 2008

C.15
Answer: a
Reference: NRC standard question

C.16
Answer: d
Reference: RINSC TS Table 3.2

C.17
Answer: c
Reference: RINSC TS Table 3.2 & RINSC SAR 7.2.6

C.18
Answer: d
Reference: RINSC TS Table 3.1 & 3.2

C.19
Answer: d
Reference: RINSC TS 4.1 Bases

C.20
Answer: c
Reference: RINSC XP-03 & NRC standard question