April 18, 2013

Mr. Ralph A. Butler, Chief Operating Officer
Research Reactor Facility
University of Missouri
Columbia, MO 65211

SUBJECT: EXAMINATION REPORT No. 50-186/OL-13-01,
UNIVERSITY OF MISSOURI – COLUMBIA

Dear Mr. Butler:

During the week of April 1, 2013, the NRC administered operator licensing examinations at your University of Missouri – Columbia 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/

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

Docket No. 50-186

Enclosure: Initial Examination Report No. 50-186/OL-13-01

cc: John Fruits, Assistant Reactor Manager of Operations
cc w/o enclosure: See next page

Mr. Ralph A. Butler, Chief Operating Officer April 18, 2013
Research Reactor Facility
University of Missouri
Columbia, MO 65211

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DISTRIBUTION w/ encls.:

PUBLIC	PRTB r/f	RidsNRRDPRPRTA
RidsNRRDPRPRTB	Facility File (CRevelle) O-7 F-08	

ADAMS ACCESSION #: ML13100A168 **TEMPLATE #:NRR-074**

OFFICE	PROB:CE		IOLB:LA		PROB:BC	
NAME	PYoung		CRevelle		GBowman	
DATE	4/16/2013		4/16/2013		4/18/2013	

cc:

John Ernst, Associate Director
Regulatory Assurance Group
Research Reactor Facility
Columbia, MO 65201

Homeland Security Coordinator
Missouri Office of Homeland Security
P.O. Box 749
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Planner, Dept of Health and Senior Services
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Department of Natural Resources
1101 Riverside Drive
Fourth Floor East
Jefferson City, MO 65101

A-95 Coordinator
Division of Planning
Office of Administration
P.O. Box 809, State Capitol Building
Jefferson City, MO 65101

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.: 50-186/OL-11-01

FACILITY DOCKET NO.: 50-186

FACILITY LICENSE NO.: R-103

FACILITY: University of Missouri – Columbia

EXAMINATION DATES: April 1 & 2, 2013

SUBMITTED BY: **/RA/** 04/16/2013
Phillip T. Young, Chief Examiner Date

SUMMARY:

During the week of April 1, 2013 the NRC administered licensing examinations to two RO applicants and one SRO-U applicant. All applicants passed these examinations.

REPORT DETAILS

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

2. Results:

	RO PASS/FAIL	SRO PASS/FAIL	TOTAL PASS/FAIL
Written	2/0	0/0	2/0
Operating Tests	2/0	1/0	3/0
Overall	2/0	1/0	3/0

3. Exit Meeting:

Phillip T. Young,	Chief Examiner, NRC
Brian Jacobi,	Assistant Reactor Manager - Training, MURR
Carl Herbold,	Assistant Reactor Manager – Operations, MURR
John L. Fruits,	Reactor Manager, MURR
Les Foyto,	Associate Director Reactor & Facilities Operations, MURR

At the conclusion of the examinations the chief examiner thanked the facility for their support during the examinations. Two applicants stated that the UPS System Manual By-pass Switch is a Make-Before-Break Switch rather than a Break-Before-Make Switch.

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

FACILITY: UNIVERSITY OF MISSOURI - COLUMBIA

REACTOR TYPE: Tank

DATE ADMINISTERED: 04/02/2013

CANDIDATE: _____

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

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

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

_____
Candidate's Signature

ENCLOSURE 2

NRC RULES AND GUIDELINES FOR LICENSE EXAMINATIONS

During the administration of this examination the following rules apply:

1. Cheating on the examination means an automatic denial of your application and could result in more severe penalties.

2. After the examination has been completed, you must sign the statement on the cover sheet indicating that the work is your own and you have neither received nor given assistance in completing the examination. This must be done after you complete the examination.

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

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

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

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

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

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

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

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

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

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

13. When you have completed and turned in you examination, leave the examination area. If you are observed in this area while the examination is still in progress, your license may be denied or revoked.

EQUATION SHEET's

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

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

$$\ell^* = 1 \ x \ 10^{-4} \ seconds$$

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

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

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

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

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

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

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

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

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

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

EQUATION SHEET's

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

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

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

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

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

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

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

$$DR_1 d_1^2 = DR_2 d_2^2$$

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

EQUATION SHEET's

DR – Rem, 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

Section A Reactor Theory, Thermo, and Facility Characteristic

QUESTION A.001 [1.0 point] (1.0)
Which ONE of the following is an example of neutron decay?

a. $_{35}Br^{87} \rightarrow {}_{33}As^{83}$

b. $_{35}Br^{87} \rightarrow {}_{35}Br^{86}$

c. $_{35}Br^{87} \rightarrow {}_{34}Se^{86}$

d. $_{35}Br^{87} \rightarrow {}_{36}Kr^{87}$

Answer: A.01 b.
Reference: DOE Fundamentals Handbook, Nuclear Physics and Reactor Theory.

QUESTION A.002 [1.0 point] (2.0)
The reactor is operating at a constant power level with equilibrium xenon. You double Reactor power. The equilibrium xenon level at the higher power level will be …

a. the same as at the lower power level.

b. higher than its value at the lower power level, but not twice as high.

c. twice as high.

d. more than twice as high.

Answer: A.02 b.
Reference: DOE Fundamentals Handbook, Module 3, Xenon, page 37.

QUESTION A.003 [1.0 point] (3.0)
The reactor is at a power of 1 watt, with a 26 second stable period. How long will it take for power to reach 1000 watts?

a. ≈180 seconds

b. ≈153 seconds

c. ≈121 seconds

d. ≈78 seconds

Answer: A.03 a. $P = P_0 e^{t/T}$ ➔ $\ln(1000/1) = t/26\text{sec}$ ➔ $26\text{sec} \times 6.9078 = 179.6 \approx 180$
Reference: Primary Reference, Volume 2, Module 4, Reactor Theory (Reactor Operations), Enabling Objective 2.1.

Section A Reactor Theory, Thermo, and Facility Characteristics

QUESTION A.004 [1.0 point] (4.0)
If the primary flow rate is 3700 gpm and the ΔT across the primary side of the heat exchanger is 15.5°F, what is the power being transferred to the secondary side of the heat exchanger? (Assume no losses to the ambient surroundings, including the pool).

a. 12 megawatts.

b. 10 megawatts.

c. 8 megawatts.

d. 6 megawatts.

Answer: A.04 c.
Reference: DOE Fundamentals Handbook, Nuclear Physics and Reactor Theory.

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

$$\dot{Q} = 3700 \frac{gallons}{minute} \times 8 \frac{lbm}{gallon} \times 60 \frac{minutes}{hour} \times 1 \frac{BTU}{^\circ F - lbm} \times 15.5^\circ F \times \frac{1 Mw - Hr.}{3.412 \times 10^6 BTU}$$

QUESTION A.005 [1.0 point] (5.0)
The reactor is subcritical with a K_{eff} of 0.96 and 30 counts per second indicated. After a fuel element is removed the count rate drops to 10 counts per second. No other changes have occurred. What is the K_{eff} of the core with the fuel element removed?

a. 0.9733

b. 0.8800

c. 0.8400

d. 0.8000

Answer: A.05 b.
$CR_1/CR_2 = [1 - K_{eff2}]/[1 - K_{eff1}]$ $30/10 = [1 - K_{eff}]/[1 - 0.96]$ $1 - K_{eff} = 3 \times 0.04 = 0.12$ $K_{eff} = 0.88$
Reference: DOE Fundamentals Handbook, Nuclear Physics and Reactor Theory, Volume X, Module Y, Enabling Objective Z.Z

Section A Reactor Theory, Thermo, and Facility Characteristic

QUESTION A.006 [1.0 point] (6.0)
Which one of the following factors is most easily varied by the reactor operator?

a. reproduction factor

b. fast fission factor

c. fast non-leakage probability

d. thermal utilization factor

Answer: A.06 d.
Reference: DOE Fundamentals Handbook, Nuclear Physics and Reactor Theory, Volume X, Module Y, Enabling Objective Z.Z

QUESTION: A.007 [1.0 point] (7.0)
Which ONE of the following statements correctly describes a characteristic of subcritical multiplication?

a. The number of neutrons gained per generation doubles for each succeeding generation.

b. A constant neutron population is achieved when the total number of neutrons produced in one generation is equal to the number of source neutrons added in the next generation.

c. For equal reactivity additions, it requires less time for the equilibrium neutron population to be reached.

d. When the indicated count rate doubles, the margin to criticality has been reduced by approximately one-half.

Answer: A.07 d.
Reference: DOE Fundamentals Handbook, Module 4, Subcritical Multiplication, page 6.

QUESTION A.08 [1.0 point] (8.0)
Five minutes following a reactor shutdown, the source range monitor is reading 3×10^6 counts/minute. Which ONE of the following is the count rate you would expect to see three minutes later.

a. 10^6 counts/minute

b. 8×10^5 counts/minute

c. 5×10^5 counts/minute

d. 3×10^5 counts/minute

Answer: A.08 d.
Reference: Standard NRC Question

Section A Reactor Theory, Thermo, and Facility Characteristics

QUESTION A.009 [1.0 point] (9.0)
By definition, an exactly critical reactor can be made prompt critical by adding positive reactivity equal to …

a. the shutdown margin
b. the K_{excess} margin
c. the β_{eff} value
d. 1.0 %ΔK/K.

Answer: A.09 c.
Reference: DOE Fundamentals Handbook, Nuclear Physics and Reactor Theory.

QUESTION A.010 [1.0 point] (10.0)
Which of the following statements correctly describe the influence of ***DELAYED NEUTRONS*** on the neutron life cycle? Delayed neutrons …

a. increase the time required for PU^{239} to moderate the fission process.
b. decrease the time required for the neutron population to change between generations.
c. increase the time required for the neutron population to change between generations.
d. decrease the amount of reflection possible with a steel reflector.

Answer: A.010 c.
Reference: DOE Fundamentals Handbook, Nuclear Physics and Reactor Theory, Volume X, Module Y, Enabling Objective Z.Z

QUESTION A.011 [1.0 point, ¼ each] (11.0)
Identify each isotope as being produced by the irradiation of **air**, irradiation of **water**, or is a **fission** product.

a. N^{16}
b. Ar^{41}
c. H^{3}
d. Xe^{135}

Answer A.11 a. = Water; b. = Air; c. = Water; d. = Fission
Reference DOE Fundamentals Handbook, Nuclear Physics and Reactor Theory, Volume 2, Module 4, *Reactor Theory (Reactor Operations),* Enabling Objective

Section A Reactor Theory, Thermo, and Facility Characteristic

QUESTION A.012 [1.0 point] (12.0)
Delayed neutrons comprise approximately what percent of all neutrons produced in the reactor?

a. 0.65%
b. 1.3%
c. 6.5%
d. 13%

Answer: A.12 a.
Reference: DOE Fundamentals Handbook, Nuclear Physics and Reactor Theory, Volume X, Module Y, Enabling Objective Z.Z

QUESTION A.013 [1.0 point] (13)
Which ONE of the following atoms will cause a neutron to lose the most energy in an elastic collision?

a. $Uranium^{238}$
b. $Carbon^{12}$
c. $Hydrogen^{2}$
d. $Hydrogen^{1}$

Answer: A.13 d.
Reference: Reference 1, Volume 1, Module 2, *Interaction of Radiation with Matter*, p. 65.

QUESTION A.014 [1.0 point] (14)
Which ONE of the following describes the ***MAJOR*** contributors to the production and depletion of Xenon respectively in the core shortly (less than an hour) after ***SHUTDOWN***

	Production	***Depletion***
a.	Radioactive decay of Iodine	Radioactive Decay
b.	Radioactive decay of Iodine	Neutron Absorption
c.	Directly from fission due to delayed neutrons	Radioactive Decay
d.	Directly from fission due to delayed neutrons	Neutron Absorption

Answer: A.14 a.
Reference: Reference 1, Volume 2, Module 3, *Production and Removal of Xenon*, p. 35

Section A Reactor Theory, Thermo, and Facility Characteristics

QUESTION A.015 [1.0 point] (15)
Which **ONE** of the following is the correct reason burnable poison is added to the core?

a. To minimize the effects of a rod withdrawal accident.

b. To increase the power achievable for a given core size.

c. To allow addition of additional fuel to compensate for burnup.

d. To decrease the effects of Xenon and Samarium on the core.

Answer A.15 c.
Reference: Reference 1, Volume 2, Module 3, *Fixed Burnable Poisons*, o, 30.

QUESTION A.016 [1.0 point] (16)
Reactor power is increasing by a factor of 10 every minute. The reactor period is:

a. 65 seconds.

b. 52 seconds.

c. 26 seconds.

d. 13 seconds.

Answer: A.16 c.
Reference: DOE Fundamentals Handbook, Module 4, Reactor Kinetics, page 17.
Reactor Period = 26/Startup Rate

QUESTION A.017 [1.0 point] (17)
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. criticality will occur with the same number of elements loaded as if there were no change in the initial count rate.

b. criticality will occur earlier (i.e., with fewer elements loaded.)

c. criticality will occur later (i.e., with more elements loaded.)

d. criticality will be completely unpredictable.

Answer: A.17 a.
Reference: DOE Fundamentals Handbook, Module 4, Subcritical Multiplication, page 6.

Section A Reactor Theory, Thermo, and Facility Characteristic

QUESTION A.18 [1.0 point] (18)
A reactor is operating at a constant power level of 250 kW. The fission rate of this reactor is approximately:

a. 0.78×10^{12} fissions/sec.

b. 1.56×10^{14} fissions/sec.

c. 0.78×10^{16} fissions/sec.

d. 3.90×10^{18} fissions/sec.

Answer: A.18 c.
Reference: DOE Fundamentals Handbook, Module 2, Reaction Rates, page 20.
250 kW = 1.562×10^{18} Mev/sec. (1.562×10^{18} Mev/sec)/(200 Mev/fission) = 0.78×10^{16} fissions/sec.

QUESTION A.019 [1.0 point] (19)
A reactor with an initial population of 1×10^{8} neutrons is operating with $K_{eff} = 1.001$. Considering only the increase in neutron population, how many neutrons (of the increase) will be prompt when the neutron population changes from the current generation to the next? Assume $\beta = 0.007$.

a. 700.

b. 7,000.

c. 99,300.

d. 100,000.

Answer: A.19 c.
Reference: DOE Fundamentals Handbook, Module 2, Prompt & Delayed Neutrons, page 29.
Increase = $1.001 \times 10^{8} - 1 \times 10^{8} = 1 \times 10^{5}$. Prompt neutron population = $0.993 \times 1 \times 10^{5} = 99{,}300$.

QUESTION A.020 [1.0 point] (20)
Which ONE of the following reactor changes requires a control rod INSERTION to return reactor power to its initial level following the change?

a. Formation of N^{16} in the coolant.

b. Removal of an experiment with positive reactivity from the reactor.

c. Buildup of Xe^{135}

d. A fault in the automatic system resulting in a primary coolant temperature decrease.

Answer: A.20 d.
Reference:

Section B Normal/Emergency Procedures & Radiological Controls

QUESTION B.001 [1.0 point] (1.0)
A "Knowledgeable Person" is defined as an operations trainee who has …

a. been designated by his/her shift LSRO.

b. successfully complete a 50% board.

c. successfully complete a 90% board.

d. been designated by the Reactor Manager.

Answer: B.01 b.
Reference: AP-RO-110 Conduct of Operations, §

QUESTION B.002 [1.0 point, 0.25 each] (2.0)
Identify the correct number (**1 through 20**) which correctly defines the maximum period between testing intervals per the Technical Specifications definitions.

a. Weekly: ___ days

b. Monthly: ___ weeks

c. Quarterly: ___ months

d. Annually: ___ months

Answer: B.02 a. = 9; b. = 6; c. = 4; d. = 14
Reference: Technical Specifications § 1.0 Definitions

QUESTION B.003 [1.0 point] (3.0)
Which one of the following conditions satisfies the requirements for containment integrity?

a. Truck door is operable and capable of being closed.

b. Containment building ventilation system automatically closing doors and automatically closing valves are closed.

c. The emergency electrical generator is operable.

d. Seal trench has enough water to maintain a seal of 47 inches.

Answer: B.03 b.
Reference: T.S. 1.15

Section B Normal/Emergency Procedures & Radiological Controls

QUESTION B.004 [1.0 point] (4.0)
An accessible area with a radiation level of 50 mR/hr should be posted as a:

a. restricted area

b. radiation area

c. high radiation area

d. very high radiation area

Answer: B.04 b.
Reference: 10CFR20.1003

QUESTION B.005 [1.0 point] (5.0)
If the reactor is not critical within the ECP limits, the reactor operator must:

a. recalculate the ECP prior to any further rod withdrawal.

b. shut down the reactor.

c. verify the ECP with a 1/M plot.

d. insert controls rods to 2 inches below ECP.

Answer: B.05 d.
Reference: OP-RO-210.

QUESTION B.006 [1.0 point] (6.0)
The shim blades:

a. shall be capable of full insertion in less than 0.7 seconds.

b. will automatically insert at a rate not to exceed 1 inch/min.

c. shall be capable of insertion to the 20% withdrawn position in less than 0.7 seconds.

d. shall remain within one inch of each other at power levels above 50 Kw.

Answer: B.06 c.
Reference: MURR Technical Specifications, Section 3.2.c.

Section B Normal/Emergency Procedures & Radiological Controls

QUESTION B.007 [1.0 point] (7.0)
According to MURR Technical Specifications which one of the following is the maximum primary coolant pressure allowed during normal operation?

a. 70 psig
b. 100 psig
c. 110 psig
d. 125 psig

Answer: B.07 c.
Reference: Technical Specification 3.4

QUESTION B.008 [1.0 point] (8.0)
The reactor has been shutdown for the last three hours due to electrical storms, (intermittent loss of power). No shutdown checksheet has been performed. Which of the following meets the MINIMUM requirements to restart the reactor?

a. You may startup after ensuring the Primary system is on-line per the applicable SOP, then performing a short form Startup Checksheet.
b. You may startup after performing a short form Startup Checksheet.
c. You may perform a hot startup with the SRO directing.
d. You may startup after performing a Full Power Startup Checksheet.

Answer: B.08 d.
Reference: NRC Examination administered September 11, 2001.

QUESTION B.009 [1.0 point] (9.0)
During normal operation of the reactor, you take a complete set of process data every …

a. ½ hour
b. hour
c. 2 hours
d. 4 hours

Answer: B.09 c.
Reference: AP-RO-110, Conduct of Operations, § 6.5.6.b. pg. 11.

Section B Normal/Emergency Procedures & Radiological Controls

QUESTION B.010 [1.0 point] (10.0)
During refueling, the lowest level of staff who may move fuel INTO OR OUT OF THE CORE WITHOUT DIRECT SUPERVISION is …

a. Auxiliary Operator
b. Reactor Operator
c. Senior Reactor Operator
d. Operations Manager

Answer: B.10 b.
Reference: SOP II, 2.1.H.

QUESTION B.011 [1.0 point] (11.0)
Per OP-RO-250, 2 Fuel Handling, when unlatching an element in the reactor, the fuel handling tool _____.

a. must be lifted up slightly to be removed from the fuel element.
b. must float off of the fuel element with no assistance from the operator.
c. must be pushed down then lifted up to be removed from the fuel element.
d. must be pushed down and twisted to be removed from the fuel element.

Answer: B.11 b.
Reference: OP-RO-250 Fuel Handling {Precaution 3.5}

QUESTION B.012 [1.0 point] (12.0)
Who has responsibility for ensuring all personnel are cleared from all levels of the containment building, according to the immediate actions for a Reactor Isolation?

a. The Shift Supervisor
b. The Reactor Director
c. The Duty Reactor Operator
d. The Duty Health Physics person

Answer: B.12 c.
Reference: FEP-2, page 2 of 4.

Section B Normal/Emergency Procedures & Radiological Controls

QUESTION B.013 [1.0 point, ¼ each] (13.0)
Identify whether Gang operation of the control blades is ALLOWED or is NOT allowed with the reactor critical for the listed evolutions.

a. Reactor Shutdown
b. Normal Reactor Startup
c. Hot Reactor Startup
d. Power Recovery Startup

Answer: B.013 a. = ALLOWED; b. = NOT; c. = ALLOWED; d. = NOT
Reference: AP-RO-110 Conduct of Operations, § 6.6.6 Control Blade Operation.

QUESTION B.014 [1.0 point, ¼ each] (14.0)
Common radioisotopes associated with research reactors are N^{16}, Ar^{4l}, H^3 and Na^{24}. The half-life for each is (seconds (sec), minutes (min) hours (hr) or years (yr)).

a. N^{16} is 7.0 _____.
b. Ar^{41} is 1.9 _____.
c. H^3 is 12.0 _____.
d. Na^{24} is 15.0 _____.

Answer: B.14 a. = sec, b. = hr; c. = yr; d. = hr;
Reference: NRC bank question

QUESTION B.15 [1.0 point] (15.0)
You initially remove a sample from the pool reading 1 R/hr at 30 cm from the source. You then replace the sample in the pool. An hour later you remove the sample and the reading is now 390 mR/hr at 30 cm. You again replace the sample back in the pool. How much longer should you wait to be able to bring out the sample without generating a high radiation area?

a. ½ hour
b. 1 hour
c. 1½ hours
d. 2 hours

Answer: B.15 c.
Reference: $I_t = I_0 e^{-\lambda t}$ $390 \text{ mR/hr} \div 1000 \text{ mR/hr} = e^{-\lambda 1 hr}$ $\ln(0.39) = -\lambda * 1 \text{ hr.}$ $\lambda = 0.9416 \text{ hour}^{-1}$
SOLVING for additional time:
$I_f = I_t e^{-\lambda t}$ $100 \text{mR/hr} = 390 \text{ mR/hr } e^{-0.9416 \text{ (time)}}$ $\ln (0.25) = -0.9163 * \text{time}$ $\text{time} = 1.4454$

Section B Normal/Emergency Procedures & Radiological Controls

QUESTION B.016 [1.0 point] (16.0)
Technical Specifications require the facility to test the operability of the Pool Fill system …

a. Weekly
b. Monthly
c. Semiannually
d. Annually

Answer: B.16 c.
Reference: Technical Specifications § 5.6 Auxiliary Systems.

QUESTION B.017 [1.0 point] (17.0)
What is the minimum amount of primary grade makeup water allowable for reactor operation?

a. 1000 gallons
b. 2000 gallons
c. 3000 gallons
d. 4000 gallons

Answer: B.17 b.
Reference: Technical Specification 3.10

QUESTION B.018 [1.0 point] (18.0)
Which ONE of the following locations is NOT an Emergency Command Center per the Emergency Plan?

a. Control Room
b. Research Park Development Building
c. Dalton Cardiovascular Research Center
d. Facility Front Lobby

Answer: B.18 c.
Reference: Emergency Plan section 6.1

Section B Normal/Emergency Procedures & Radiological Controls

QUESTION B.019 [1.0 point] (19.0)
Which ONE of the following control rod manipulations is NOT by procedure?

a. Gang operation of the control rods after criticality to reduce power.
b. Gang operation of the control rods as part of automatic shimming.
c. Simultaneous withdrawal of one control blade and the regulating blade.
d. Gang operation of the controls rods during hot startup.

Answer: B.19 c.
Reference: AP-RO-110 step 6.6.6

QUESTION B.020 [1.0 point] (20.0)
Two point sources have the SAME Curie strength. Source A's gammas have an energy of 1 Mev, while Source B's gammas have an energy of 2 Mev. You obtain a measurement from the same GM tube 10 feet from each source. The measured dose rate from Source B is …

a. is four times that of Source A.
b. is twice that of Source A.
c. is the same as that of Source A.
d. is half that of Source A.

Answer: B.20 c.
Reference: Standard NRC Question (GM tubes detects counts ONLY, they do not detect relative strengths of radiation.)

Section C Facility and Radiation Monitoring Systems

QUESTION C.001 [1.0 point, ¼ each] (1.0)
Identify whether each of the following valves fails OPEN or SHUT.

a. Pressurizer Drain Valve (527A)

b. Vent Tank Vent Valve (552A)

c. Pressurizer Isolation Valve (527C)

d. Demin Inlet Isolation Valve (527E)

Answer: C.01 a. = S; b. = S; c. = S; d. = S
Reference: Reactor Operator Training Manual, § I.5, Valve Operating System, ¶¶ B.6, 8, , 12

QUESTION C.002 [1.0 point] (2.0)
What type of sensor is used to detect the position of the "rabbit" in the core?

a. photo-electric cell

b. magnetic switch

c. micro switch

d. reed switch

Answer: C.02 a.
Reference: SAR, Chapter 10 - Experimental Facilities and Utilization – 10.3.4 Pneumatic Tube System

QUESTION C.003 [1.0 point] (3.0)
Which ONE of the following conditions is required for proper operation of the Antisiphon system?

a. System pressure must be greater than 10 psig.

b. System pressure must be greater than 27 psig.

c. System water level must be more than 10 inches above the antisiphon valves.

d. System water level must be more than 6 inches above the antisiphon valves.

Answer: C.009 b.
Reference: MURR Anti-Siphon System Lesson Plan

Section C Facility and Radiation Monitoring Systems

QUESTION C.004 [1.0 point] (4.0)

Which ONE of the following alarms on the control panel is NOT associated with the startup interlock?

a. Jumper Board in Use

b. Thermal Column Door Open

c. Nuclear Instrument Anomaly

d. Source range level indication >20 cps or intermediate range level recorder indication >2 x 10^{-5}% power

Answer: C.04 a.
Reference: SAR, Chapter 7 -Instrumentation and Control Systems; 7.5.3.1 Rod Withdrawal Prohibit

QUESTION C.005 [1.0 point] (5.0)

The normal path for adding water to the pool is by way of gravity drain from either demineralized water tank to …

a. a diffuser header located about a foot below the normal fill line.

b. a garden hose located at the top of the reactor pool.

c. the suction of the pool coolant system pump.

d. the suction of the pool skimmer pump.

Answer: C.05 d.
Reference: OP-RO-465, § 6.1

QUESTION C.006 [1.0 point, ⅓ each] (6.0)

Match the appropriate response condition (a through c) with the correct back light color (1 through 4).

a. Scram	1. Red
b. Rod run-in	2. Yellow
c. Alarm	3. White
	4. Blue

Answer: C.06 a. = 1; b. = 4; c. = 3
Reference: SAR, Chapter 7 -Instrumentation and Control Systems - 7.3.1 Annunciator

Section C Facility and Radiation Monitoring Systems

QUESTION C.007 [1.0 point] (7.0)
Which ONE of the Radiation Monitors is used to track radioactive Argon, Neon and Krypton to the environment?

a. Bridge ALARA
b. Stack Gas
c. Stack Particulate
d. Stack Iodine

Answer: C.07 b.
Reference: Reactor Operator Training Manual § II.

QUESTION C.008 [1.0 point] (8.0)
The normal (green) lamp on an Area Radiation Monitor is out. This is an indication of …

a. too low a voltage to the detector.
b. the Sr^{90} test source is missing
c. too many pulses to the detector (saturation).
d. the signal due to the Sr^{90} test source is verified correct.

Answer: C.08 a.
Reference: RO Training Manual § II.

QUESTION C.009 [1.0 points, 0.2 each] (9.0)
Indicate whether each of the following reactivity coefficients is **POS**itive or **NEG**ative for the indicated locations.

a. Void Coefficient of the Flux Trap
b. Void Coefficient of the Core
c. Temperature Coefficient of the Core
d. Temperature Coefficient of the Pool
e. Temperature Coefficient of the Flux Trap

Answer: C.09 a. = POS; b. = NEG; c. = NEG; d. = POS; e. = POS
Reference: MURR Hazards Summary Report, p. 4-14.,SOP/VIII-7 Critical Parameters List

Section C Facility and Radiation Monitoring Systems

QUESTION C.010 [1.0 point] (10.0)

Which one of the following describes the operation of the emergency power system on a loss of normal power? The emergency generator starts

a. five (5) seconds after the loss of normal power, closes in on the bus, and automatically transfers back to normal power as soon as it is restored.

b. one (1) second after the loss of normal power, and must be manually transferred back to normal power when it is restored.

c. five (5) seconds after the loss of normal power, and automatically shuts down ten (10) minutes after normal power is restored.

d. one (1) second after the loss of normal power and automatically transfers back to normal power ten (10) minutes after normal power is restored.

Answer: C.10 d.
Reference: HSR § 7.1.4 pp 7-4

QUESTION C.011 [1.0 point] (11.0)

During startup, you notice that Shim Blade #1 magnet engaged light goes out. Which action is allowed by the Startup Interlock?

a. Drive in Shim Blade #1, then re-engage the magnet.

b. You must scram the reactor to reset the interlock, then re-engage all magnets.

c. You may re-energize the magnet as soon as you notice the light is extinguished.

d. You must take the Master Switch to "OFF" then back to "ON" to reset the interlock. Then re-engage all magnets.

Answer: C.11 a.
Reference: HSR Chapter 9.0 Instrumentation and Control, § 9.5 Startup Interlocks

QUESTION C.012 [1.0 point, ⅓ each] (12.0)

Common radioisotopes associated with research reactors are Ar^{4l}, H^3 and Na^{24}. How is the radiological effect of each of these isotopes decreased for MURR workers.

a. Ar^{41}	1. Vents at top of pool
b. H^3	2. Containment Ventilation
c. Na^{24}	3. Purification System (Demineralizer)

Answer: C.012 a. = 2; b. = 1; c. = 3
Reference: Previous NRC Bank Question

Section C Facility and Radiation Monitoring Systems

QUESTION C.013 [1.0 point] (13.0)

Which ONE of the following correctly describes the actions of the automatic shim control circuit? Shim rods will automatically insert when the regulating rod reaches the ____ withdrawn position. The insertion will be enough to drive the regulating rod to ____ withdrawn.

a. 20% 60%

b. 20% 70%

c. 30% 60%

d. 30% 70%

Answer: C.013 a.
Reference: MURR Training Manual, p. II

QUESTION C.014 [1.0 points, ¼ each] (14.0)

Match each POOL Coolant system function in column A with the component PRIMARILY responsible for that function in column B.

FUNCTION	COMPONENT
a. Reduce Water Hardness (Remove ions).	1. Filters
b. Reduce doses due to N^{16}.	2. Demineralizer
c. Remove suspended solids.	3. Hold-up Tank
d. Maximize mixing of water in pool	4. Diffuser

Answer: C.14 a. = 2; b = 3; c = 1; d. = 4.
Reference: Draft SAR §§ 5.3.6, 5.3.7, 5.5.2 and 5.5.3.

QUESTION C.015 [1.0 point] (15.0)

Procedure OP-RO-410 Primary Coolant System, contains a caution to immediately perform two steps to minimize the time the primary system is solid. The first step VERIFIES that Anti-Siphon Valves 543A and 543B close. Step 5.4.5 should open …

a. Primary Coolant Isolation Valves 507A/B.

b. Pressurizer Water Addition Valve 527B

c. Pressurizer Water Drain Valve 527B

d. Surge Line Isolation Valve 527C

Answer: C.15 d.
Reference: OP-RO-410 Caution following step 5.4.2.

Section C Facility and Radiation Monitoring Systems

QUESTION C.016 [1.0 point] (16.0)
You are going to lower pool level lower than the surface block intake level. Prior to starting the evolution you must

a. close the upper and open the lower using the “T” wrench.

b. do nothing, both suctions (upper and lower) are normally open.

c. close the upper and open the lower using the handwheels on the valves.

d. close the upper and open the lower the switches in the control room (solenoid controlled air valves).

Answer: C.16 a.
Reference: OP-RO-465 Pool Level Control - Skimmer System

QUESTION C.017 [1.0 point] (17.0)
Which ONE of the following conditions is NOT a Nuclear Instrument Anomaly?

a. PRM selector switch not in OPERATE position.

b. IRM selector switch not in OPERATE position.

c. SRM high voltage supply is low.

d. PRM at 120% power.

Answer: C.17 d.
Reference: SAR 2006 - § 7.4.2 Nuclear Flux Monitors

QUESTION C.018 [1.0 point] (18.0)
On receipt of a scram signal, with the regulating rod controlling in AUTO, the reg rod will …

a. remain at its position at the time of the scram.

b. receive a rod run-in signal and be driven into the core.

c. be magnetically decoupled from the drive, and drop into the core via gravity.

d. receive a mis-match signal and be driven out of the core attempting to maintain power stable.

Answer: C.18 a.
Reference: SAR 2006 - 7.5.2 § Control Rods

Section C Facility and Radiation Monitoring Systems

QUESTION C.019 [1.0 point] (19.0)

A high airborne activity accident in the containment has caused a reactor isolation. All personnel have evacuated containment. How can you determine whether there is still a high airborne activity?

a. Take an air sample using a connection on the containment air building leak rate system.

b. Remote readout of containment building exhaust #1 and #2 area radiation monitors.

c. Remote readout of Stack Gas, Particulate and Iodine Monitors.

d. Take an air sample at the facility stack.

Answer: C.19 a.
Reference: SV-HP-135

QUESTION C.020 [1.0 point] (20.0)

Secondary Cooling System pumps should not be started at the same time because:

a. the power surge will trip the pump motor supply breakers.

b. initial high flow rates will result in thermal shock to the heat exchangers.

c. the pressure surge may produce a water hammer in the heat exchangers.

d. the basin level will be reduced, resulting in a low sump level trip.

Answer: C.20 d.
Reference: SOP VI.1.