December 16, 2010

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

SUBJECT: INITIAL EXAMINATION REPORT No. 50-186/OL-11-01,
UNIVERSITY OF MISSOURI – COLUMBIA

Dear Mr. Butler:

During the week of November 22, 2010, 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 internet e-mail phillip.young@nrc.gov.

Sincerely,

/TBlount for RA/

Johnny H. Eads Jr., Chief
Research and Test Reactors Oversight Branch
Division of Policy and Rulemaking
Office of Nuclear Reactor Regulation

Docket No. 50-186

Enclosures: 1. Initial Examination Report No. 50-186/OL-11-01
2. Written examination with facility comments incorporated

cc without enclosures:
Please see next page

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DISTRIBUTION w/ encls.:

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

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

OFFICE	PRTB:CE		IOLB:LA	E	PRTB:SC	
NAME	PYoung		CRevelle		TBlount for JEads	
DATE	12/14/10		12/10/10		12/16/10	

C = COVER E = COVER & ENCLOSURE N = NO COPY OFFICIAL RE

cc:

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

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Fourth Floor East
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A-95 Coordinator
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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: November 22 & 23, 2010

SUBMITTED BY: **/RA/** 12/14/10
Phillip T. Young, Chief Examiner Date

SUMMARY:

During the week of November 22, 2010 the NRC administered licensing examinations to one SRO-U and one RO 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	1/0	0/0	1/0
Operating Tests	1/0	1/0	2/0
Overall	1/0	1/0	2/0

3. Exit Meeting:
Phillip T. Young, Chief Examiner, NRC
Robert Hudson, Training Coordinator, MURR
John L. Fruits, Assistant Reactor Manager of Operations, MURR
Les Foyto, Reactor Manager, MURR

At the conclusion of the examinations the chief examiner thanked the facility for their support during the examinations. There were no generic weaknesses to report.

ENCLOSURE 1

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

FACILITY: University of Missouri - Columbia

REACTOR TYPE: TRIGA

DATE ADMINISTERED: November 22, 2010

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		_____	____% FINAL GRADE	TOTALS

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

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

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

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

$$T_{½} = \frac{0.693}{\lambda}$$

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

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

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

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

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

EQUATION SHEET's

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

1 Curie = 3.7×10^{10} dis/sec

1 kg = 2.21 lbm

1 Horsepower = 2.54×10^{3} BTU/hr

1 Mw = 3.41×10^{6} BTU/hr

1 BTU = 778 ft-lbf

°F = 9/5°C + 32

1 gal (H_2O) ≈ 8 lbm

°C = 5/9 (°F - 32)

c_P = 1.0 BTU/hr/lbm/°F

c_p = 1 cal/sec/gm/°C

Section A Reactor Theory, Thermo, and Facility Characteristics

Question A.001 [1.0 point] {1.0}
Which ONE of the following requires a control rod INSERTION to maintain reactor power constant following the change?

a. Samarium buildup
b. Primary coolant temperature decreases
c. Xenon buildup
d. U^{235} concentration decrease (Fuel Burnup)

Answer: A.001 b.
Reference: DOE Fundamentals Handbook, Module X,

Question A.002 [1.0 point] {2.0}
During a Critical Experiment "1/M" data is required to be taken. What does the 1/M represent?

a. The inverse of the moderator coefficient of reactivity.
b. The inverse of core total U^{235} mass.
c. The inverse migration length of neutrons of varying energies.
d. The inverse multiplication of the count rate between generations.

Answer: A.002 d.
Reference: DOE Fundamentals Handbook, Nuclear Physics and Reactor Theory,
Volume X, Module Y, Enabling Objective Z.Z

Question A.003 [1.0 point] {3.0}
Which ONE of the following is the reason that Xenon Peaks after a shutdown?

a. Iodine decays faster than Xenon decays
b. Promethium decays faster than Xenon decays
c. Xenon decays faster than Iodine decays
d. Xenon decays faster than Promethium

Answer: A.003 a.

Reference: DOE Fundamentals Handbook

Section A Reactor Theory, Thermo, and Facility Characteristics

Question A.004 [1.0 point] {4.0}
Thermal neutrons are …

a. neutrons possessing thermal rather than kinetic energy.

b. the primary source of thermal energy increase in the reactor coolant during reactor operation.

c. neutrons produced a significant time (on the order of seconds) after its initiating fission took place.

d. neutrons that experience no net change in energy after several collisions with atoms of the diffusing media.

Answer: A.004 d.
Reference: DOE Fundamentals Handbook, Module X,

Question A.005 [1.0 point] {5.0}
Which one of the following is the definition of the ***FAST FISSION FACTOR***?

a. The ratio of the number of neutrons produced by fast fission to the number produced by thermal fission.

b. The ratio of the number of neutrons produced by thermal fission to the number produced by fast fission.

c. The ratio of the number of neutrons produced by fast and thermal fission to the number produced by thermal fission.

d. The ratio of the number of neutrons produced by fast fission to the number produced by fast and thermal fission.

Answer: A.005 c.
Reference: DOE Fundamentals Handbook, Volume 2, Module 3, *Neutron Life Cycle*, p. 3.

Question A.006 [1.0 point] {6.0}

β and β_{eff} both describe the total fraction of delayed neutrons. The difference between the two is that β_{eff} is …

a. smaller than β since delayed neutrons are born at lower energy levels than prompt neutrons.

b. larger than β since delayed neutrons are born at lower energy levels than prompt neutrons.

c. smaller than β since delayed neutrons are born at higher energy levels than prompt neutrons.

d. larger than β since delayed neutrons are born at higher energy levels than prompt neutrons.

Answer: A.006 b.
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 explains the response of a ***SUBCRITICAL*** reactor to equal insertions of positive reactivity as the reactor approaches criticality? Each insertion causes a …

a. ***SMALLER*** increase in the neutron flux resulting in a ***LONGER*** time to stabilize.

b. ***LARGER*** increase in the neutron flux resulting in a ***LONGER*** time to stabilize.

c. ***SMALLER*** increase in the neutron flux resulting in a ***SHORTER*** time to stabilize.

d. ***LARGER*** increase in the neutron flux resulting in a ***SHORTER*** time to stabilize.

Answer: A.007 b.
Reference: DOE Fundamentals Handbook, Volume 2, Module 4, *Subcritical Multiplication*,

Section A Reactor Theory, Thermo, and Facility Characteristics

Question A.008 [1.0 point] {8.0}
Which of the following factors has the LEAST effect on rod worth?

a. number and location of adjacent rods.

b. temperature of the moderator.

c. temperature of the fuel.

d. core age.

Answer: A.008 c.
Reference: DOE Fundamentals Handbook, Nuclear Physics and Reactor Theory,
Volume X, Module Y, Enabling Objective Z.Z

Question A.009 [1.0 point] {9.0}
Which one of the following correctly describes the relationship between differential rod worth (DRW) and integral rod worth (IRW)?

a. DRW is the slope of the IRW curve at a given location.

b. DRW is the area under the IRW curve at a given location.

c. DRW is the square root of the IRW curve at a given location.

d. There is no relationship between DRW and IRW.

Answer A.009 a.
Reference: DOE Fundamentals Handbook, Nuclear Physics and Reactor Theory,
Volume X, Module Y, Enabling Objective Z.Z

Question A.010 [1.0 point] {10.0}
Why is the stable negative period following a scram always the same value, regardless of initial power level? The rate of power change is dependent on the …

a. mean lifetime of the longest lived delayed precursor.
b. constant decay rate of prompt neutrons.
c. mean lifetime of the shortest lived delayed neutron precursor.
d. constant decay rate of prompt gamma emitters.

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

Question A.011 [1.0 point] {11.0}
Which one of the following statements correctly describes the property of a **GOOD MODERATOR**?

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

Answer: A.011 c.
Reference: DOE Fundamentals Handbook, Nuclear Physics and Reactor Theory,
Volume X, Module Y, Enabling Objective Z.Z

Section A Reactor Theory, Thermo, and Facility Characteristics

Question A.012 [1.0 point] {12.0}
Reactor power doubles in 42 seconds. Based on the period associated with this transient, how long will it take for reactor power to increase by a factor of 10?

a. 80 seconds
b. 110 seconds
c. 140 seconds
d. 170 seconds

Answer: A.012 c.
Reference: DOE Fundamentals Handbook, Nuclear Physics and Reactor Theory.

$P = P_0 e^{t/\tau}$ 1st find τ. τ = time/(ln(2)) = 42/0.693 = 60.6 sec.
Time = $\tau \times \ln(10) = 60.6 \times 139.5$ sec

Question A.013 [1.0 point] {13.0}
Which ONE of the following is the reason for an installed neutron source within the core? A startup without an installed neutron source …

a. is impossible as there would be no neutrons available to start up the reactor.
b. would be very slow due to the long time to build up neutron population from so low a level.
c. can be compensated for by adjusting the compensating voltage on the source range detector.
d. 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.

Answer: A.013 d.
Reference: DOE Fundamentals Handbook, Nuclear Physics and Reactor Theory.

Question A.014 [1.0 point] {14.0}

Initially Nuclear Instrumentation is reading 30 CPS and the reactor has a K_{eff} of 0.90. You add an experiment which causes the Nuclear instrumentation reading to increase to 60 CPS. Which ONE of the following is the new K_{eff}?

a. 0.91

b. 0.925

c. 0.95

d. 0.975

Answer: A.014 c.

Reference: $CR_2/CR_1 = (1 - K_{eff1})/(1 - K_{eff2})$ $60/30 = (1 - 0.900)/(1 - K_{eff2})$ $1-K_{eff2} =$

$½ \times 0.1 = 0.05$ $K_{eff2} = 1 - 0.05 = 0.95$

Question A.015 [1.0 point] {15.0}

Suppose the temperature coefficient of a core is -2.5×10^{-4} ΔK/K/°C and the average control rod worth of the regulating control rod is 5.895×10^{-3} ΔK/K/inch. If the temperature INCREASES by 50°C what will the automatic control command the regulating rod to do? Select the answer that is closest to the calculated value.

a. 5.6 inches in

b. 2.1 inches out

c. 0.5 inches in

d. 4.3 inches out

Answer: A.015 b.

Reference: DOE Fundamentals Handbook, Volume 2, Module 3, *Reactivity Coefficients,* p. 48

The temperature increase will result in a change in reactivity of: -2.5×10^{-4} ΔK/K/°C × 50°C = -1.25×10^{-2} ΔK/K. Since the temperature rise results in a negative reactivity insertion, the control rod will need to drive out to add positive reactivity. D = $(1.25 \times 10^{-2}$ ΔK/K) ÷ $(5.895 \times 10^{-3}$ ΔK/K/inch) = 2.12 inches.

Section A Reactor Theory, Thermo, and Facility Characteristics

Question A.016 [1.0 point] {16.0}
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.016 b.
Reference: Standard NRC Question $A = A_0 e^{-\lambda T}$ (22 minutes)

Question A.017 [1.0 point] {17.0}
Match type of radiation (Column A) with the proper penetrating power (Column B).

a. Gamma	1. Stopped by thin sheet of paper
b. Beta	2. Stopped by thin sheet of metal
c. Alpha	3. Best shielded by light material
d. Neutron	4. Best shielded by dense material

Answer: A.017 a. = 4; b. = 2; c. = 1; d. = 3
Reference: Basic Nuclear Concepts, p. 7.4.2

Question A.018 [1.0 point] {18.0}
What is the kinetic energy range of a thermal neutron?

a. > 1 MeV

b. 100 KeV – 1 MeV

c. 1 eV – 100 KeV

d. < 1 eV

Answer: A.018 d.
Reference: DOE Fundamentals Handbook, Volume 1, Module 2, *Neutron Moderation*, p. 23.

Question A.019 [1.0 point] {19.0}
The primary coolant temperature coefficient of reactivity is $-5x10^{-5}$ delta K/K/deg.F. When a control rod with an average rod worth of 0.01% delta K/K/inch is withdrawn 10 inches, reactor power increases and becomes stable at a higher level. At this point, the primary coolant temperature has:

a. increased by 20 deg.F.

b. decreased by 20 deg.F.

c. increased by 2 deg.F.

d. decreased by 2 deg.F.

Answer: A.019 a.
Reference: DOE Fundamentals Handbook, Module 3, Reactivity, page 21.
Control rod inserts positive reactivity = 0.0001delta k/k/inch x 10 inches = +0.001 delta k/k. Primary coolant temperature inserts negative reactivity = $-5x10^{-5}$ delta k/k/deg.F x(+20 deg.F) = -0.001 delta k/k.

Section A Reactor Theory, Thermo, and Facility Characteristics

Question A.020 [1.0 point] {20.0}

The moderator-to-fuel ratio describes the relationship between the number of moderator atoms in a volume of core to the number of fuel atoms. A reactor which is:

a. undermoderated will have a positive moderator temperature coefficient.

b. undermoderated will have a negative moderator temperature coefficient.

c. overmoderated will have a constant moderator temperature coefficient.

d. overmoderated will have a negative moderator temperature coefficient.

Answer: A.020 b.

Reference: DOE Fundamentals Handbook, Module 3, Reactivity Coefficients, page 25.

Section B Normal/Emergency Procedures & Radiological Controls

Question: B.001 [1.0 point] {1.0}
Annual maintenance was last performed on a system on July 31, 2010. The last date annual maintenance may be performed on the system without being late is …

a. July 31, 2010
b. August 31, 2010
c. September 30, 2010
d. October 31, 2010

Answer: B.001 c.
Reference: T.S. 1.2 Calibration or Testing Interval.

Question: B.002 [1.0 point] {2.0}
When is the reactor licensee authorized to take reasonable action that departs from a license condition or a technical specification?

a. The licensee is never allowed to violate any NRC authorized operating limits.

b. The licensee can depart from technical specifications for calibration purposes.

c. The licensee is authorized to do whatever is necessary to protect public health and safety in an emergency.

d. The license holder can do anything deemed necessary for normal operations, so long as the licensee notifies the NRC within an hour after the action.

Answer: B.002 c.
Reference: 10 CFR 50.54(x)

Section B Normal/Emergency Procedures & Radiological Controls

Question: B.003 [1.0 point] {3.0}

Monday morning maintenance has been completed. A full power pre-startup checksheet was completed at 09:00 am. The new trainees have been performing startups and shutdowns all day for NRC examinations. All equipment has been operating properly. Following the completion of exams, a cooling tower fan failed. It was a loose wire which was quickly corrected. Due to the late hour (19:30) the startup following the examinations will start after shift change at 20:00 pm. Which ONE of the following statements is correct? Because the …

a. cooling tower equipment is not part of a short form pre-startup checksheet, and it is less than 12 hours since the last full power startup checksheet, you may startup after successfully completing a short form pre-startup checksheet.

b. cooling tower equipment is part of a short form pre-startup checksheet, regardless of the time you must perform a full power startup checksheet prior to startup.

c. time since the last full power startup checksheet is greater than 8 hours regardless of wether the cooling tower equipment is part of a short form pre-startup checksheet, you must perform a full power startup checksheet prior to startup.

d. last full power startup checksheet was preformed during a different shift a new full power check sheet must be performed regardless of time or equipment malfunctions.

Answer: B.003 c.
Reference: AP-RO-110 Rev 15; 6.6.3 Reactor Startup Checksheets – Time Limit Requirements

Question: B.004 [1.0 point] {4.0}

According to Technical Specifications, the drop time for each rod shall be measured ____ and one of four blades shall be inspected _____.

a. monthly every six months
b. quarterly every six months
c. quarterly annually
d. every six months annually

Answer: B.004 b.
Reference: Technical Specification 5.3.

Section B Normal/Emergency Procedures & Radiological Controls

Question: B.005 [1.0 point] {5.0}
Which ONE of the following radiation monitors may be placed out of service for two hours for maintenance or calibration, providing no experimental or maintenance activities are conducted which could likely result in the release of unknown quantities of airborne radioactivity.

a. Reactor Building Exhaust air plenum Radiation Monitor
b. Reactor Bridge ALARA Radiation Monitor
c. Reactor Bridge Radiation Monitor
d. Stack Radiation Monitor

Answer: B.005 d.
Reference: Technical Specifications, Table in § 3.4(a).

Question: B.006 [1.0 point] {6.0}
Which ONE of the following is NOT a responsibility of the Console Operator following a reactor isolation?

a. Verify that the containment building has sealed by the ventilation door and exhaust valve indication lights.
b. Ensure all personnel have evacuated all levels of the containment building.
c. Position himself at the outer airlock allowing only authorized personnel entry.
d. Investigate the cause of the alarm and magnitude of the incident.

Answer: B.006 d.
Reference: EP-RO-012 step 2.0

Question: B.007 [1.0 point] {7.0}
In the case of a partial site area evacuation, according to EP-RO-013, all personnel who have evacuated the reactor building will proceed to

a. Dalton parking lot
b. Science Instrument Shop
c. Research Park Development Building
d. USDA Research Laboratory parking lot

Answer: B.007 a.
Reference: EP-RO-013, Facility Evacuation, Attachement 5.1, Evacuation Map

Section B Normal/Emergency Procedures & Radiological Controls

Question: B.008 [1.0 point] {8.0}
Which ONE of the following types of experiments may NOT be irradiated within the confines of the pool?

a. cryogenic liquids
b. fueled experiments
c. explosive materials
d. materials corrosive to reactor components

Answer: B.008 a.
Reference: Technical Specification 3.6(m)

Question: B.009 [1.0 point, ¼ point each] {9.0}
Identify each of the actions listed below as either a Channel Check (**Check**), a Channel Test (**Test**), or a Channel Calibration (**Cal**).

a. Prior to startup you place a known radioactive source near a radiation detector, noting meter movement, and alarm function operation.

b. During startup you compare all of your nuclear instrument channels ensuring they track together.

c. At power , you perform a heat balance (calorimetric) and determine the need to adjust Nuclear Instrumentation readings.

d. During reactor shutdown you note -80 second period on nuclear instrumentation.

Answer: B.009 a. = Test; b. = Check; c. = Cal; d. = Check
Reference: Technical Specifications

Question: B.010 [1.0 point] {10.0}
During a startup the reactor is not critical within ECP limits, per AP-RO-110, the minimum level of staff authorized to permit a continuation of the startup is …

a. Any licensed Senior Reactor Operator
b. Lead Senior Reactor Operator
c. Assistant Reactor Manager
d. Reactor Manager

Answer: B.010 c.
Reference: AP-RO-110, § 6.6.5.d

Section B Normal/Emergency Procedures & Radiological Controls

Question: B.011 [1.0 point] {11.0}
Which ONE of the following is the minimum number of hours you must stand watch per quarter to maintain your license active?

a. 2
b. 4
c. 8
d. 12

Answer: B.011 b.
REF: 10CFR55.53e

Question: B.012 [1.0 point] {12.0}
The Quality Factor is used to convert …

a. dose in rads to dose equivalent in rems.
b. dose in rems to dose equivalent in rads.
c. contamination in rads to contamination equivalent in rems
d. contamination in rems to contamination equivalent in rads

Answer: B.012 a.
Reference: 10CFR20

Question: B.013 [1.0 point] {13.0}
A radiation survey of an area reveals a general radiation reading of 1 mrem/hr. However, there is a small section of pipe which reads 10 mrem/hr at one (1) meter. Assuming that the pipe is a point source, which ONE of the following defines the posting requirements for the area in accordance with 10CFR Part 20?

a. Restricted Area.
b. Radiation Area.
c. High Radiation Area.
d. Grave Danger, Very High Radiation Area.

Answer: B.013 c.
Reference: 10 mrem/hr at 1 meter (100 cm.) = 111.1mrem/hr at 30 cm.

Section B Normal/Emergency Procedures & Radiological Controls

Question: B.014 [1.0 point] {14.0}
Which ONE of the following is the exposure you would expect (approximately) two feet from a point source containing 5 curies of Co^{60}.

a. 190 mR/hr

b. 1.9 R/hr

c. 19 R/hr

d. 190 R/hr

Answer: B.014 c.
R/hr = $6CiE/d^2$, R/hr = $(6 \times 5 \text{ curies} \times 2.5MeV)/(2 \text{ feet})^2 = 75/4 = 18.75$ R/hr ≈ 19 R/hr
Reference: Standard NRC question.

Question: B.015 [1.0 point] {15.0}
The procedure for starting up the secondary system for 10 Mw operations requires greater than a 5 minute delay in starting the second pump. Which ONE of the following is the correct reason for this delay?

a. To prevent a low sump level trip.

b. To prevent an electrical overload on the system.

c. To prevent damage to the pump discharge check valves.

d. To prevent water hammer damage to the heat exchangers.

Answer: B.015 a.
Reference: OP-RO-480, Secondary Coolant System

Question: B.016 [1.0 point] {16.0}
During a normal reactor startup you must stop pulling the shim-safety blades in gang when you reach the position equivalent to _____ inches below the ECP position.

a. 5

b. 2-½

c. 2

d. 1-¼

Answer: B.016 c.
Reference: OP-RO-210, Precaution 3.4.

Section B Normal/Emergency Procedures & Radiological Controls

Question: B.017 [1.0 point] {17.0}
The Primary System Fuel Failure Monitor is secured due to an electrical problem. How often must the primary coolant be sampled to continue reactor operation?

a. every hour
b. every two hours
c. every four hours
d. every eight hours

Answer: B.017 c.
Reference: Technical Specifications, § 3.9, Coolant System

Question: B.018 [1.0 point] {18.0}
During refueling, the lowest level of staff who may move fuel INTO OR OUT OF THE CORE UNDER DIRECT SRO SUPERVISION is …

a. Auxiliary Operator
b. Reactor Operator
c. Reactor Operator Trainee
d. Reactor Health Physics

Answer: B.018 c.
Reference: OP-RO-250

Question: B.019 [1.0 point] {19.0}
An experiment is removed from the reactor with a radiation level of 10R/hr at 15 feet. 15 minutes later, the radiation level is 7.2 Rem/hr at 15 feet. Approximately how long must you let the experiment decay before the radiation level is less than 100 mR/hr at 1 foot.

a. 4 hours
b. 8 hours
c. 12 hours
d. 16 hours

Answer B.019 b.
Reference first solve for λ_{eff}; $A = A_0\, e^{-t\,\lambda eff}$; $\ln (A/A_0) = \text{time} \times \lambda_{eff}$
$\lambda_{eff} = (\ln (7.2/10)) \div \text{time} = (-0.329)/15 \text{ minutes} = -0.0219 \text{ minutes}^{-1}$
Next solve for initial dose at 1 foot. $A_{1\,ft} = A_{15\,ft} \times 15^2 = 10 \text{ R/hr} \times 225 = 2250 \text{ R/hr}$ at 1 foot.
Finally solve for time to get to 0.1 R/hr at 1 foot.
$0.1 = 2250\, e^{t\,\lambda eff}$ ===> time = $\ln (2250/0.1) \div \lambda_{eff} = 457.6$ minutes = 7.6 hours

Section B Normal/Emergency Procedures & Radiological Controls

Question: B.020 [1.0 point] {20.0}
The fastest reactor period which may be used to raise power to 1 mW according to procedure is …

a. 10 seconds

b. 30 seconds

c. 50 seconds

d. 100 seconds

Answer: B.020 b.
Reference: OP-RO-210

Section C Facility and Radiation Monitoring Systems

Question: C.001 (1.00 point) {1.0}
When the high alarm contact associated with CE932 is activated, an alarm sounds on an annunciator which reads:

a. "Reactor Loop Coolant Hi Activity."
b. "Reactor or Pool Loop Hi Cond."
c. "Secondary Coolant Hi Activity."
d. "Off Gas Hi Activity."

Answer: C.001 b.
Reference: Training Manual for Reactor Operations, page I.4.2.

Question: C.002 (1.00 point, 0.125 each) {2.0}
Identify each of the following valve operator system valve indications as being either via limit switch (**L/S**) on the valve (actual valve position) or air operator (**A/O**) position, and whether the OPEN position is **G**REEN or **R**ED. (NOTE: Two answers should be circled per item.)

a. Pool Loop 6" isolation valve
b. Primary Loop 12" isolation valve
c. Pressurizer, 2" Bypass Drain
d. Pressurizer 1" Supply Valve
e. Reflector Convective Loop Valve
f. Anti-siphon Valve
g. N_2 ½" Exhaust valve.
h. Liquid Level 2" fill

Answer: C.002 a & b = L/S (green); c & d = A/O (red); e & f = L/S (red); g & h = A/O (red)
Reference: Reactor Operator Training Manual,

Question: C.003 (1.00 point) {3.0}
Which ONE of the following is the correct (temporary) method for maintaining power to critical reactor instrumentation when performing maintenance on the Uninterruptible Power Supply?

a. Close the bypass switch, allowing the batteries to feed a backup UPS.
b. Close the static switch, allowing the batteries to feed a backup UPS.
c. Close the bypass switch, allowing site power to feed the instrumentation.
d. Close the static switch, allowing site power to feed the instrumentation.

Answer: C.003 c.
Reference: Reactor Operator Training Manual § III.3.C.1.3, page II.3.3,

Section C Facility and Radiation Monitoring Systems

Question: C.004 (1.00 point) {4.0}
How is Reactor Coolant temperature controlled?

a. Varying reactor loop flow by varying speed of pumps P501A/B.
b. Varying reactor loop flow by varying the position of butterfly valve 901.
c. Varying secondary loop flow by varying speed of pumps P1, P2 and P3.
d. Varying secondary loop flow by varying the position of butterfly valve S-1.

Answer: C.004 d.
Reference: SAR Section 5.4

Question: C.005 (1.00 point) {5.0}
Which ONE of the following conditions will **NOT** result in changing the regulating blade control from automatic to manual.

a. Scram
b. Run-In
c. Shimming a control blade
d. Operating the regulating blade switch

Answer: C.005 c.
Reference: HSR, § 9.6.2

Question: C.006 (1.00 point) {6.0}
Which one of the following describes the automatic operation of the Shim Rods?

a. The Shim Rods insert when the Regulating Rod position decreases to 20% withdrawn.
b. The Shim Rods insert when the Regulating Rod position increases to 20% withdrawn.
c. The Shim Rods withdraw when the Regulating Rod position decreases to 20% withdrawn.
d. The Shim Rods withdraw when the Regulating Rod position increases to 10% withdrawn.

Answer: C.006 a.
Reference: HSR, § 9.6.2 last ¶,

Section C Facility and Radiation Monitoring Systems

Question: C.007 (1.00 point) {7.0}
What is the purpose of the ventilation ducts built in to the pool wall? These ducts are designed to remove …

a. H^3
b. N^{16}
c. Ar^{41}
d. I^{131}

Answer: C.007 a.
Reference: Rx Operator Training Manual, § I.11, Containment Building Exhaust System p. I.11.1, 2nd ¶.

Question: C.008 (1.00 point) {8.0}
How long after shutdown must the Primary system be in operation?

a. 5 minutes
b. 10 minutes
c. 15 minutes
d. 30 minutes.

Answer: C.008 c.
Reference: OP-RO-410, Primary Coolant System, § 6.0 Caution

Question: C.009 (1.00 point) {9.0}
WHICH ONE of the following detectors is used primarily to measure N^{16} release to the environment?

a. NONE, N^{16} has too short a half-life to require environmental monitoring.
b. Stack Gas Monitor
c. Stack Particulate Monitor
d. Bridge Area Monitor

Answer: C.009 a.
Reference: Standard NRC question

Section C Facility and Radiation Monitoring Systems

Question: C.010 (1.00 point) {10.0}
The Fission Product Monitor samples primary coolant at a point:

a. between the outlet of the primary pumps and the inlet to the heat exchangers.

b. between the outlet of the heat exchangers and the inlet to the core.

c. between the outlet of the core and the inlet to the primary pumps.

d. at the inlet to the holdup tank.

Answer: C.010 b.
Reference: Rx Operator Training Manual, page II.7.1.

Question: C.011 (1.00 point) {11.0}
The Building Exhaust System is operating normally, one fan in fast speed, both fan controllers in the auto position. Upon loss of power to the running fan the stand-by fan will …

a. start in fast speed.

b. start in slow speed, the operator must push a button to shift it to fast speed.

c. start in slow speed, after 15 seconds it will automatically shift to fast speed.

d. remain off, the operator must push a button to start the standby pump in either slow or fast speed.

Answer: C.011 b.
Reference: OP-RO-730, Building Exhaust System Fans

Question: C.012 (1.00 point) {12.0}
Which ONE of the following electrical loads **CANNOT** be supplied by the Emergency Generator?

a. Air Locks

b. Exhaust Fan EF-13

c. Intercom System

d. Pool Pump P508A

Answer: C.012 d.
Reference: Rx Operator Training Manual, § III.1 Electrical Power Distribution and § III.3 Emergency Electrical System

Section C Facility and Radiation Monitoring Systems

Question: C.013 (1.00 point) {13.0}
When setting the reactor power calculator flow potentiometer you must make a correction for cleanup flow. Which ONE of the following is the correct adjustment and reason for this adjustment? Explain why the cleanup flow is either added or subtracted from the indicated flow in reactor loops A and B when determining the pot setting for the reactor power calculator flow potentiometer.

a. Subtract cleanup flow. Cleanup flow bypasses the core, but **IS** measured by the indicated flow.

b. Add cleanup flow. Cleanup flow also goes through the core, but **IS NOT** measured by the indicated flow.

c. Subtract cleanup flow. Cleanup flow also goes through the core, but **IS NOT** measured by the indicated flow.

d. Add cleanup flow. Cleanup flow bypasses the core, but **IS** measured by the indicated flow.

Answer: C.013 a.
Reference: OP-RO-350 Reactor Power Calculator Flow Potentiometer Adjustment.

Question: C.014 (1.00 point, 0.25 each) {14.0}
For each status of the Alarm and Annunciate System indicate which of the conditions listed would result in that status.

Status Descriptions	Conditions
a. Illumination On Dim	(1) Alarm was received and the operator pressed the Acknowledge pushbutton. The alarm condition has not yet cleared.
b. Illumination Flashing	(2) Alarm was received but the operator has not yet pressed the Acknowledge pushbutton. The alarm condition has not yet cleared.
c. Illumination On Bright	(3) Alarm was received and the operator pressed the Acknowledge pushbutton. The alarm condition subsequently cleared but the operator has not yet pressed the Reset button.
d. Illumination Off	(4) Alarm was received and the operator pressed the Acknowledge pushbutton. The alarm condition subsequently cleared and the operator pressed the Reset button.

Answer: C.014 a. = 3; b. = 2; c. = 1; d. = 4
Reference: Training Manual, p. II-68, Hazards Summary Report, p. 9-19

Section C Facility and Radiation Monitoring Systems

Question: C.015 (1.00 point) {15.0}
Which one of the following is the design feature used to seal the COOLING SYSTEM WATER LINES entering the reactor building?

a. The lines enter the side of the building through a 4.6 foot water leg.

b. The lines enter beneath the pool and are sealed with a packing gland.

c. The lines have a 6.4 foot loop seal which extends above the active fuel.

d. The lines enter the side of the building and are sealed with an inflatable gasket.

Answer: C.015 b.
Reference: MURR Hazards Summary Report Section 1.4.5

Question: C.016 (1.00 point) {16.0}
Where does the Drain Collection tank overflow, overflow to?

a. “Floor Drain in room 114".

b. Retention Tank #3

c. Sanitary Sewer

d. Reactor Pool

Answer: C.016 a.
Reference: Rx Operator Training Manual, § I.8. Drain Collection Tank System, p. I.8.1. ¶ B

Question: C.017 (1.00 point) {17.0}
Which ONE of the following is the reason that the pool demineralizer system water returns to the pool about 2 feet below the pool surface? In order to …

a. aid in the mixing of the water, which results in a more even temperature distribution.

b. reduce pool surface temperature, since the demineralizer water is cooler than pool water.

c. reduce interference between the pool cooling system and the pool skimmer, which takes its suction at the pool surface.

d. create a blanket of warmer water at the top of the pool to reduce mixing, and therefore reduce the dose rate at the surface of the pool.

Answer: C.017 d.
Reference: MURR HSR, § 7.1.10 p. 7-15.

Section C Facility and Radiation Monitoring Systems

Question: C.018 (1.00 point) {18.0}
Which ONE of the following is the method used to DE-ICE the cooling tower fans.

a. Run the cooling tower fan in reverse.

b. Use the facilities steam line located in the area for that purpose.

c. Use a heat gun (similar to a hair dryer) designated for de-icing use.

d. De-icing is not necessary due to anti-freeze added to cooling tower water.

Answer: C.018 a.
Reference: OP-RO-480, § 6.3

Question: C.019 (1.00 point) {19.0}
The ventilation system has two backup doors located in the ventilation supply and return plenums which shut on containment isolation. Which ONE of the following is the method used to shut these doors? The doors are …

a. air motor operated, with their own emergency air supply tanks.

b. held open by air pistons, which when vented, the doors close via gravity.

c. motor operated, with air supplied from the emergency air supply system.

d. held open by solenoid, which when deenergized, the door closes via gravity.

Answer: C.019 b.
Reference: HSR § 3.2.5, Last ¶ on pg. 3-4 and 1st ¶ on pg. 3-5.

Question: C.020 (1.00 point) {20.0}
Q OL-07-02 Question C.009 [1.0 point] (9.0)
Which of the following conditions will result in an automatic rod run-in?

a. High Power

b. Low Pressurizer Pressure

c. Anti-Siphon System Pressure High

d. Thermal Column Door Open

Answer: C.020 a.
Reference: SAR - TABLE 7-6 ROD RUN-INS