January 2, 2008

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

SUBJECT: INITIAL EXAMINATION REPORT NO. 50-186/OL-08-01, UNIVERSITY OF MISSOURI – COLUMBIA

Dear Mr. Butler:

During the week of December 03, 2007, the NRC administered operator licensing examinations at your University of Missouri – Columbia Reactor. The examinations were conducted according to NUREG-1478, "Non-Power Reactor Operator Licensing Examiner Standards," 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 10 CFR 2.390 of the Commission's regulations, 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 (the Public Electronic Reading Room) 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 pty@nrc.gov.

Sincerely,

***/RA/***

Johnny Eads, Chief
Research and Test Reactors Branch B
Division of Policy and Rulemaking
Office of Nuclear Reactor Regulation

Docket No. 50-186

Enclosures:
1. Examination Report No. 50-186/OL-08-01
2. Corrected Written Examination

cc w/encls: Please see next page

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| Date | 12/18/2007 | | 12/20/2007 | | 1/02/2008 | |

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cc:

University of Missouri
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Jefferson City, MO 65101

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

**ENCLOSURE 1**

EXAMINATION REPORT NO: 50-186/OL-08-01

UNIVERSITY OF MISSOURI – COLUMBIA

FACILITY LICENSE NO.: R-103

SUBMITTED BY: /RA/ 12/ 17 /2007

Phillip T. Young, Chief Examiner Date

SUMMARY:

During the week of December 03, 2007, the NRC administered operator licensing examinations to one Senior Reactor Operator and one Reactor Operator candidate. Both applicants passed all portions of the examination

**Exit Meeting:**

Phillip T. Young, Chief Examiner
Robert Hudson, Training Coordinator, MURR
Les Foyto, Reactor Manager

At the conclusion of the site visit, the examiner met with representatives of the facility staff to discuss the results of the examinations. The examiner thanked the facility for their support of the examination. The facility presented comments on the written examination, and these comments have been incorporated into the examination attached to this report.

U.S. NUCLEAR REGULATORY COMMISSION
RESEARCH AND TEST REACTOR LICENSE EXAMINATION

UNIVERSITY OF MISSOURI – COLUMBIA

WRITTEN EXAMINATION

12/03/2007

ENCLOSURE 2

Question A.001 {2.0 points, 0.4 each} (2.0)
Matching - Indicate for each item in Column A the item in Column B that is associated with it.

| Column A | Column B |
|---|---|
| a. Highest $\sigma_f$ for fast neutrons | 1. $U^{235}$ |
| b. Highest $\sigma_f$ for thermal neutrons | 2. $U^{238}$ |
| c. Highest $\sigma_a$ for thermal neutrons | 3. $B^{10}$ |
| d. Lowest $\sigma_a$ for thermal neutrons | 4. Water |
| e. Highest $\sigma_s$ for all neutrons | 5. Graphite |

Answer A.001 a. = 2; b. = 1; c. = 3; d. = 5; e. = 4
Reference DOE Fundamentals Handbook, Module X, Reactor Kinetics, page xx.

Question A.002 {1.0 point} (3.0)
ELASTIC SCATTERING is the process by which a neutron collides with a nucleus and …

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

Answer A.002 a
Reference Primary Reference, Volume 1, Module 1, Atomic and Nuclear Physics, Enabling Objective 3.1

Question A.003 {1.0 point} (4.0)
Which of the following statements describes the concentration of Xenon in the core after a scram from extended operation at 10 MW? Xenon concentration …

a. initially decreases due to the loss of Iodine production then increases to maximum concentration
b. decreases to a Xenon free condition in approximately ten (10) hours
c. increases to maximum in approximately ten (10) hours due to the reduction in Xenon burnup
d. remains at equilibrium value since power level has no effect on Xenon concentration

Answer A.003 c.
Reference Primary Reference, Volume 2, Module 3, Reactor Theory (Nuclear Parameters), Enabling Objective 4.5.

Question A.004 {1.0 point} (5.0)
The effective neutron multiplication factor, $K_{eff}$ is defined as…

a. absorption/(production + leakage)

b. (production + leakage)/absorption

c. (absorption + leakage)/production

d. production/(absorption + leakage)

Answer A.004 d.
Reference Primary Reference, Volume 2, Module 4, Reactor Theory (Reactor Operations), Enabling Objective 1.1

Question A.005 {1.0 point} (6.0)
Which ONE of the following factors is the most significant in determining the differential worth of a control rod?

a. The rod speed.

b. Reactor power.

c. The flux shape.

d. The amount of fuel in the core.

Answer A.005 c.
Reference Primary Reference, Volume 2, Module 4, Reactor Theory (Reactor Operations), Enabling Objective 5.4

Question A.006 {1.0 point} (7.0)
Using the Integral Rod Worth Curve provided identify which ONE of the following represents $K_{excess}$?

a. Area under curve “B”.

b. $\rho_C$

c. $\rho_{max} - \rho_C$

d. Areas under curve “A” & “B”

Answer A.006 c.
Reference Standard NRC Question covering Technical Specification Parameter.

Question A.007 {1.0 point} (8.0)
Which ONE of the following is the correct definition of $\beta_{effective}$? The number of delayed neutrons compared to the total number of neutrons per generation …

a. corrected for resonance escape.

b. corrected for leakage.

c. corrected for time after the fission event.

d. corrected for both leakage and resonance escape.

Answer A.007 d.
Reference Primary Reference, Volume 2, Module 4, Reactor Theory (Reactor Operations), Enabling Objective 2.2

Question A.008 {1.0 point} (9.0)
Which ONE of the following is correct with regard to criticality?

a. Critical rod height does NOT depend on how fast control rods are withdrawn.

b. Critical rod height dictates the reactor power level when criticality is first achieved.

c. The reactivity of the reactor increases towards infinity during the approach to criticality.

d. The slower the approach to criticality, the lower the reactor power level will be when reaching criticality.

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

Question: A.009 {1.0 point} (10.0)
Delayed neutron precursors decay by beta(-) decay. Which ONE reaction below is an example of beta(-) decay?

a. ${}_{35}Br^{87}$ -> ${}_{36}Kr^{87}$

b. ${}_{35}Br^{87}$ -> ${}_{34}Kr^{87}$

c. ${}_{35}Br^{87}$ -> ${}_{35}Kr^{88}$

d. ${}_{35}Br^{87}$ -> ${}_{35}Kr^{86}$

Answer A.009 a.
Reference DOE Fundamentals Handbook, Module 1, Modes of Radioactive Decay, page 24.

Question A.010 {1.0 point} (11.0)
With the reactor on a constant period which transient will take the LONGEST time to complete? A reactor power change of …

a. 5%, going from 1% to 6% of rated power.
b. 10%, going from 10% to 20% of rated power.
c. 15%, going from 20% to 35% of rated power.
d. 20%, going from 40% to 60% of rated power.

Answer A.010 a.
Reference MURR exam administered 4/1994.

Question A.011 {1.0 point} (12.0)
Which ONE of the following describes the difference between a moderator and reflector?

a. A reflector increases the fast non-leakage factor and a moderator increases the thermal utilization factor.
b. A reflector increases the neutron production factor and a moderator increases the fast fission factor.
c. A reflector decreases the thermal utilization factor and a moderator increases the fast fission factor.
d. A reflector decreases the neutron production factor and a moderator decreases the fast non-leakage factor.

Answer A.011 a.
Reference Reference 1, Volume 2, Module 4, pp. 25-26

QUESTION A.012 {1.0 point} (13.0)
During a reactor startup, criticality occurred before the value calculated. Which ONE of the following reasons could be the cause?

a. Experiment adding positive reactivity.
b. $Xe^{135}$ peaked.
c. Moderator temperature increased.
d. Power defect (Reactor power increasing).

Answer A.012 a.
Reference

Question A.013 {1.0 point} (14.0)
A few minutes after a reactor scram period has steadied and reactor power is at $5 \times 10^5$ counts/minute. Three minutes later you would expect reactor power to be at …

a. $5 \times 10^6$ counts/minute.

b. $1 \times 10^5$ counts/minute.

c. $5 \times 10^4$ counts/minute.

d. $1 \times 10^5$ counts/minute.

Answer A.013 c.
Reference This is an 80 sec. period which implies power decreases by ~ ⅓ decade per minute, in 3 minutes power will decrease by 1 decade. DOE Fundamentals Handbook, Nuclear Physics and Reactor Theory, Volume 2,

Question A.014 {1.0 point} (15.0)
A reactor has a count rate of 45 cps with a $K_{eff}$ of 0.965. Which one of the following is the $K_{eff}$ of this reactor when the count rate increases to 90 cps?

a. 0.9800

b. 0.9825

c. 0.9850

d. 0.9875

Answer A.014 ~~c.~~ b.
Reference DOE Fundamentals Handbook, Nuclear Physics and Reactor Theory, Volume
CR1 (1-Keff1) = CR2 (1-Keff2)
45 (1- 0.965) = 90 (1-keff2)
[45(0.035)]/90 = 1-Keff2
0.9825 = Keff2
0.9826

Question A.015 {1.0 point} (16.0)
A reactor is subcritical with a $K_{eff}$ of 0.955. If you add 4.5% Δk/k of positive reactivity into the core, the reactor will be …

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

Answer A.016 a.
Reference DOE Fundamentals Handbook, Nuclear Physics & Reactor Theory, Vol 2, Module 4, Reactor Theory (Reactor Operations), Enabling Objective 1.3

$$SDM = \frac{1-k_{eff}}{k_{eff}} = \frac{1-0.955}{0.955} = \frac{0.045}{0.955} = 0.04712 \text{ If you add } 0.045\text{, the result will still be } 0.212\% \text{ shutdown}$$

Question A.016 {1.0 point} (17.0)
You perform two startups with exactly the same conditions (temperature, xenon, samarium, rod speed, etc.).
For the first startup you proceed directly to criticality. For the second startup, you stop at two inches below the ECP to change shift personnel. Following shift change the startup proceeds directly to criticality. With respect to control rod height and reactor power at criticality, for the second startup,

a. Rod height will be lower, Power will be the same.
b. Rod height will be higher, Power will be the same.
c. Rod height will be the same, Power will be lower.
d. Rod height will be the same, Power will be the higher.

Answer A.016 d.
Reference DOE Fundamentals Handbook, Nuclear Physics and Reactor Theory, Volume 2, Module 4, Reactor Theory (Reactor Operations), Enabling Objective 1.1

Question A.017 {1.0 point} (18.0)
The PRIMARY reason that a neutron source is installed in the reactor is to …

a. allow for testing and irradiation of experiments when the core is shutdown.
b. supply the neutrons required to start the chain reaction for subsequent reactor startups.
c. provide a neutron level high enough to be monitored for a controlled reactor startup.
d. increase the excess reactivity of the reactor which reduces the frequency for refueling.

Answer A.017 c.
Reference DOE Fundamentals Handbook, Nuclear Physics & Reactor Theory, Vol 1, Module 1, Reactor Theory (Reactor Operations), Enabling Objective 3.1

Question A.018 {1.0 point} (19.0)
A reactor has a moderator temperature coefficient of reactivity is 1.0 x $10^{-4}$ ΔK/K/°C. If the average coolant temperature decreases by 10°C, a regulating rod with a differential rod worth of 0.05%ΔK/K/inch must be:

a. inserted 2 inches
b. withdrawn 2 inches
c. inserted 0.5 inches
d. withdrawn 0.5 inches

Answer A.018 b.
Reference Burn, R., Introduction to Nuclear Reactor Operations, © 1988, §

$$-1.0 \times 10^{-4} \frac{\Delta K}{K°C} \times -10°C = +10^{-3} \frac{\Delta K}{K}$$
$$+10^{-3} \frac{\Delta K}{K} = 0.0005 \frac{\Delta K}{K} \times ?Inches$$
$$?Inches = \frac{10^{-3} \frac{\Delta K}{K}}{5 \times 10^{-4} \frac{\Delta K}{K}} = +2 inches (Withdrawn)$$

Question A.019 {1.0 point} (20.0)
Which ONE of the following describes the difference between prompt and delayed neutrons? Prompt neutrons …

a. account for less than 1% of the neutron population, while delayed neutrons account for the rest.

b. are released only during fast-fission events, while delayed neutrons are released during the decay process.

c. are released during the fission process (fast & thermal), while delayed neutrons are released during the decay process.

d. are the dominating factor in determining reactor period, while delayed neutrons have little effect on reactor period.

Answer A.019 c.
Reference Burn, R., Introduction to Nuclear Reactor Operations, © 1988, §

Question B.001 [1.0 point, ¼ each] {1.0}
The appropriate federal regulation contains many requirements for Operator Licenses, match each of the requirements listed in column A with it's appropriate time period in column B. (Note: Periods from column B may be used more than once or not at all.)

| | Column A (Requirements) | Column B (Years) |
|---|---|---|
| a. | License Renewal | 1 |
| b. | Requalification Written Examination | 2 |
| c. | Requalification Operating Test | 4 |
| d. | Medical Examination | 6 |

Answer: B.001 a. = 6; b. = 2; c. = 1; d. = 2
Reference: 10CFR55

Question B.002 [1.0 point] {1.0}
How long (by standard practice) must the reactor be secured prior to venting a beam port containing $Ar^{41}$?

a. 1 hour
b. 8 hours
c. 12 hours
d. 24 hours

Answer: B.002 b.
Reference: AP-RO-110 step 6.9.2.d

Question B.003 [1.0 point] {3.0}
Which ONE of the following statements correctly describes the relationship between a Safety Limit (SL) and a Limiting Safety System Setting (LSSS)?

a. The SL is a maximum operationally limiting value that prevents exceeding the LSSS during normal operations.

b. The SL is a parameter that assures the integrity of the fuel cladding. The LSSS initiates protective action to preclude reaching the SL.

c. The LSSS is a parameter that assures the integrity of the fuel cladding. The SL initiates protective action to preclude reaching the LSSS.

d. The SL is a maximum setpoint for instrumentation response. The LSSS is the minimum number of channels required to be operable.

Answer: B.003 b.
Reference: T.S. § A Definitions

Question B.004 [1.0 point] {4.0}
In the event of a high stack monitor readings (in excess of alarm points), the reactor operator should immediately:

a. notify the ~~shift supervisor~~ Lead Senior Reactor Operator. (per facility comment)

b. scram the reactor.

c. shut down the reactor.

d. reduce power slowly until the alarm clears.

Answer: B.004 a.
Reference: REP-21

Question B.005 [1.0 point] {5.0}
During startup of the Primary coolant system, per procedure you start the pumps at 63 psig. After starting the second pump, the pumps cycle then on. Per procedure you should …

a. continue the system startup.

b. stop both pumps, and inform the Lead Senior Reactor Operator.

c. stop both pumps, wait for primary pressure to increase greater than 66 psig, then restart the pumps.

d. continue the system startup, after informing the Lead Senior Reactor Operator.

Answer: B.005 c.
Reference: OP-RO-410, Primary Coolant System.

Question B.006 [1.0 point] {6.0}
If the reactor is not critical when the upper ECP limit is reached, you must:

a. stop and recalculate the ECP prior to further rod withdrawal.

b. shut down the reactor.

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

d. check the control rod position transmitters.

Answer: B.006 ~~b.~~ a.
Reference: ~~SOP I.4.3.G.5 p. SOP/I-7~~
OP-OR-210, Rev 6, “Reactor Startup – Normal,” step 5.2.7

Question B.007 [1.0 point, ¼ each] {7.0}
Match each of the radioisotopes associated with operating the reactor in column A with its PRIMARY source (irradiation of AIR or WATER, or FISSION product).

a. $_{1}H^{3}$

b. $_{18}Ar^{41}$

c. $_{7}N^{16}$

d. $_{54}Xe^{135}$

Answer: B.007 a, = water; b, = air; c, = water; d, = fission
Reference: Standard NRC Question. Also chart of the Nuclides.

Question B.008 [1.0 point] {8.0}
Per the definition in the Emergency Plan, Protective Action Guide(s) is (are) …

a. The person or persons appointed by the Emergency Coordinator to ensure that all personnel have evacuated the facility or a specific part of the facility.

b. a condition or conditions which call(s) for immediate action, beyond the scope of normal operating procedures, to avoid an accident or to mitigate the consequences of one.

c. Projected radiological dose or dose commitment values to individuals that warrant protective action following a release of radioactive material.

d. Specific instrument readings, or observations; radiological dose or dose rates; or specific contamination levels of airborne, waterborne, or surface- deposited radioactive materials that may be used as thresholds for establishing emergency classes and initiating appropriate emergency measures.

Answer: B.008 c.
Reference: Emergency Plan, § 9.0 Definitions.

Question B.009 [1.0 point] {9.0}
The Emergency Planning Zone (EPZ) …

a. is the geographical area that is beyond the site boundary.

b. specifies contamination levels of airborne, radiological dose or dose rates that may be used as thresholds for establishing emergency classes.

c. is the geographical area that is beyond the site boundary where the Reactor Director has direct authority over all activities.

d. lies within the site boundary and is bounded by a 150 meter radius from the MURR exhaust stack.

Answer: B.009 d.
Reference: E-Plan Definitions 9.8

Question B.010 [1.0 point] {10.0}
The SHUTDOWN MARGIN of the MURR shall be at least:

a. 2% delta k/k.

b. 0.02% delta k/k.

c. 0.02% delta k/k with any one shim blade fully withdrawn.

d. 2% delta k/k with any one shim blade fully withdrawn.

Answer: B.010 d.
Reference: MURR Technical Specifications, Section 3.1.e.

Question B.011 [1.0 point] {11.0}
“All control blades, including the regulating blade, shall be operable during reactor operations.” This is an example of a:

a. safety limit.

b. limiting safety system setting.

c. limiting condition for operation.

d. surveillance requirement.

Answer: B.011 c.
Reference: MURR Technical Specifications, Section 3.2.a.

Question B.012 [1.0 point] {12.0}
While working in an area marked "Caution, Radiation Area," you discover your dosimeter is off scale and leave the area. Assuming you had been working in the area for 45 minutes, what is the maximum dose you would have received?

a. 3.8 mr

b. 35.6 mr

c. 75 mr

d. 100 mr

Answer: B.012 c.
Reference: 10 CFR 20.1003 Maximum dose in a rad area is 100 mr/hr.
100 mr/hr × 0.75 hr = 75 mr.

Question B.013 [1.0 point] {13.0}
Which ONE of the following is the MINIMUM reactor period to satisfy the interlock for placing the regulating blade in automatic mode? (wording clarified per facility comment)

a. 30 seconds

b. 35 seconds

c. 50 seconds

d. 100 seconds

Answer: B.013 b.
Reference: SOPII § II.1.3.

Question B.014 [1.0 point] {14.0}
Which ONE of the following conditions would NOT preclude sending a volunteer into a high radiation area in order to save a life?

a. The radiation levels in the area are unknown.

b. All volunteers are women of child bearing age.

c. All volunteers are men under the age of 45.

d. The only volunteer is a new hire, not trained in the consequences of receiving an emergency dose.

Answer: B.014 c.
Reference: SEP 11 Monitoring Planned Exposures in excess of Limits in 10 CFR 20. SEP Worksheet D.

Question B.015 [1.0 point] {15.0}
Which one of the following actions should be taken by the reactor operator if an experimenter informs him that the irradiation container has become lodged somewhere in the pneumatic tube?

a. Immediately scram the reactor and notify the Lead Senior Reactor Operator
b. Reduce power by rod run-in to less than 50% power
c. Notify the Reactor Manager
d. Notify the Lead Senior Reactor Operator or Manager of Health Physics

Answer: B.015 d.
Reference: MURR Hazards Summary 8-25

Question B.016 [1.0 point] {16.0}
Two inches of shielding reduce the gamma exposure in a beam of radiation from 400 mR/hr to 200 mR/hr. If you add an additional four inches of shielding what will be the new radiation level? (Assume all reading are the same distance from the source.)

a. 25 mR/hr
b. 50 mR/hr
c. 75 mR/hr
d. 100 mR/hr

Answer: B.016 b.
Reference: 2 inches equal a half-thickness. Adding 4 inches results in a total of three half-thicknesses for $(400) \times (½)^3 = 400/8 = 50$ mR/hr

Question B.017 [1.0 point] {17.0}
According to Technical Specification 3.1 “Each movable experiments or the movable parts of any individual experiment shall not exceed ____ Δk/k.”

a. 0.001
b. 0.0025
c. 0.006
d. 0.00738

Answer: B.017 a.
Reference: Technical Specification 3.1(I)

Question B.018 [1.0 point] {18.0}
Per the Emergency plan, "The Emergency Director may authorize personnel voluntary whole body exposures up to ____ rem dose equivalent per individual for lifesaving actions."

a. 25

b. 50

c. 75

d. 100

Answer: B.018 c.
Reference: Emergency Plan § 5.01, 4th ¶, pg. 12.

Question B.019 [1.0 point] {19.0}
You receive 100 mRem of beta (β), 25 mRem of (γ) and 5 mRem of neutron radiation dose. What is your total dose?

a. 130 mRem

b. 150 mRem

c. 175 mRem

d. 205 mRem

Answer: B.018 a.
Reference: 10 CFR 20 (A rem is a rem is a rem)

Question B.020 [1.0 point] {20.0}
Normally refueling will be performed using the _____ tool with pool level _____.

a. air operated; normal

b. manually operated; normal

c. air operated; lowered

d. manually operated; lowered

Answer: B.020 a.
Reference: SOP II, § 2.1.J.

Question C.001 [1.0 point] (1.0)
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.001 b.
Reference: Reactor Operator Training Manual § II.

Question C.002 [1.0 point] (2.0)
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.002 a.
Reference: RO Training Manual § II.

Question C.003 [2.0 points, 0.4 each] (4.0)
Indicate whether each of the following reactivity coefficients is POSitive or NEGative 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.003 a. = POS; b. = NEG; c. = NEG; d. = POS; e. = POS
Reference: MURR Hazards Summary Report, p. 4-14.,SOP/VIII-7 Critical Parameters List

Question C.004 [1.0 point] (5.0)
Which one of the following design features minimizes the effects of $H^3$ (Tritium)?

a. Vents at the top of the pool

b. Hold up tanks in the primary coolant system

c. Primary demineralizer system

d. Controlled release of the gases held in the beam ports

Answer: C.004 a.
Reference:

Question C.005 [1.0 point] (6.0)
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.005 d.
Reference: HSR § 7.1.4 pp 7-4

Question C.006 [1.0 point] (7.0)
The purification system contains a fission product monitor. This monitor detects radiation from fission products collected in …

a. the filter

b. the holdup tank

c. the cation column

d. the anion column

Answer: C.006 d.
Reference: Plant and Radiation monitoring Systems, #28.

Question C.007 [2.0 points, 0.5 each] (9.0)
For the actions in Column A select the appropriate pressurizer system pressure listed in Column B. Pressures in Column B may be used once, more than once or not at all. Only one answer may occupy each space in column A.

| COLUMN A<br>ACTIONS | COLUMN B<br>SETPOINTS (psig) |
|---|---|
| a. High pressurizer Pressure scram | 1. 112.5 ± 2.5 |
| b. Low pressurizer pressure alarm | 2. 78.0 |
| c. Low pressurizer pressure scram | 3. 65.0 |
| d. Nitrogen System Low Pressure Alarm | 4. 63.0 |

Answer: C.007 a. = 2; b. = 3; c. = 4; d. = 1
Reference: AP-RO-110, Table 10.2

Question to be deleted from future use, the condition described would require an extended set of circumstances per facility comment.

~~Question C.008 [1.0 point] (10.0)~~
~~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.008 a.~~
~~Reference: HSR Chapter 9.0 Instrumentation and Control, § 9.5 Startup Interlocks~~

Question C.009 [1.0 point] (11.0)
Which one of the following describes the operation of the containment building ventilation exhaust valves on a loss of electrical power?

a. Air is applied to the close side of the east valve (16A) causing the valve to close

b. Air is applied to the close side of the west valve (16B) causing the valve to close

c. Air is vented from the open side of the west valve (16B allowing spring pressure to close the valve

d. Air is vented from the open side of the east valve (16A) allowing air pressure on the close side to close the valve

Answer: C.009 b.
Reference: MURR Training Manual for Reactor Operators Section I.11 pp I

Question C.010 [1.0 point] (12.0)
The corrosion inhibitors require a pH range between 7 and 8 to work correctly. Which ONE of the following is added to the secondary to maintain the pH?

a. Carbonic Acid
b. Sulfuric Acid
c. Sodium Hydroxide
d. Potassium-Tetraborate-Tetrahydrate.

Answer: C.010 b.
Reference: HSR § 5.4.6, pg. 5-26.

Question C.011 [1.0 point] (13.0)
In order to reduce $N^{16}$ radiation when taking a sample from the primary, the water is first sent through a

a. 100 gallon holdup tank upstream of the primary pumps
b. 100 gallon holdup tank upstream of the  demineralizer pump
c. 6000 gallon holdup tank upstream of the primary pumps
d. 6000 gallon holdup tank upstream of the  demineralizer pump

Answer: C.011 b.
Reference: Hazards Summary Report Figure A.2,

Question C.012 [1.0 point, ⅓ each] (14.0)
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

Question C.013 [1.0 point] (15.0)
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 [2.0 points, ¼ each] (16.0)
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.014 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] (17.0)
You are operating the reactor at 10 megawatts with the regulating rod in automatic at 50% withdrawn. You notice an anomaly and scram the reactor. Which ONE of the following is true. (Assume no operator action beyond scram insertion.)

a. All control elements (shim blades and regulating blade) are de-energized and at the bottom of their travel.

b. All shim blades are de-energized and at the bottom of their travel, the regulating blade is in automatic mode at 50% withdrawn.

c. All shim blades are de-energized and at the bottom of their travel, the regulating blade is in manual mode at 50% withdrawn.

d. All shim blades are de-energized and at the bottom of their travel , the regulating blade is in automatic mode and is being driven in to its bottom of travel.

Answer: C.015 c.
Reference: HSR § 9.6.2, p. 9-15. C.12

Question C.016 [1.0 point] (18.0)
Which ONE of the following is the design feature which prevents an OVERPRESSURE condition from damaging the reactor containment? The containment …

a. contains a "seal trench" with a minimum of 4.6 feet of water which will blow out onto the floor of the laboratory basement relieving the overpressure condition.

b. contains a plug designed to blow out at a preset limit.

c. contains an air relief valve which starts opening at a preset limit.

d. exhaust damper is designed to open when air pressure exceeds a preset limit.

Answer: C.016 a.
Reference: Draft SAR § 6.2.3.1

Question C.017 [1.0 point] (19.0)
Which ONE of the following conditions will NOT cause a rod run-in?

a. High Power

b. Low Pressurizer Pressure

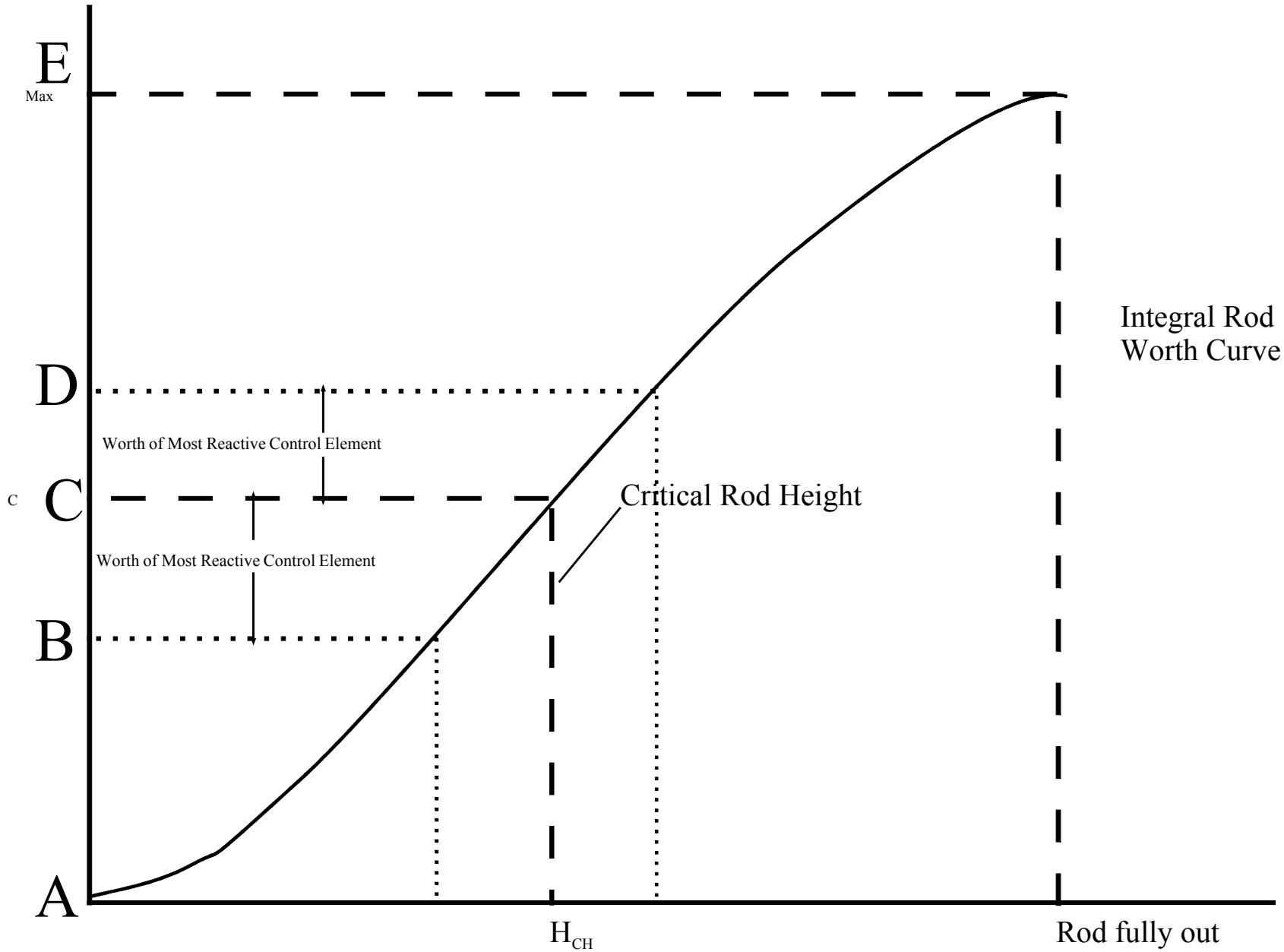
c. Rod Not in Contact with Magnet

d. Vent Tank Low Level

Answer: C.017 b.
Reference: MURR SOP/I-15–I-18.

Question deleted per Facility comment NO CORRECT ANSWER. Answers a. and b. both partially correct.

~~Question C.018 [1.0 point] (20.0)~~
~~The reactor reflector is made of …~~
~~a. graphite~~
~~b. beryllium~~
~~c. $D_2O$~~
~~d. $H_2O$ (the pool).~~
~~Answer: C.018 b.~~
~~Reference: SOP II~~


E
Max
D
C
C
B
A
Worth of Most Reactive Control Element
Worth of Most Reactive Control Element
Critical Rod Height
Integral Rod
Worth Curve
$H_{CH}$
Rod fully out