June 17, 2008

Mr. Ralph A. Butler, Chief Operating Officer
Research Reactor Facility
1513 Research Park
University of Missouri
Columbia, MO 65211

SUBJECT: INITIAL EXAMINATION REPORT NO. 50-186/OL-08-02, UNIVERSITY OF MISSOURI – COLUMBIA

Dear Mr. Butler:

During the week of May 19, 2008, the NRC administered an operator licensing examination at your Missouri University Research Reactor. The examination was 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 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. Initial Examination Report No. 50-186/OL-08-02
2. Facility Comments
3. Written examination with facility comments incorporated

cc without enclosures:
Please see next page

June 17, 2008

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SUBJECT: INITIAL EXAMINATION REPORT NO. 50-186/OL-08-02, UNIVERSITY OF MISSOURI – COLUMBIA

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**ADAMS ACCESSION #: ML081510579** **TEMPLATE #:NRR-074**

| OFFICE | PRTB:CE | | IOLB:LA | E | PRTB:SC | |
|---|---|---|---|---|---|---|
| NAME | PYoung pty | | CHart cah | | JEads jhe | |
| DATE | 6/17/08 | | 6/17/08 | | 6/17/08 | |

**OFFICIAL RECORD COPY**

cc:

University of Missouri
Associate Director
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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-08-02,

FACILITY DOCKET NO.: 50-186

FACILITY LICENSE NO.: R-103

FACILITY: UNIVERSITY OF MISSOURI – COLUMBIA

EXAMINATION DATES: May 19 – 20, 2008

SUBMITTED BY: **/RA/** 5/23/08
Phillip T. Young, Chief Examiner Date

SUMMARY:

During the week of May 19, 2008, the NRC administered operator licensing examinations to two Reactor Operator candidates and two Senior Operator Upgrade candidates. All four candidates passed all portions of their respective 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 | 2/0 | 4/0 |
| Overall | 2/0 | 2/0 | 4/0 |

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

The examiner thanked the facility for their cooperation during the exam and reminded them that they have five working days to submit comments on the written examination. There were no generic issues.

ENCLOSURE 1

**Robert A. Hudson**
Training Coordinator – Reactor Operations
University of Missouri Research Reactor
Columbia, Mo 65211

**MURR OPERATIONS**

Mr. Young,

We have reviewed the written portion of the licensing examination administered at MURR on 5/20/08; and submit the following comments for your consideration:

**Question B.016** Which ONE of the following is the 10CFR20 definition for "Annual Limit on Intake (ALI)"?
Comment: The answer key indicates item 'B' to be the correct answer. Our review of 10CFR20 indicates the correct answer should be 'D'.
Reference: 10CFR20 Section 1003 - Definitions

**Question C.002** Which ONE of the following is NOT a feature of the pneumatic tube system designed to limit the radiation hazard?
Comment: The answer key indicates item 'D' to be the correct answer. Our review indicates the correct answer should be 'A'.
Reference: Hazard Summary Report, Section 8.5 - Pneumatic Tubes
SAR, Chapter 10.3.4 - Pneumatic Tube System

**Question C.004** The three-way solenoid valves in the Valve Operating System can be arranged to operate and fail in different configurations. Match the valves listed as A through D with the three-way valve de-energized configuration shown as 1 through 3.
Comments: The answer key indicates 'a = 3, b = 2, c = 1', to be the correct answer. Our review indicates no correct answer was available.
The question states solenoid valves in the Valve Operating System fail in different configurations. This is not true, solenoid valves in the system are arranged differently for 'normal' operation, yet all the solenoid valves fail in the same configuration [the supply header closes, while the vent and operator ports open].

ENCLOSURE 2

The configurations shown on the exam illustrate 'normal' operating conditions for solenoids in the MURR Valve Operating System Lesson. All configurations shown in the references are with the solenoid valves in their "normal" operating condition NOT in the de-energized condition.
No D distracter listed.

Suggested changes to the question:
The three-way solenoid valves in the Valve Operating System can be arranged to operate ~~and fail~~ in different configurations. Match the valves listed as A through C with the three-way valve de-energized configuration shown as 1 through 3

Reference: MURR Valve Operating System Lesson
MURR Print # 2324 - Valve Operation & Air System

**Question C.005** Which ONE of the following DOES NOT describe a function of the Uninterruptible Power Supply?

Comment: The answer key indicates item 'C' to be the correct answer. Our review of references indicates the correct answer should be 'A'.

Reference: MURR Print # 522 Electrical Distribution
SAR Chapter 8.0 – Electrical Power Systems – 8.1.2 Description of System

In addition, the following questions are correct but we would offer a few suggestions.

**Question A.004** A reactor is critical at 18.1 inches on a controlling rod. The controlling rod is withdrawn to 18.4 inches. The reactivity inserted is 0.001 □k/k. What is the differential rod worth?

Comment: Distracters A and B are identical.

**Question B.003** The on-duty shift consists of you (Licensed Reactor Operator) the Lead Senior Reactor Operator (LSRO) and a Reactor Operator Trainee (Knowledgeable Person). You receive a message concerning an emergency in your family. What actions should you take before you leave?

Comment: Distracter C and answer D refer to Shift Supervisors; current terminology is Lead Senior Reactor Operator (LSRO).

Please contact me if you would like additional information have any questions,

Thank You Again
Rob Hudson

# University of Missouri – Columbia

# US NRC Operator License Examination

# Written Exam with Answer Key

# May 19, 2008

ENCLOSURE 3

**Question**: A.001 [1.0 point] {1.0}
One minute following a scram from full power, the indications on the nuclear channels are primarily due to:

a. Prompt neutrons
b. Delayed and photo-neutrons
c. Prompt and delayed neutrons
d. Prompt, delayed and photo-neutrons

Answer: A.001 b.
Reference: Burn, R., *Introduction to Nuclear Reactor Operations,* © 1988, § 6.2.1, & 6.2.2 p. 6-2.

**Question**: A.002 [1.0 point] {2.0}
Shortly after shutting down the reactor you note that reactor period is a stable negative value. You note reactor power. Three minutes later the reactor is has the same stable negative value and reactor power has decreased by a factor of …

a. 2
b. 2.718 (e)
c. 5
d. 10

Answer: A.002 d.
Reference: DOE Fundamentals Handbook, Nuclear Physics and Reactor Theory, Volume 2, Module 4, *Reactor Theory (Reactor Operations),* Enabling Objective 2.6 $P = P_0 e^{t/\beta}$, where t = 180 seconds and β = -80 seconds, $P/P_0 = e^{-180/80} = 0.1054$

**Question**: A.003 [2.0 points, 0.4 each] {4.0}
Indicate whether each of the following reactivity coefficients are **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**: A.004 [1.0 point] {5.0}
A reactor is critical at 18.1 inches on a controlling rod. The controlling rod is withdrawn to 18.4 inches. The reactivity inserted is 0.001 ΔK/K. What is the differential rod worth

a. 0.001 ΔK/K/inch at 18.25 inches
b. 0.001 ΔK/K/inch at 18.4~~25~~ inches {typographical error corrected, facility comment}
c. 0.003 ΔK/K/inch at 18.4 inches
d. 0.003 ΔK/K/inch at 18.25 inches

Answer: A.004 d.
Reference: DOE Fundamentals Handbook, Nuclear Physics and Reactor Theory

**Question**: A.005 [1.0 point] {6.0}
Which one of the following is the correct reason that delayed neutrons allow human control of the reactor?

a. Delayed neutrons increase the mean neutron lifetime.
b. More delayed neutrons are produced than prompt neutrons.
c. Delayed neutrons take longer to thermalize than prompt neutrons.
d. Delayed neutrons are born at higher energies than prompt neutrons.

Answer: A.005 a.
Reference: DOE Fundamentals Handbook, Nuclear Physics and Reactor Theory

**Question**: A.006 [1.0 point] {7.0}
Moderating efficiency takes into account how well an isotope will slow down a neutron, combined with its absorption cross-section. We know that $_1H^1$ is best suited for slowing down a neutron. Which ONE of the listed isotopes will have the best overall moderating efficiency?

a. $_1H^2$
b. $_1H^3$
c. $_6H^{12}$
d. $_{92}H^{238}$

Answer: A.006 a.
Reference: DOE Fundamentals Handbook, Volume 1, Module 2, p. 27.

**Question**: A.007 [1.0 point] {8.0}
Several processes occur that may increase or decrease the available number of neutrons. SELECT from the following the six-factor formula term that describes an INCREASE in the number of neutrons during the cycle.

a. Resonance escape probability (p).
b. Fast non-leakage probability ($\square_f$).
c. Thermal utilization factor (f).
d. Fast Fission factor (ε).

Answer: A.007 d.
Reference: DOE Fundamentals Handbook, Volume 2, Module 3, pp. 3-8

**Question**: A.008 [1.0 point] {9.0}
Which ONE of the following reactions correctly describes Beta$^-$ ($\beta^-$) decay?

a. $_{35}Br^{87} \square\ _{33}As^{83}$
b. $_{35}Br^{87} \square\ _{35}Br^{86}$
c. $_{35}Br^{87} \square\ _{34}Se^{86}$
d. $_{35}Br^{87} \square\ _{36}Kr^{87}$

Answer: A.008 d.
Reference: DOE Fundamentals Handbook, Volume 1, Module 1, pp 24 - 25.

**Question**: A.009 [1.0 point] {10.0}
A reactor is subcritical by 5% delta k/k with a count rate of 100 cps on the startup channel. Rods are withdrawn until the count rate is 1000 cps. Which ONE of the following is the condition of the reactor following the rod withdrawal?

a. Critical with $k_{eff}$ = 1.000.
b. Subcritical with $k_{eff}$ = 0.995.
c. Subcritical with $k_{eff}$ = 0.950.
d. Supercritical with $k_{eff}$ = 1.005.

Answer: A.009 b.
Reference: DOE Fundamentals Handbook, Module 4, Subcritical Multiplication, page 6. $CR_1 (1-K_1) = CR_2 (1-K_2)$;
$\rho = (K -1)/K$; $-0.05 = (K - 1)/K$; $K = 0.952$.
$100(1 - 0.952) = 1000(1 - K_2)$; $K_2 = 0.995$.

**Question**: A.010 [1.0 point] {11.0}
Which ONE of the following conditions will INCREASE the shutdown margin of a reactor.

a. Lowering moderator temperature (Assume negative temperature coefficient).
b. Insertion of a positive reactivity worth experiment.
c. Burnout of a burnable poison.
d. Fuel depletion.

Answer: A.010 d.
Reference: DOE Fundamentals Handbook, Volume 2, Module 4, Reactor Theory (Reactor Operations), Enabling Objective 3.6

**Question**: A.011 [1.0 point] {12.0}
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 after pulling the rods in gang to 10 inches, to speak on the phone for 10 minutes. Which ONE of the following best describes the rod height and power at criticality for the second startup relative to the first 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 higher.
d. Rod height will be the same, Power will be the same.

Answer: A.011 c.
Reference: DOE Fundamentals Handbook, Volume 2, Module 4, Reactor Theory (Reactor Operations), Enabling Objective 1.1.

**Question**: A.012 [1.0 point] {13.0}
The reactor had been running for 36 hours straight at 10 megawatts when it was shutdown for maintenance. The maintenance took six hours, and you have just restarted the reactor and raised power to 10 megawatts and placed the reactor in auto control. Which ONE of the following is the expected response of the regulating rod for the next half hour? (Assume no fuel replacement during shutdown.)

a. Drive in
b. Drive out
c. Not move
d. Drive out then back in

Answer: A.012 a.
Reference: DOE Fundamentals Handbook, Volume 2, Module 3, Reactor Theory (Nuclear Parameters), Enabling Objective 4.5.

**Question:** A.013 [1.0 point] {14.0}
"CORE EXCESS" is …

a. extra reactivity into the core due to the presence of the source neutrons.
b. a measure of the resultant reactivity if all of the control rods and other poisons were removed.
c. the combined reactivity worth of control rods and chemical poison needed to keep the reactor shutdown.
d. the maximum reactivity insertion with the reactor shutdown with control rods fully inserted under peak Xenon conditions.

Answer: A.013 b.
Reference: DOE Fundamentals Handbook

**Question**: A.014 [1.0 point] {15.0}
Which ONE of the following statements concerning reactor poisons is NOT true?

a. During reactor operation, Xenon concentration is dependent on reactor power level.
b. Following shutdown, Samarium concentration will increase to some value then stabilize.
c. During reactor operation, Samarium concentration is independent of reactor power level.
d. Following shutdown, Xenon concentration will initially increase to some value then decrease exponentially.

Answer: A.014 c.
Reference: DOE Fundamentals Handbook

**Question**: A.015 [1.0 point] {16.0}
You are the reactor operator controlling the reactor in manual. An experimenter is preparing to inject an experiment worth - 1%ΔK/K into the reactor. What type of reactor period do you expect to see?

($\ell^* = 1 \times 10^{-4}$; $\lambda_{eff} = 0.1$; $\beta_{eff} = 0.00738$ ΔK/K)

a. ≈ 2 sec.

b. ≈ 10 sec.

c. ≈ 20 sec

d. ≈ 40 sec

Answer: A.015 c.
Reference: DOE Fundamentals Handbook,

**Question**: A.016 [1.0 point] {17.0}
The reactor is critical at a watt with the regulating blade at position X. You withdraw the reg rod to increase power to 500 watts. To stabilize power at this level you must insert the reg rod to …

a. a position lower than X.

b. position X.

c. a position slightly higher than X.

d. all the way into the core.

Answer: A.016 b.
Reference: DOE Fundamentals Handbook

**Question**: A.017 [1.0 point] {18.0}
An Integral Rod Worth (IRW) curve is _____, while a Differential Rod Worth (DRW) curve is _____.

a. the total reactivity worth added by the rod at any point of withdrawal; the reactivity change per unit movement of the rod at the point of withdrawal.

b. at its maximum value when the rod is approximately half-way out of the core; at its maximum value when the rod is fully withdrawn from the core.

c. the slope of the DRW curve at any point of withdrawal; the area under the IRW curve at any point of withdrawal.

d. the reactivity change per unit movement of the rod at any point of withdrawal; the total reactivity worth of the rod at any point of withdrawal.

Answer: A.017 a.
Reference: DOE Fundamentals Handbook, Module 3, Control Rods, page 51.

**Question**: A.018 [1.0 point] {19.0}
During a reactor startup, the count rate is increasing linearly on a logarithmic scale, with no rod motion. This means that:

a. the reactor is subcritical and the count rate increase is due to the buildup of delayed neutron precursors.

b. the reactor is subcritical and the count rate increase is due to source neutrons.

c. the reactor is critical and the count rate increase is due to source neutrons.

d. the reactor is supercritical.

Answer: A.018 d.
Reference: DOE Fundamentals Handbook, Module 4, Reactor Kinetics, page 14.

**Question**: A.019 [1.0 point] {20.0}
Regulating rod worth for a reactor is 0.001 ΔK/K/inch. Moderator temperature **INCREASES** by 9°F, and the regulating rod moves 4½ inches inward to compensate. The moderator temperature coefficient $\alpha_{Tmod}$ is …

a. $+5 \times 10^{-4}$ ΔK/K/°F

b. $-5 \times 10^{-4}$ ΔK/K/°F

c. $+2 \times 10^{-5}$ ΔK/K/°F

d. $-2 \times 10^{-5}$ ΔK/K/°F

Answer: A.019 a.
Reference: DOE Fundamentals Handbook, Nuclear Physics and Reactor Theory.
0.001 ΔK/K/~~inch~~ × 4.5 ~~inch~~ ÷ 9°F = 0.001 ÷ 2 = 0.0005 = $5 \times 10^{-4}$ ΔK/K/°F

**Question**: B.001 [1.0 point, 0.25 each] {1.0}
Match the type of radiation in column A with its associated Quality Factor (10CFR20) from column B.

| Column A | Column B |
|---|---|
| a. alpha | 1 |
| b. beta | 2 |
| c. gamma | 5 |
| d. neutron (unknown energy) | 10 |
| | 20 |

Answer: B.001 a. = 20; b. = 1; c. = 1; d. = 10
Reference: NRC Generic Section B Bank {10CFR20.100x}

**Question**: B.002 [2.0 points, ⅓ point each] {3.0}
Match each of the Technical Specification Limits in column A with its corresponding value in column B. (Each limit has only one answer, values in Column B may be used more once, more than once or not at all.)

| Column A | Column B |
|---|---|
| a. Minimum Shutdown Margin | 1. 0.0980 ΔK |
| b. Each secured Removable Experiment | 2. 0.0200 ΔK |
| c. Core Excess Reactivity | 3. 0.0060 ΔK |
| d. Absolute Value of all experiments in Center test hole | 4. 0.0025 ΔK |
| e. Movable parts of any individual experiments | 5. 0.0010 ΔK |
| f. Each Unsecured Experiment | |

Answer: B.002 a. = 2; b. = 3; c. = 1; d. = 3; e. = 5; f. = 4
Reference: Technical Specifications § 3.1 Reactivity Specifications e, f, g, h, i, and j.

**Question**: B.003 [1.0 point] {4.0}
The on-duty shift consists of you (Licensed Reactor Operator) the Lead Senior Reactor Operator (LSRO) and a Reactor Operator Trainee (Knowledgeable Person). You receive a message concerning an emergency in your family. What actions should you take before you leave?

a. Shutdown the reactor in accordance with _____.

b. Wait for another Reactor Operator to arrive before you leave.

c. Turn over the watch to the trainee, who may operate the reactor under the direction of the LSRO ~~Shift Supervisor~~. {question updated per facility comment}

d. Turn over the watch to the LSRO ~~Shift Supervisor~~ who may operate the reactor with the trainee present in the control room. {question updated per facility comment}

Answer: B.003 d.
Reference: AP-RO-110, Conduct of Operations § 6.5,3,d, p. 10.

**Question**: B.004 [1.0 point] {5.0}
The reflector high and low differential pressure scram:

a. provides a backup to the pool coolant low flow scram.

b. provides a backup to the primary low pressure scram.

c. provides a backup to the primary coolant low flow scram.

d. assures adequate cooling of the fuel and flux trap region.

Answer: B.004 a.
Reference: MURR Technical Specifications, Section 3.3.a bases.

**Question**: B.005 [1.0 point] {6.0}
According to the Technical Specifications, which ONE of the following conditions is NOT permissible when the reactor is operating?

a. Above 100 kW, the maximum distance between the highest and lowest shim blade = 1 inch.

b. Emergency generator is out of service for one hour for maintenance.

c. A fueled experiment containing 300 millicuries of $I^{135}$.

d. Core excess reactivity = 0.006 $\Delta$ k/k.

Answer: B.005 b.
Reference: MURR Technical Specifications, Section 3.10.a.

**Question**: B.006 [1.0 point] {7.0}
Which ONE of the following operations requires the direct supervision (i.e., presence) of a Senior Reactor Operator?

a. Start up pool coolant system.
b. Stack monitor operational test.
c. Start up primary coolant system.
d. Adjustment of nuclear instrumentation.

Answer: B.006 d.
Reference: OP-RO-340

**Question**: B.007 [1.0 point] {8.0}
Which ONE of the following is **NOT** a requirement of OP-RO-531 Primary and Pool Sample Station?

a. The primary must be sampled daily for $H^3$.
b. Do not operate if $I^{131}$ concentration exceeds $5 \times 10^{-3}$ µCi/ml
c. HP coverage is required if abnormal fission product activity is present.
d. If the primary system fuel failure detector is out of service the primary must be sampled every 4 hours.

Answer: B.007 a.
Reference: OP-RO-531, Primary and Pool Sample Station

**Question**: B.008 [1.0 point] {9.0}
10CFR50.54(x) states: “A licensee may take reasonable action that departs from a license condition or a technical specification (contained in a license issued under this part) in an emergency when this action is immediately needed to protect the public health and safety and no action consistent with license conditions and technical specifications that can provide adequate or equivalent protection is immediately apparent." 10CFR50.54(y) states that the minimum level of staff which may authorize this action is …

a. NRC Manager.
b. any Reactor Operator licensed at facility.
c. any Senior Reactor Operator licensed at facility.
d. Facility Manager (or equivalent name at facility).

Answer: B.008 c.
Reference: NRC Generic Section B Bank {10CFR50.54(y)}

**Question**: B.009 [1.0 point] {10.0}
An experimenter wishes to irradiate three specimens with reactivity worths of 0.0005 Δk/k, 0.0013 Δk/k and 0.0027 Δk/k. Can these specimens be placed in the reactor as UNSECURED experiments and why (why not).

a. Yes, each specimen is less than 0.006 Δk/k.
b. No, one of the specimens is greater than 0.0025 Δk/k.
c. Yes, the sum of the three specimens is less than 0.025 Δk/k.
d. No, the sum of the three specimens is greater than 0.01 Δk/k.

Answer: B.009 b.
Reference: Technical Specifications, §§ 3.1(g)–(k).

**Question**: B.010 [1.0 point] {11.0}
When pumping the Liquid Waste tanks to the sanitary sewer, the maximum accumulated activity for nuclides other than $H^3$ is 2 millicuries for the Lead Senior Reactor Operator to authorize the procedure. The maximum accumulated activity for $H^3$ is …

a. 1 millicuries
b. 5 millicuries
c. 10 millicuries
d. 20 millicuries

Answer: B.010 c.
Reference: OP-RO-741, Waste Tank System Operation

**Question**: B.011 [1.0 point] {12.0}
A survey instrument with a window probe was used to measure an irradiated experiment. The results were 100 millirem/hr window open and 60 millirem/hr window closed. What was the gamma dose?

a. 40 millirem/hr
b. 60 millirem/hr
c. 100 millirem/hr
d. 160 millirem/hr

Answer: B.011 b.
Reference: NRC Generic Section B Bank {Instrument reads only gamma with window closed therefore reading with window closed is gamma dose.}

**Question**: B.012 [1.0 point] {13.0}
When placing the Rod Control Mode in "Auto", why should the Wide Range Monitor Level indication be greater than 2% above the "Power level Set"? Ensure that the…

a. Period is longer than 35 seconds.
b. Reactor Power Calculator is operating and indicating properly.
c. Area Radiation Monitor reads will not exceed acceptable levels.
d. First automatic movement of the Regulating Blade is in the inward direction.

Answer: B.012 d.
Reference: OP-RO-210

**Question**: B.013 [1.0 point] {14.0}
Unless extended in writing, a Radiation Work Permits expire in:

a. 8 hours
b. 24 hours
c. 48 hours
d. one week

Answer: B.013 b.
Reference: AP-HP-105

**Question**: B.014 [2.0 points, ½ each] {16.0}
Identify each of the following reactor plant limitations as a Safety Limit (**SL**), Limiting Safety System Setting (**LS**SS) or a Limiting Condition for Operation (**LC**O). (Choices may be used more than once or not at all.)

a. Primary Coolant Pressure (minimum) 75 psia
b. 1" (maximum) distance between highest and lowest shim arms above 100 Kilowatts
c. 1625 gpm (minimum) either loop.
d. A minimum of one decade of overlap shall exist between adjacent ranges of nuclear instrument channels.

Answer: B.014 a. = LS; b. = LC; c. = LS; d. = LC
Reference: Technical Specifications

**Question**: B.015 [1.0 point] {17.0}
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. Concerning the two measurements, which ONE of the following statements is true?

a. The measured dose rate from Source B is four times that of Source A.
b. The measured dose rate from Source B is twice that of Source A.
c. The measured dose rate from Source B. is half that of Source A.
d. Both measurements are the same.

Answer: B.015 d.
Reference: NRC Generic Section B Bank {GM tubes cannot distinguish between energies.}

**Question**: B.016 [1.0 point] {18.0}
Which ONE of the following is the 10CFR20 definitions for "Annual Limit on Intake (ALI)"?

a. Projected dose commitment values to individuals, that warrant protective action following a release of radioactive material.
b. The concentration of a radionuclide in air which, if inhaled by an adult worker for a year, would result in a total effective dose equivalent of 100 millirem.
c. The effluent concentration of a radionuclide in air which, if inhaled continuously over a year, would result in a total effective dose equivalent of 50 millirem for noble gases.
d. 10CFR20 derived limit, based on a Committed Effective Dose Equivalent of 5 Rems whole body or 50 Rems to any individual organ, for the amount of radioactive material inhaled or ingested in a year by an adult worker.

Answer: B.016 d. ~~b.~~ {typographical error correct, facility comment}
Reference: NRC Generic Section B Bank {10CFR20.1003 Definitions}

**Question**: B.017 [1.0 point] {19.0}
When placing Fire Protection Systems in online, failure to wait for air systems to reach normal operating pressure before proceeding could result in..

a. Sprinklers may activate
b. Sprinkler head damage
c. Inoperability of detection capability
d. Hydrant or Post Indicator Valve (PIV) damage

Answer: B.017 a.
Reference: OP-OR-555

**Question**: B.018 [1.0 point] {20.0}
An experiment is removed from the reactor and is determined to have a radiation level of 10 Rem/hr at 15 feet from the experiment. Forty Five (45) minutes later the radiation level is 7.2 Rem/hr at 15 feet. Which one of the following is the length of time the experiment must decay before the radiation level at one (1) foot is less than 100 mrem/hr?

a. 3 hours

b. 5.26 hours

c. 18.6 hours

d. 40.6 hours

Answer: B.018 d.
Reference: NRC Generic Section B Bank

**Question**: C.001 [1.0 point] {1.0}
Which Area Radiation Monitors below can cause a Reactor Isolation?

a. Bridge, Bridge ALARA, Air Plenum 1, Air Plenum 2.
b. Bridge, Bridge ALARA, Fission Product Monitor, Air Plenum 1.
c. Fission Product Monitor, Air Plenum 1, Air Plenum 2, Bridge ALARA.
d. Beamport Floor North Wall, Beamport Floor West Wall, Beamport Floor South Wall, Bridge.

Answer: C.001 a.
Reference: MURR Area Radiation Monitor System Lesson

**Question**: C.002 [1.0 point] {2.0}
Which ONE of the following is NOT a feature of the pneumatic tube system designed to limit the radiation hazard?

a. Double encapsulation of samples.
b. Speed at which the sample container is transported through the system.
c. Facility exhaust fans operation prevent stagnant air in the vicinity of the rabbit system.
d. A time delay starts the east p-tube blower approximately 15 seconds after the west p-tube blower.

Answer: C.002 a. ~~d.~~ {typographical error correct, facility comment}
Reference: SAR, Chapter 10 - Experimental Facilities and Utilization – 10.3.4 Pneumatic Tube System

**Question**: C.003 [1.0 point] {3.0}
Containment building isolation is accomplished by closing two butterfly valves, 16A and 16B, in the main exhaust line. Which ONE of the following describes the operation of these valves?

| | Valve 16A | Valve 16B |
|---|---|---|
| a. | air open, air close | air open, spring close. |
| b. | air open, spring close | air open, air close. |
| c. | motor-operated (open and close) | air open, air close. |
| d. | air open, spring close | motor-operated (open and close) |

Answer: C.03 b.
Reference: SAR Chapter 6 - Engineered Safety Features - 6.2.3.8 Hot Exhaust Line

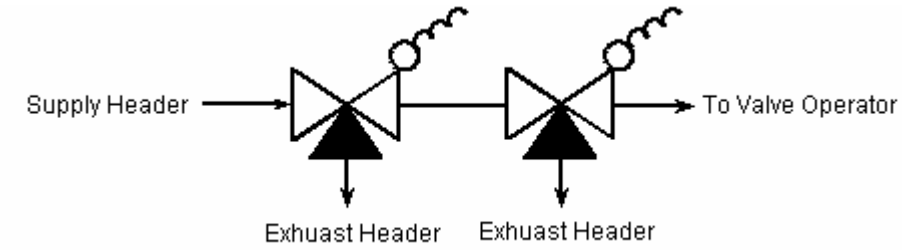
Question C.004 deleted from this examination and corrected per facility comment for use on future examinations.

**Question**: C.004 [1.0 points, ⅓ each] {4.0}

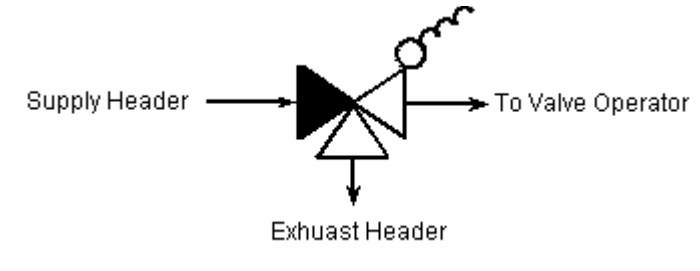
The three-way solenoid valves in the Valve Operating System can be arranged to operate ~~and fail~~ in different configurations. Match the valves listed as A through C ~~D~~ with the three-way valve de-energized configuration shown as 1 through 3.

a. Pressurizer Isolation - 527C
b. Primary Demineralizer Inlet - 527E and Outlet - 527F
c. Anti-Siphon Isolations - 543A & B

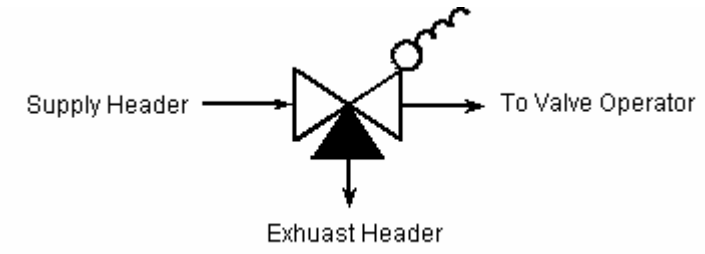
1.




2.




3.




Answer: C.004 a. = 3; b. = 2; c. = 1
Reference: MURR Valve Operating System Lesson

**Question**: C.005 [1.0 point] {5.0}
Which ONE of the following **DOES NOT** describe a function of the Uninterruptible Power Supply?

a. supply power to the Emergency Distribution Center (CTR-1).

b. supply power to the Area Radiation Monitoring System (ARMS) to ensure radiation levels are known.

c. reduce spurious (false) reactor scrams caused by voltage fluctuations or a momentary interruption in electrical power.

d. ensures that the reactor control console and instrument panel indications are maintained during the transition period from the time of a loss of normal electrical power to the time the diesel generator supplies the load.

Answer: C.005 a. ~~c.~~ {typographical error corrected, facility comment}
Reference: SAR Chapter 8.0 - Electrical Power Systems - 8.1.2 Description of System

**Question**: C.006 [1.0 point] {6.0)
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.006 a.
Reference: SAR, Chapter 10 - Experimental Facilities and Utilization – 10.3.4 Pneumatic Tube System

**Question**: C.007 [1.0 point] {7.0}
A Facility Evacuation can be manually initiated from the control console and:

a. the reactor bridge.

b. equipment room 278.

c. the front lobby.

d. equipment room 114.

Answer: C.007 c.
Reference: CP-6 Building Evacuation/Isolation Scram

**Question**: C.008 [1.0 point] {8.0}
Which ONE of the following is the reason for the 100 gallon holdup tank in the purification system? This tank

a. is part of the regeneration system.
b. allows $N^{16}$ gamma activity to decay off.
c. contains spent resin from the demineralizer units.
d. provides water hammer protection for the purification system.

Answer: C.008 b.
Reference: SAR, Chapter 5 Reactor Coolant Systems - 5.7.2 Primary Coolant Demineralizer Loop Hold-Up Tank

**Question**: C.009 [1.0 point] {9.0}
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

**Question**: C.010 [1.5 points, 0.25 each] {10.5}
Match each of the beamports in column A with the correct characteristics in Column B

| | Column A<br>Beamport | Column B<br>Characteristic |
|---|---|---|
| a. | A | 1. 6" radial (6R) |
| b. | B | 2. 6" radial - tangential (6RT) |
| c. | C | 3. 4" radial (4R) |
| d. | D | 4. 4" radial - tangential (4RT) |
| e. | E | |
| f. | F | |

Answer: C.010 a. = 3; b. = 1; c. = 2; d. = 4; e. = 1; f. = 3
Reference: SAR, Chapter 10 - Experimental Facilities and Utilization – Table 10-1

**Question**: C.011 [1.0 point] {11.5}
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.011 a.
Reference: SAR, Chapter 7 -Instrumentation and Control Systems; 7.5.3.1 Rod Withdrawal Prohibit

**Question**: C.012 [1.5 points, 0.1875 each] {13.0}
Match the channel in column A with the correct detector in column B.

| Column A | Column B |
|---|---|
| a. Fission Product Monitor | 1. Geiger Müeller |
| b. Secondary Coolant Monitor | 2. Scintillation Detector |
| c. Stack Gas Monitor | 3. GeLi Detector |
| d. Stack Particulate Monitor | 4. $BF_3$ Ion Chamber Detector |
| e. Stack Iodine Monitor | |
| f. Bridge ARMS | |
| g. Exhaust Plenum 1 | |
| h. Room 114 ARMS | |

Answer: C.012 a. = 2; b. = 2; c. = 2; d. = 2;
e. = 2; f. = 1; g. = 1; h. = 4
Reference: SAR, Chapter 7 -Instrumentation and Control Systems; Figure 7.11 Area Radiation Monitoring System pages 7-63/64

**Question**: C.013 [1.0 point] {14.0}
Just prior to withdrawing control rods with all process control systems on line, the Master Control Switch (1S1) is taken from the ON position to the OFF position. Which ONE of the following conditions will result?

a. All systems will shut down.

b. All systems will remain running, but without automatic operation.

c. All systems will remain running with all automatic functions operable.

d. The system is mechanically interlocked and you cannot move 1S1 to the off position with all systems running.

Answer: C.013 c.
Reference: SAR, Chapter 7 -Instrumentation and Control Systems; 7.5.3 Manual Control.

**Question**: C.014 [1.0 point] {15.0}
The purpose of the thermal column is to …

a. enhance natural convection flow.

b. provide thermal neutron flux for experiments.

c. enhance heat transfer characteristics of the core.

d. provide a thermal temperature rise for experiments.

Answer: C.014 b.
Reference: SAR, Chapter 10 - EXPERIMENTAL FACILITIES AND UTILIZATION

**Question**: C.015 [1.0 point] {16.0}
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.015 d.
Reference: OP-RO-465, § 6.1

**Question**: C.016 [1.0 point] {17.0}
The reactor is in the automatic mode of operation. Which ONE of the following conditions will **NOT** cause control to shift back to manual?

a. Regulating rod control switch (1S5) actuated.
b. Regulating rod inserted to the 10% withdrawn position.
c. Regulating blade position is greater than 60% withdrawn.
d. Wide Range Monitor selector switch is in the 5 kW black scale position.

Answer: C.016 c.
Reference: SAR, Chapter 7 -Instrumentation and Control Systems; 7.5.4 Automatic Control

**Question**: C.017 [2.0 points, ½ point each] {19.0}
For each of the Rod Run-In Functions listed below, fill in the minimum number of instrument channels required by Technical Specifications for Reactor Operation in Mode 1.

| Column A Rod Run-In | Minimum Number of Channels |
|---|---|
| a. High Reactor Power | 1 |
| b. Reactor Period | 2 |
| c. Rod not in contact with magnet | 3 |
| d. Vent Tank Low Level | 4 |

Answer: C.017 a. = 3; b. = 2; c. = 4; d. = 1
Reference: Technical Specification 3.4. Reactor Instrumentation

**Question**: C.018 [1.0 point, ⅓ each] {20.0}
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.018 a. = 1; b. = 4; c. = 3
Reference: SAR, Chapter 7 -Instrumentation and Control Systems - 7.3.1 Annunciator