February 7, 2007

Mr. William E. Bonzer, Interim Reactor Director
University of Missouri–Rolla
Nuclear Reactor Facility
1870 Miner Circle
Rolla, MO 65409-0630

SUBJECT: INITIAL EXAMINATION REPORT NO. 50-123/OL-07-01, UNIVERSITY OF MISSOURI–ROLLA

Dear Mr. Bonzer:

During the week of January 8, 2007, the NRC administered an operator licensing examination at your University of Missouri–Rolla Reactor. The examination was conducted according to NUREG-1478, "Non-Power Reactor Operator Licensing Examiner Standards," Revision 1. 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. 50-123

Enclosures:
1. Initial Examination Report No. 50-123/OL-07-01
2. Facility comments with NRC resolution
3. Examination and modified answer key

cc w/enclosures
Please see next page

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Please see next page

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DATE	2/05/2007	2/05/2007	2/07/2007

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cc:

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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.: 50-123/OL-07-01

FACILITY DOCKET NO.: 50-123

FACILITY LICENSE NO.: R-79

FACILITY: University of Missouri–Rolla

EXAMINATION DATES: January 9 - 11, 2007

SUBMITTED BY *_/RA/ by Patrick Isaac for_* _1/26/2007_
Phillip T. Young, Chief Examiner Date

SUMMARY:

During the week of January 8, 2007, the NRC administered operator licensing examinations to four Reactor Operator license candidates and two Senior Reactor Operator (Upgrade) license candidate. One Reactor Operator license candidate failed section A and B of the written examination. All other license candidates passed all applicable portions of their examinations.

REPORT DETAILS

1. Examiners:
   Phillip T. Young, Chief Examiner

2. Results:

	RO PASS/FAIL	SRO PASS/FAIL	TOTAL PASS/FAIL
Written	3/1	2/0	3/1
Operating Tests	4/0	2/0	6/0
Overall	3/1	2/0	5/1

3. Exit Meeting:
   Phillip T. Young, NRC, Chief Examiner
   William E. Bonzer, Interim Reactor Director, University of Missouri-Rolla
   Daniel N. Estel, Training Coordinator, University of Missouri-Rolla

   The examiner discussed weaknesses identified during the facility operating tests, and thanked the facility for their support of the examinations. The facility staff told the examiner they would have their comments on the written examination soon. Those comments were e-mailed to the examiner and are included as enclosure 2 to this document.

FACILITY COMMENTS ON NRC WRITTEN EXAMINATION WITH
NRC RESOLUTIONS ADDED.

Email From: "Estel, Daniel Nelson" <destel@umr.edu>
To: <pty@nrc.gov>
Subject: NRC Exam at UMRR/Facility Docket 50-123/License No. R-79

Mr. P.T. Young:

We are presenting our review of the written operator licensing examination given at the University of Missouri-Rolla Nuclear Reactor Facility on the morning of January 9, 2007. We have reviewed the test and received comments from the trainees that we wish to respond to.

The following question has answers we would like you to address. Question B.010 lists d as the correct answer. We believe that answers a, c, and d are all correct answers. In the Technical Specification (TS) 6.1.3 page 39, at the bottom are two statements concerning training staffing requirements.

Answer b falls outside of the listed excess reactivity limits. The TS say students and trainees may operate the reactor under the direct supervision of a licensed operator if excess reactivity is less than 0.7%. Answer b says less than 1.2%. This situation does not meet the conditions imposed by the TS.

Answers a, c, and d meet the conditions imposed by the TS.

Answer a lists trainees under direct supervision of an SRO with excess reactivity equal to or greater than 0.7% and less than 1.2%. This fall within the TS limits of greater than 0.7% and less than 1.5%.

Answer c lists trainees under the direct supervision of an SRO and excess reactivity equal to or greater than 0.4% and less than 1.2%. This falls within the same limits as answer a.

Answer d lists both students and trainees under the direct supervision of licensed operator with excess reactivity less than 0.4%. Again, this falls within the limits imposed by the TS that students and trainees may operate the reactor under the direct supervision of a licensed operator provided the excess reactivity is less than 0.7%.

Therefore, we think that answers a, c, or d could be a correct answer.

Thank you again for your visit to our facility and for considering our request concerning the answer to B.010.

Sincerely,

Daniel N. Estel, Training Coordinator
William Bonzer, UMRR Interim Director

NRC Resolution: Agree with comment. This question is eliminated.

ENCLOSURE 2

OPERATOR LICENSING EXAMINATION
With Answer Key

UNITED STATES NUCLEAR REGULATORY COMMISSION

UNIVERSITY OF MISSOURI–ROLLA
Week of January 8, 2007

Enclosure 3

Question A.001 [1.0 point] (1.0)
Given the following: ρ_{excess} – 0.50% delta k/k, control rod 1 – 0.25% delta k/k
control rod 2 – 0.45% delta k/k control rod 3 – 0.55% delta k/k

Calculate the ***TECHNICAL SPECIFICATION LIMIT*** for Shut Down Margin for this core.

a. 0.20% delta k/k

b. 0.75% delta k/k

c. 1.25% delta k/k

d. 1.75% delta k/k

A.001 a.
REF: Burn, R., *Introduction to Nuclear Reactor Operations,* © 1988, §

Question A.002 [1.0 point] (2.0)
The reactor supervisor tells you the K_{eff} for the reactor is 0.98. After placing an experiment worth into the core, count rate increases from 50 cpm to 55 cpm. What is the worth of the experiment?

a. +0.085% delta k/k

b. +0.189% delta k/k

c. -0.085% delta k/k

d. -0.189% delta k/k

A.002 b.
REF: Burn, R., *Introduction to Nuclear Reactor Operations,* © 1988, §
$CR_1/CR_2 = (1-k_{eff2})/(1 - k_{eff1}) = (1 - keff_2) = (1 - 0.98) \times 50/55 = 0.02 \times 50/55 = -0.018182$ or $k_{eff} = 0.98182$
$\Delta\rho = (k_{eff2} - k_{eff1})/(k_{eff2}\ k_{eff1}) = (098182 - 0.98000)/(098182 \times 0.98000) = 1.890 \times 10^{-3} = 0.189\%$ delta k/k

Question A.003 [1.0 point] (3.0)
During a reactor startup, criticality occurred at a lower rod height than the last startup. Which ONE of the following reasons could be the cause?

a. Adding an experiment with positive reactivity.

b. Xe^{135} peaked.

c. Moderator temperature increased.

d. Power defect (Reactor power increasing).

A.003 a.
REF: Burn, R., *Introduction to Nuclear Reactor Operations,* © 1988, §

Question A.004 [1.0 point] (4.0)
Which ONE of the following is the correct definition of $\beta_{effective}$? The relative amount of delayed neutrons …

a. per generation.

b. per generation corrected for leakage.

c. per generation corrected for time after the fission event.

d. per generation corrected for both leakage and time after the fission event.

A.004 b
REF: Burn, R., *Introduction to Nuclear Reactor Operations,* © 1988, §

Question A.005 [1.0 point] (5.0)
You're increasing reactor power on a steady + 26 second period. How long will it take to increase power by a factor of 1000?

a. 60 seconds (1 minute)

b. 180 seconds (3 minutes)

c. 300 seconds (5 minutes)

d. 480 seconds (8 minutes)

A.005 b
REF: Burn, R., *Introduction to Nuclear Reactor Operations,* © 1988, §
$\ln(P/P_0) \times \text{period} = \text{time}$, $\ln(1000) \times 26 = 6.908 \times 26 = 179.6 \approx 180$ seconds

Question A.006 [1.0 point] (6.0)
With the reactor on a constant period which transient will take the **LONGEST** time to complete? A reactor power change of …

a. 5% of rated power, going from 1% to 6% of rated power.

b. 10% of rated power, going from 10% to 20% of rated power.

c. 15% of rated power, going from 20% to 35% of rated power.

d. 20% of rated power, going from 40% to 60% of rated power.

A.006 a.
REF: Burn, R., *Introduction to Nuclear Reactor Operations,* © 1988, §

Question A.007 [1.0 point] (7.0)
Regulating rod worth for a reactor is 0.001 ΔK/K/inch. Moderator temperature **<u>INCREASES</u>** by 9°F, and the regulating rod moves 4½ inches inward to compensate. The moderator temperature coefficient α_{Tmod} is …

a. $+5 \times 10^{-4}$ ΔK/K/°F

b. -5×10^{-4} ΔK/K/°F

c. $+2 \times 10^{-5}$ ΔK/K/°F

d. -2×10^{-5} ΔK/K/°F

A.007 a.
REF: Burn, R., *Introduction of Nuclear Reactor Operations*, © 1988, §
0.001 ΔK/K/~~inch~~ × 4.5 ~~inch~~ ÷ 9°F = 0.001 ÷ 2 = 0.0005 = 5×10^{-4} ΔK/K/°F

Question A.008 [1.0 point] (8.0)
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

A.008 c.
REF: Burn, R., *Introduction of Nuclear Reactor Operations*, © 1988, §
$P = P_0 e^{t/\tau}$ 1st find τ. τ = time/(ln(2)) = 42/0.693 = 60.6 sec. Time = τ × ln(10) = 60.6 × 139.5 sec

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

a. the shutdown margin

b. the K_{excess} margin

c. the β_{eff} value

d. 1.0 %ΔK/K.

A.009 c.
REF: Burn, R., *Introduction of Nuclear Reactor Operations*, © 1988, §

Question A.010 [1.0 point] (10.0)
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. Thermal utilization factor.

b. Resonance escape probability.

c. Thermal non-leakage probability.

d. Reproduction factor.

A.010 d.
REF: Burn, R., *Introduction of Nuclear Reactor Operations*, © 1988, §

Question A.011 [1.0 point] (11.0)
K_{eff} for the reactor is 0.85. If you place an experiment worth +17.6% into the core, what will the new K_{eff} be?

a. 0.995

b. 0.9995

c. 1.005

d. 1.05

A.011 b.
REF: Burn, R., *Introduction of Nuclear Reactor Operations*, © 1988, §

Question A.012 [1.0 point] (12.0)
Which ONE of the following is the reason for the -80 second period following a reactor scram?

a. The ability of U^{235} to fission source neutrons.

b. The half-life to the longest-lived group of delayed neutron precursors is 55 seconds.

c. The amount of negative reactivity added on a scram is greater than the shutdown margin.

d. The Doppler effect, which adds positive reactivity due to the temperature decrease following a scram.

A. 12 b.
REF: Burn, R., *Introduction of Nuclear Reactor Operations*, © 1988, §

Question A.013 [1.0 point] (13.0)
Which ONE of the following is an example of neutron decay?

a. ${}_{35}Br^{87}$ ➜ 33As^{83}

b. ${}_{35}Br^{87}$ ➜ ${}_{35}Br^{86}$

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

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

A.013 b.
REF: Burn, R., *Introduction of Nuclear Reactor Operations*, © 1988, §

Question A.014 [1.0 point] (14.0)
Which ONE of the following describes the **MAJOR** contributor to the production and depletion of Xenon respectively in a **STEADY-STATE OPERATING** reactor?

	Production	Depletion
a.	Radioactive decay of Iodine	Radioactive Decay
b.	Radioactive decay of Iodine	Neutron Absorption
c.	Directly from fission	Radioactive Decay
d.	Directly from fission	Neutron Absorption

A.014 b.
REF: Burn, R., *Introduction of Nuclear Reactor Operations*, © 1988, §

Question A.015 [1.0 point] (15.0)
You enter the control room and note that all nuclear instrumentation show a steady neutron level, and no rods are in motion. Which ONE of the following conditions CANNOT be true?

a. The reactor is critical.

b. The reactor is subcritical.

c. The reactor is supercritical.

d. The neutron source has been removed from the core.

A.015 c.
REF: Burn, R., *Introduction of Nuclear Reactor Operations*, © 1988, §

Question A.016 [1.0 point] (16.0)
Core excess reactivity changes with …

a. fuel element burnup

b. control rod height

c. neutron energy level

d. reactor power level

A.016 a.
REF: Burn, R., *Introduction of Nuclear Reactor Operations*, © 1988, §

Question: A.017 [1.00]
Which ONE of the following conditions will DECREASE shutdown margin?

a. Adding an experiment which inserts negative reactivity.

b. Addition of uranium fuel.

c. Depletion of uranium fuel.

d. Increasing pool water temperature, if temperature coefficient is negative.

A.017 b.
Ref: Anything which adds positive reactivity will decrease the shutdown margin.

Question: A.018 [1.00] (18.0)
Which factor in the six-factor formula is described by the ratio:

number of fast neutrons produced by thermal fission
number of thermal neutrons absorbed in the fuel

a. fast fission factor.

b. resonance escape probability.

c. reproduction factor.

d. thermal utilization factor.

A.018 c.
Ref: Burn, Introduction to Nuclear Reactor Operations, Page 3-16

Question: A.019 [1.00] (19.0)
A critical reactor is operating at a steady-state power level of 1.000 kW. Reactor power is increased to a new steady-state power level of 1.004 kW. Neglecting any temperature effects, what reactivity insertion is required to accomplish this?

a. 0.004 delta k/k.

b. 0.4% delta k/k.

c. 1.004% delta k/k.

d. Indeterminant, since any amount of positive reactivity could have been used.

A.019 d.
Ref: The amount of positive reactivity only affects the rate at which the transient occurs. Since no time is specified for the change, any amount will do.

Question: A.020 [1.00] (20.0)
The effective neutron multiplication factor, Keff is defined as:

a. absorption/(production + leakage)

b. (production + leakage)/absorption

c. (absorption + leakage)/production

d. production/(absorption + leakage)

A.020 d.
Ref: Burn, Introduction to Nuclear Reactor Operations, Page 3-16.

Question B.001 [1.0 point] (1.0)
TS 6.3 lists items which utilize written procedures at UMRR to ensure safe operation of the reactor. Who normally approves written procedures for reactor operations? If these procedures require substantial changes having safety significance, who then must approve the procedures?

a. Reactor Director; Radiation Safety Committee

b. Reactor Manager; Reactor Director

c. Radiation Safety Officer; Reactor Director

d. Reactor Director; Radiation Safety Officer

B.1 a
REF: Technical Specifications § 6.3

Question B.002 [1.0 point] (2.0)
A sample was removed from the reactor with an initial dose rate of 1 R/hr. If the half life of the sample is 10 minutes, what would the on contact dose rate reading be on a radiation survey instrument taken at the top of the pool an hour later?

a. 150 mR/hr

b. 15 mR/hr

c. 1.5 mR/hr

d. 1.5 R/hr

B.2 b
REF: Standard NRC question; Knoll, Glenn; “Radiation Detection and Measurement,” John Wiley and Sons Inc., January 2000

Question B.003 [1.0 point] (3.0)
Where are the “Controlled Copies” of the Standard Operating Procedures located?

a. Basement of the Physics Building and the Control Room

b. Office Reception Area and Beam Room Area

c. Beam Room Area and Basement of the Physics Building

d. Control Room and Office Reception Area

B.3 d
REF: SOP 100 § B.2

Question B.004 [1.0 point] (4.0)
The reactor will be shutdown and the SRO on Duty notified if ***"TURNAROUND"*** is not observed on the Safety Channels and the Power Range of the Log and Linear Channel by the time the reactor reaches …

a. 1 Kilowatt

b. 5 Kilowatts

c. 10 Kilowatts

d. 20 Kilowatts

B.4 c
REF: SOP 104, § B.2.

Question B.005 [1.0 point] (5.0)
Technical Specification 5.4.1 requires "the fuel storage pit, which is located below the floor of the reactor pool and at the end opposite the core, will be capable of storing the complete fuel inventory of ___. The neutron multiplication factor of the fully loaded storage pit shall not exceed ____ under any conditions.

a. HEU and LEU, 0.9

b. HEU or LEU, 0.9

c. HEU or LEU but not both, 0.9

d. only LEU fuel, 0.8

B.5 c
REF: Technical Specification 5.4.1

Question B.006 [1.0 point, ½ point each] (7.0)
Identify each of the following as either a Safety Limit (SL), Limiting Safety System Setting (LSSS), or a limiting Condition for Operation (LCO).

a. The temperature of the fuel element cladding shall be less than 580°C (1076°F).

b. The resistivity of the pool water shall be greater than 0.2 megohm-cm as long as there are fuel elements in the pool.

c. The reactor thermal power shall be no greater than 300kWt, or 150% of full power.

d. The free-drop time for each of the three shim/safety rods must be less than 600 msec.

B.6 a. = SL; b. = LCO; c. = LSSS; d. = LCO
REF: T.S. §§ a, 2.1; b, 3.3(2); c, 2.2; d, 3.2.3

Question B.007 [1.0 point] (8.0)
A Reactor Operator has not been actively performing functions and duties for over 6 months. To resume functions authorized by the license, issued under part 50.51, what is the minimum hours required to perform shift functions under the direction of an operator or senior operator as appropriate and in the position to which the individual will be assigned?

a. 12 hours

b. 4 hours

c. 8 hours

d. 6 hours

B.7 d
REF: 10 CFR 55.53(f)(2)

Question B.008 [1.0 point] (9.0)
A power calibration has been done in accordance with SOP-816. It is found that the power indicated on the linear recorder is 10% higher than calculated power. As a result:

a. the recorder is adjusted so that it reads the calculated power.

b. the position of the detector is adjusted so that the recorder reads the calculated power.

c. the high voltage to the detector is adjusted so that the recorder reads the calculated power.

d. the compensating voltage on the detector is adjusted so that the recorder reads the calculated power.

B.08 b.
Reference: SOP 816, UMRR Power Calibration.

Question B.009 [1.0 point] (10.0)
Per the Emergency plan, who may officially authorize voluntary radiation exposure up to the emergency dose limit of 25 rem when immediate action is essential? Who is the official authorized in all other cases?

a. The Radiation Safety Officer, the official in charge of the Emergency Support Center

b. The official in charge of the Emergency Support Center, Radiation Safety Officer

c. The Radiation Safety Officer, an authorized official from the NRC

d. Senior Reactor Operator, Reactor Director

B.9 b
REF: Emergency Plan § 7.4.6

QUESTION B.010 DELETED PER FACILITY COMMENT

~~**Question** B.010 [1.0 point] (11.0)~~
~~According to TS 6.1.3, Staffing, which ONE of the following conditions must be met when the reactor is being used for training purposes.~~

~~a. Trainees may operate the reactor under the direct supervision of a senior reactor operator when the excess reactivity is equal to or greater than 0.7% delta k/k and less than 1.2% delta k/k.~~

~~b. Students and trainees may operate the reactor under the direct supervision of a licensed reactor operator provided the excess reactivity is less than 1.2% delta k/k.~~

~~c. Trainees may operate the reactor under the direct supervision of a senior reactor operator when the excess reactivity is equal to or greater than 0.4% delta k/k and less than 1.2% delta k/k.~~

~~d. Students and trainees may operate the reactor under the direct supervision of a licensed operator provided the excess reactivity is less than 0.4% delta k/k.~~

~~**B.10** d~~
~~REF: Technical Specification 6.1.3~~

Question B.011 [1.0 point] (12.0)
According to Technical Specification 3.7.1 "Experiments worth more than ______delta k/k shall be inserted or removed with the reactor shutdown.

a. 0.4%

b. 0.7%

c. 1.2%

d. 1.5%

B.11 a
REF: Technical Specification 3.7.1

Question B.012 [1.0 point] (13.0)
What buildings are used in case of an emergency as the **NORMAL** Emergency Support Center (evacuation not required) and **ALTERNATE** Emergency Support Center?

a. Fulton Hall; Nuclear Engineering Building Department Office

b. Physics Building; Nuclear Engineering Building Department Office

c. Nuclear Engineering Building Department Office; Physics Building

d. Fulton Hall; Physics Building

B.12 b
REF: Emergency Plan, § 8.1, *Emergency Support Center, p. 21.*

Question B.013 [1.0 point] (14.0)
You are handling a radioactive sample and the reading on the sample is 90 mR/hr at a foot. Do you need a Health Physicist (or designee) present to handle this sample? When do you need to have a health physicist (or designee) present to handle radioactive material samples?

a. Yes, a sample reading greater than 75 mR/hr at a foot.

b. No, a sample reading greater than 150 mR/hr at a foot.

c. No, a sample reading greater than 100 mR/hr at a foot.

d. Yes, a sample reading greater than 50 mR/he at a foot.

B.13 c
REF: SOP 601, “Handling Radioactive Samples” § C.2(a),(b), (c), and (d)

Question B.014 [1.0 point] (15.0)
A small radioactive source is to be stored in the reactor building. The source reads 1.1 Rem/hr at a foot. Assuming no shielding is to be used, a Radiation Area barrier would have to be erected at least what distance away from the source?

a. 10 feet

b. 15 feet

c. 25 feet

d. 35 feet

B.14 b
REF: Standard NRC question

QUESTION B.015 [1.0 point, ½ point each] (17.0)
Match the event in Column A to the emergency classification in Column B. An item in Column B may be used more than once.

Column A	Column B
a. fuel damage indicated by high coolant fission product activity	1. Unusual event
b. breach of security	2. Alert
c. fuel damage and imminent failure of other physical barriers containing fission products	3. Site Area Emergency
d. significant releases of radioactive materials as a result of experiment failures	

B.15 a. = 1; b. = 1; c. = 3; d. = 2
REF: Emergency Plan § 4.0 - 4.3

Question B.016 [1.0 point] (18.0)
Three visitors are to be allowed entry to the facility. In accordance with SOP 208:

a. three dosimeters may be placed in the bay area, and the maximum radiation value obtained will be credited to all visitors.

b. no dosimetry is required as long as the escort is wearing dosimetry.

c. each visitor is issued a dosimeter.

d. one visitor is issued a dosimeter, and the radiation value obtained will be credited to the other two visitors.

B.016 c.
Ref: SOP 208, Reactor Security.

Question B.017 [1.0 point] (19.0)
A Rundown Alarm signal has been received and control rods are inserting. The alarm condition clears and the operator stops the Rundown. In accordance with SOP-150, the reactor may be restarted (rods withdrawn):

a. after the operator has determined the cause of the rundown.
b. after the operator has taken corrective action.
c. after notifying the SRO on Duty.
d. only with the permission of the SRO on Duty.

B.017 d.
Ref: SOP 150, Response to Alarms.

Question B.018 [1.0 point] (20.0)
The reactor is operating when a rabbit is withdrawn from the core. The dose rate outside the glovebox is 100 mR/hour. In accordance with SOP-710, the reactor operator should:

a. shoot the rabbit back into the core and notify the SRO on duty.

b. shoot the rabbit back into the core, turn the rabbit system off, shut down the reactor and notify the SRO on duty.

c. manually scram the reactor, leave the rabbit in its present position and notify the SRO on duty.

d. manually scram the reactor, leave the rabbit in its present position and turn the rabbit system off.

B.018 b.
Ref: SOP 710, Insertion and Removal of Experiments.

Question: C. 001 [1.0 point] (1.0)
WHICH ONE of the following parameters can initiate a reactor scram, a rundown, and rod withdrawal prohibit?

a. Recorders not operating.

b. Radiation dose rate.

c. Reactor power.

d. Reactor period.

Answer: C.001 d.
Reference: University of Missouri-Rolla Technical Specifications, Tables 3.1, 3.2.

Question: C. 002 [1.0 point] (2.0)
In order to reduce the buildup of radioisotopes in the reactor bay, the facility has three fans in the ventilation system. These fans have the capability to replace the air in the reactor bay approximately:

a. every 1.4 minutes, or about forty changes per hour.

b. every 14 minutes, or about four changes per hour.

c. every 140 minutes, or about one-half change per hour.

d. every 1400 minutes, or about one change per day.

Answer: C.002 a.
Reference: University of Missouri-Rolla SAR, page 5-5.

Question: C. 003 [1.0 point] (3.0)
A minimum depth of water between the top of the core and the pool surface is maintained in order to provide:

a. the proper amount of cooling of the core.

b. shielding against radiation at the pool surface.

c. sufficient suction head for the purification pump.

d. sufficient cooling for the fuel element storage space.

Answer: C.003 b.
Reference: University of Missouri-Rolla SAR, page 3-45.

Question: C. 004 [1.0 point] (4.0)
Following a loss of building electrical power:

a. power to reactor instrumentation will not be lost due to a fast transfer (less than 50 msec) to the reserve supply.

b. power to reactor instrumentation will be restored following a 5 second time delay as transfer to the reserve supply occurs.

c. power will be lost to reactor instrumentation but will be automatically restored when building power returns.

d. power will be lost to reactor instrumentation and will not return until building power returns and the power supplies are manually reset.

Answer: C.004 d.
Reference: SOP-308

Question: C. 005 [1.0 point] (5.0)
The purpose of the two water retention tanks is to:

a. provide a sump from which water may be pumped directly into the sanitary sewer.

b. allow the activity of overflow water from the reactor pool to decay prior to pumping the water back into the pool.

c. provide a source of water for the HCl and NaOH tanks.

d. hold the liquids resulting from regeneration of the ion exchanger.

Answer: C.005 d.
Reference: University of Missouri-Rolla SAR, page 5-5.

Question: C. 006 [1.0 point] (6.0)
Which ONE of the following describes the operation of the building ventilation system exhaust duct and intake louvers?

a. The louvers automatically close when the ventilation fans are turned off.

b. The louvers automatically close when the building evacuation alarm sounds.

c. When the louvers reach their fully-closed position, the ventilation fans automatically turn off.

d. The louvers automatically close when any radiation area monitor alarms.

Answer: C.006 a.
Reference: University of Missouri-Rolla SAR, page 5-7.

Question: C. 007 [1.0 point] (7.0)
The equations which describe the operation of the neutron source are:

a. Pu-239 -> alpha + U-235 B-10 + alpha -> N-13 + neutron

b. Pu-239 -> beta + Am-239 B-10 + beta -> Be-9 + neutron

c. Pu-239 -> alpha + U-235 Be-9 + alpha -> C-12 + neutron

d. Pu-239 -> beta + Am-239 Be-9 + beta -> Li-8 + neutron

Answer: C.007 c.
Reference: SOP-653

Question: C. 008 [1.0 point] (8.0)
For a shim-safety rod, the "withdraw limit" light is ON, the "insert limit" light is OFF, and the "contact" light is OFF. This means that:

a. The rod and drive are not in contact, the rod is full out and the drive is full in.
b. The rod and drive are both full out.
c. The rod and drive are both full in.
d. The rod and drive are not in contact, the drive is full out and the rod is full in.

Answer: C.008 d.
Reference: University of Missouri-Rolla SAR, page 3-37.

Question: C. 009 [1.0 point] (9.0)
Two safety channels, a master and slave sensing circuit, are part of the reactor protection system which provides the mechanism for scramming the reactor. In order to have a reactor scram:

a. a scram signal must be present in each of the circuits.

b. a scram signal must be present in the master circuit; the slave circuit need not have a scram signal.

c. a scram signal must be present in the slave circuit; the master circuit need not have a scram signal.

d. a scram signal can be present in either circuit.

Answer: C.009 d.
Reference: University of Missouri-Rolla SAR, page 3-38.

Question: C. 010 [1.0 point] (10.0)
At a power level of 200 kW, the core average thermal neutron flux is approximately 1.5x1012 neutrons/cm2/sec. The average fast neutron flux is approximately:

a. 3 times greater.

b. 100 times greater.

c. 10 times smaller.

d. 3 times smaller.

Answer: C.010 a.
Reference: University of Missouri-Rolla SAR, page 3-3.

Question: C. 011 [1.0 point] (11.0)
Which part of the shim/safety rod assembly is responsible for ensuring that the rod receives more torque for inserting the rod than for withdrawing the rod?

a. Dashpot Assembly

b. Slip Clutch Assembly

c. Magnet Assembly

d. Linear Actuator

Answer: C.011 b
Reference: SAR § 3.2.3

Question: C. 012 [1.0 point] (12.0)
A significant amount of N^{16} is generated in the core. In order to minimize the dose at the top of the pool, the facility utilizes

a. a ventilation system at the side of the pool to whisk away N^{16} gases.

b. two "diffuser pumps" which pump the N^{16} laden water to the bottom of the tank.

c. two "diffuser pumps" which by forcing water downwards slow the rise of N^{16} thus maintaining a layer of water as a shield.

d. the purification system which removes the N^{16} via the ion bed.

Answer: C.012 c
Reference: SAR §

Question: C. 013 [1.0 point] (13.0)
Which ONE of the following is the actual design feature which prevents siphoning of pool water on a failure of the purification system?

a. A valve upstream of the primary pump will shut automatically.

b. A valve downstream of the primary pump will shut automatically.

c. “Vacuum breaks” are located in the system which prevent draining the pool below about 16 feet above the core.

d. The Emergency Fill system will automatically maintain pool level.

Answer: C.013 c.
Reference: SOP 309 *Response to a Coolant System Leak*

Question: C. 014 [1.0 point] (14.0)
Which ONE of the following has a battery backup so that even on a loss of power it will cause an alarm at the campus police station?

a. Pool Low Level

b. All three Radiation Area Monitors

c. Continuous Air Monitor

d. Fire Alarm System

Answer: C.014 d.
Reference: SAR § 5.5

Question: C. 015 [1.0 point] (15.0)
The ion exchanger resin has an upper limit for operation. This temperature is …

a. 46°C (115°F)

b. 57°C (135°F)

c. 78°C (172°F)

d. 90°C (194°F)

Answer: C.015 b.
Reference: SAR § 5.2, p. 5-3.

Question: C. 016 [1.0 point] (16.0)
A neutron flux will activate isotopes in Air. This is the reason that N_2 gas is used to drive the rabbit into and out of the core. The primary isotope we worry about in irradiating air is …

a. N^{16} (O^{16} (n,p) N^{16})

b. C^{14} (C^{13} (n, γ) C^{14})

c. Ar^{41} (Ar^{40} (n, γ) C^{41})

d. H^2 (H^1 (n, γ) H^2)

Answer: C.016 c
Reference: SAR § 4.3 3rd ¶

Question: C. 017 [1.0 point] (17.0)
The regulating rod is a(n) …

a. aluminum tube

b. boron carbide tube

c. boral (boron and aluminum alloy) tube

d. stainless-steel tube.

Answer: C.017 d.
Reference: SAR, § 3.2.3, 5th ¶

Question: C. 018 [1.0 point] (18.0)
Which ONE of the following is the **NORMAL** method for adding makeup water to the reactor?

a. Directly to the top of the pool using a hose.

b. At the inlet to the filter prior to the demineralizer

c. At the outlet to the filter prior to the demineralizer.

d. At the outlet of the demineralizer.

Answer: C.018 b.
Reference: SAR Figure 22, also SOP 301

Question: C. 019 [1.0 point] (19.0)
Which ONE of the following represents the normal flow rate for the purification system?

a. 10 gpm

b. 20 gpm

c. 30 gpm

d. 40 gpm

Answer: C.019 c.
Reference: SAR § 5.2, 3rd ¶

Question: C. 020 [1.0 point] (20.0)
Which ONE of the following is the method used to get rid of radioactive liquid waste? Radioactive liquid waste is…

a. held, for decay of short lived isotopes then sampled for 10CFR20 limits and if satisfactory, pumped to the sanitary sewer system.

b. put through evaporators, filters and ion exchangers, reducing the liquid waste to proper solid form.

c. diluted with deionized water to less than 10CFR20 limits, then pumped to the sanitary sewer system.

d. tested for 10CFR20 limits, then pumped to the sanitary sewer system.

Answer: C.020 a.
Reference: SAR § 5.3, 1st ¶

END OF Section C - Facility and Radiation Monitoring Systems
END OF EXAMINATION