July 19, 2004

Dr. Mariesa Crow, Dean
School of Mines and Metallurgy
University of Missouri - Rolla
305 McNutt Hall
Rolla, MO 65401

SUBJECT: INITIAL EXAMINATION REPORT NO. 50-123/OL-04-01, UNIVERSITY OF MISSOURI - ROLLA

Dear Dr. Crow:

During the week of May 3, 2004, the NRC administered initial examinations to employees of your facility who had applied for a license to operate your University of Missouri reactor. The examination was conducted in accordance with NUREG-1478, "Non-Power Reactor Operator Licensing Examiner Standards," Revision 1. At the conclusion of the examination, the examination questions and preliminary findings were discussed with those members of your staff identified in the enclosed report.

The NRC is concerned with the pass rate for these examinations. To summarize, only one of the twelve reactor operator candidates passed both the written examination and operating test. Two of the four senior reactor operator upgrade candidates passed the examination, and the senior reactor operator instant candidate failed the written examination. The final result is that only three of seventeen candidates passed. For the operator license examinations administered in March 2002, three of seven candidates passed. For the examinations administered in March 2003, six of twelve candidates passed. I am concerned about these low pass rates. In addition, I have noted that for the retake examination administered in September, 2003 all four applicants passed. However, the examination scores of the three individuals retaking all or part of the written examination did not exhibit a strong performance.

During the exit meeting on May 7, 2004, the NRC examiners stated that, based on the results of the operating tests only (the written examinations not yet having been graded), between one-third and one-half of the candidates would probably pass the examinations. When the NRC administers operator license examinations, it does so with the expectation that all of the candidates are fully prepared and expected to perform well. Facility management signatures on NRC Form 398 (the candidate's application) certify that the candidate has successfully completed the facility's requirements to be licensed as an operator and it is providing us your assurance that the candidate is fully prepared and has adequately demonstrated the knowledge, skills and ability to pass the examination. Candidates who are not adequately prepared should not be allowed to take the examinations. That determination must be made by you, the licensee, and should be based on challenging licensee-administered written and oral audit examinations throughout the training period. Based on the examiners' comments in each individual candidate's examination report, there are a number of generic deficiencies that could have been revealed by an independent audit process that appropriately evaluates the individuals' ability to successfully pass the NRC operator licensing examination and exhibit the knowledge and skills required to be a licensed reactor operator. We hope that you will find these comments helpful in modifying your training process so as to avoid a repetition of these results.

Finally, there were a substantial number of problems associated with the pre-examination requirements for applications. In many instances the applications did not contain the required signatures and had to be returned to the facility. Furthermore, required medical examination results for some candidates were not available prior to the examinations. This lack of attention to detail is of concern.

The examination report issued following the March 2003 examination specifically noted weaknesses with some parts of your training program. The results of this examination suggest declining trends in performance that warrant your attention. In order to give me the assurance I need, I would appreciate if you could provide me with a timely written response to the concerns we have related to your operator license training program and its performance. Specifically I would be very interested in knowing about the actions you intend to take to improve program performance and how they will result in improved the examination scores and pass rate.

In accordance with 10 CFR 2.390 of the Commission's regulations, a copy of this letter and the enclosures will available electronically for public inspection in the NRC Public Document Room or from the Publicly Available Records (PARS) component of NRC's document system (ADAMS). ADAMS is accessible from the NRC Web site at (the Public Electronic Reading Room) http://www.nrc.gov/NRC/ADAMS/index.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. Warren Eresian at 301-415-1833 or internet e-mail wje@nrc.gov.

Sincerely,

/RA/

Patrick M. Madden, Section Chief
Research and Test Reactors Section
New, Research and Test Reactors Program
Division of Regulatory Improvement Programs
Office of Nuclear Reactor Regulation

Docket No. 50-123

Enclosures: 1. Initial Examination Report No. 50-123/OL-04-01
2. Examination and answer key

cc w/encls:
Please see next page

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In accordance with 10 CFR 2.790 of the Commission's regulations, a copy of this letter and the enclosures will available electronically for public inspection in the NRC Public Document Room or from the Publicly Available Records (PARS) component of NRC's document system (ADAMS). ADAMS is accessible from the NRC Web site at (the Public Electronic Reading Room) http://www.nrc.gov/NRC/ADAMS/index.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. Warren Eresian at 301-415-1833 or internet e-mail wje@nrc.gov.

Sincerely,
/RA/
Patrick M. Madden, Section Chief
Research and Test Reactors Section
New, Research and Test Reactors Program
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Docket No. 50-123
Enclosures: 1. Initial Examination Report No. 50-123/OL-04-01
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cc w/encls:
Please see next page

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EXAMINATION PACKAGE ACCESSION NO.: ML041820281
EXAMINATION REPORT ACCESSION #: ML041560027 **TEMPLATE #: NRR-074**

OFFICE	RNRP:CE		RNRP:E		IROB:LA		RNRP:SC	
NAME	WEresian		PYoung		EBarnhill		PMadden	
DATE	06/ 14 /2004		06/ 29 /2004		07/ 9 /2004		07/ 14 /2004	

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U. S. NUCLEAR REGULATORY COMMISSION
OPERATOR LICENSING INITIAL EXAMINATION REPORT

REPORT NO.:	50-123/OL-04-01
FACILITY DOCKET NO.:	50-123
FACILITY LICENSE NO.:	R-79
FACILITY:	University of Missouri
EXAMINATION DATES:	May 3-7, 2004
EXAMINERS:	Warren Eresian, Chief Examiner Phillip Young

SUBMITTED BY: **/RA/** 06/ /2004
Warren Eresian, Chief Examiner Date

SUMMARY:

During the week of May 3, 2004, the NRC administered operator licensing examinations to twelve Reactor Operator candidates, four Senior Reactor (Upgrade) candidates and one Senior Reactor Operator (Instant) candidate. One Reactor Operator candidate and two Senior Reactor Operator (Upgrade) candidates passed the examinations.

ENCLOSURE 1

<u>REPORT DETAILS</u>

1. Examiners: Warren Eresian, Chief Examiner
   Phillip Young, Examiner

2. Results:

	RO PASS/FAIL	SRO PASS/FAIL	TOTAL PASS/FAIL
Written	**1/11**	**0/1**	**1/12**
Operating Tests	**6/6**	**3/2**	**9/8**
Overall	**1/11**	**2/3**	**3/14**

3. Exit Meeting:

Dr. Akira T. Tokuhiro, Reactor Director
Mr. Dan Estel, Training Coordinator
Mr. William Bonzer. Reactor Manager
Warren Eresian, NRC Chief Examiner
Phillip Young, NRC Examiner

The NRC thanked the facility staff for their cooperation during the examinations. The NRC examiners noted the large number of generic deficiencies and expressed their concern with regard to the performance of the candidates during the operating tests, noting that between one-third and one-half of the candidates would probably pass the operating tests. The Reactor Director stated that this was about the result that was expected. The NRC examiners expressed their dissatisfaction with this comment, stating that all candidates who take the examination should be expected to pass, and if a candidate is not adequately prepared then that candidate should not be allowed to take the examination.

The facility provided comments on the written examination, resulting in the deletion of one question and the acceptance of two correct answers for two other questions.

Section A R Theory, Thermo & Fac. Operating Characteristics

QUESTION A.001 [1.0 point]

Control Rod withdrawal predominantly changes K_{eff} by changing the …

a. fast fission factor (ε).

b. thermal utilization factor (f).

c. neutron reproduction factor (η).

d. resonance escape probability (p).

Answer A.001 b
Reference: Burn, R., *Introduction to Nuclear Reactor Operations,* © 1988, §

QUESTION A.002 [1.0 point]
Which ONE of the following is an example of alpha decay?

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

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

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

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

Answer: A.002 a
Reference: Burn, R., *Introduction to Nuclear Reactor Operations,* © 1988, §

QUESTION A.003 [1.0 point]

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.003 c
Reference: Burn, R., *Introduction to Nuclear Reactor Operations,* © 1988, §

ENCLOSURE 2

Section A R̷ Theory, Thermo & Fac. Operating Characteristics

QUESTION A.004 [1.0 point]

The reactor supervisor tells you the reactor is shutdown with a shutdown margin of 12%. An experimenter inserts an experiment in the core and nuclear instrumentation increases from 100 counts per minute to 200 counts per minute. What is the new K_{eff} of the reactor?

a. 0.920

b. 0.946

c. 0.973

d. 1.000

Answer: A.004 b
Reference: Standard NRC Question

$$K_{eff_1} = \frac{1}{1 + SDM} = \frac{1}{1 + 0.12} = 0.892857$$

$$CR_1(1 - K_{eff_1}) = CR_2(1 - K_{eff_2});$$

$$1 - K_{eff_2} = \frac{100}{200}(1 - 0.892857) = (0.0535715)$$

$$K_{eff_2} = 0.9464285$$

QUESTION A.005 [1.0 point]

INELASTIC SCATTERING is the process by which a neutron collides with a nucleus and …

a. is absorbed, with the nucleus emitting a gamma ray.

b. recoils with the same kinetic energy it had prior to the collision.

c. recoils with a lower 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.005 c
Reference: Burn, R., *Introduction to Nuclear Reactor Operations,* © 1988, §

Section A ℞ Theory, Thermo & Fac. Operating Characteristics

QUESTION A.006 [1.0 point]

Using the Integral Rod Worth Curve provided identify which ONE of the following represents ρ_{excess}

a. Area under curve “B”

b. ρ_C

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

d. Area under curve “A” and “B”

Answer: A.006 c
Reference: Burn, R., *Introduction to Nuclear Reactor Operations,* © 1988, §

QUESTION A.007 [1.0 point]

Which ONE of the following is the correct reason that delayed neutrons enhance control of the reactor?

a. There are more delayed neutrons than prompt neutrons.

b. Delayed neutrons take longer to reach thermal equilibrium.

c. Delayed neutrons increase the average neutron generation time.

d. Delayed neutrons are born at higher energies than prompt neutrons and therefore have a greater effect.

Answer: A.007 c
Reference: Burn, R., *Introduction to Nuclear Reactor Operations,* © 1988, §

QUESTION A.008 [1.0 point]

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 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.008 c
Reference: Burn, R., *Introduction to Nuclear Reactor Operations,* © 1988, §

QUESTION A.009 [1.0 point]

Which ONE of the following isotopes has the largest microscopic cross-section for absorption for thermal neutrons?

a. Sm^{149}

b. U^{235}

c. Xe^{135}

d. B^{10}

Answer: A.009 c
Reference: Burn, R., *Introduction to Nuclear Reactor Operations,* © 1988, §

QUESTION A.010 [1.0 point]

Which ONE of the following conditions describes a critical reactor?

a. $K_{eff} = 1$; $\Delta k/k$ (ρ) = 1

b. $K_{eff} = 1$; $\Delta k/k$ (ρ) = 0

c. $K_{eff} = 0$; $\Delta k/k$ (ρ) = 1

d. $K_{eff} = 0$; $\Delta k/k$ (ρ) = 0

Answer: A.010 b
Reference: Burn, R., *Introduction to Nuclear Reactor Operations,* © 1988, §

QUESTION A.011 [1.0 point]

A complete core load is in progress on a research reactor. The following data has been taken.

Number of Elements Installed	Detector A Counts (cpm)
0	11
2	13
4	17
6	22
8	34

Using the graph paper provided, determine which of the following is the approximate number of fuel elements that will be required to be loaded for a critical mass.

a. 8

b. 10

c. 12

d. 14

Answer: A.011 b or c
Reference: Burn, R., *Introduction to Nuclear Reactor Operations,* © 1988, §

QUESTION A.012 [1.0 point]

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

a. 0.91

b. 0.925

c. 0.95

d. 0.975

Answer: A.012 c
Reference: 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.013 [1.0 point]

After a week of full power operation, Xenon will reach its peak following a shutdown in approximately:

a. 6 hours

b. 12 hours

c. 24 hours

d. 48 hours

Answer: A.013 b
Reference: Burn, R., *Introduction to Nuclear Reactor Operations,* © 1988, §

QUESTION A.014 [1.0 point]

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 (f).

b. Resonance escape probability (p).

c. Fast non-leakage probability ($\mathcal{L}_f$).

d. Fast Fission factor (ε).

Answer: A.014 d
Reference: Burn, R., *Introduction to Nuclear Reactor Operations,* © 1988, §

QUESTION A.015 [1.0 point]

Two critical reactors at low power are identical except that Reactor 1 has a beta fraction of 0.0072 and Reactor 2 has a beta fraction of 0.0060. An equal amount of positive reactivity is inserted into both reactors. Which ONE of the following will be the response of Reactor 2 compared to Reactor 1?

a. The resulting power level will be lower.

b. The resulting power level will be higher.

c. The resulting period will be longer.

d. The resulting period will be shorter.

Answer: A.015 d
Reference: Equation Sheet. $\tau = (\ell^*/\rho) + [(\beta-\rho)/\lambda_{eff}\rho]$

QUESTION A.016 [1.0 point]

Most text books list β for a U^{235} fueled reactor as 0.65% delta k/k. However, your SAR lists β_{eff} as being 0.7% delta k/k. Why is β_{eff} larger than β?

a. Delayed neutrons are born at higher energies than prompt neutrons resulting in a greater worth for these neutrons.

b. Delayed neutrons are born at lower energies than prompt neutrons resulting in a less loss due to leakage for these neutrons.

c. the fuel includes U^{238} which has a relatively large β for fast fission.

d. some U^{238} in the core becomes Pu^{239} (by neutron absorption) which has a larger β for fission.

Answer: A.016 b
Reference: Burn, R., *Introduction to Nuclear Reactor Operations,* © 1988, §

QUESTION A.017 [1.0 point]

You perform two initial startups a week apart. Each of the startups has the same starting conditions, (core burnup, pool and fuel temperature, and count rate are the same). The only difference between the two startups is that during the SECOND one you stop for 10 minutes to answer the phone. For the second startup compare the critical rod height and count rate to the first startup.

	Rod Height	Count Rate
a.	Higher	Same
b.	Lower	Same
c.	Same	Lower
d.	Same	Higher

Answer: A.017 d
Reference: Burn, R., *Introduction to Nuclear Reactor Operations,* © 1988, §

QUESTION A.018 [1.0 point]

About two minutes following a reactor scram, period has stabilized, and is decreasing at a CONSTANT rate. If reactor power is 10^{-5}% full power what will the power be in three minutes.

a. 5×10^{-6} % full power

b. 2×10^{-6} % full power

c. 10^{-6} % full power

d. 5×10^{-7} % full power

Answer A.018 c
Reference: $P = P_0\, e^{-T/\tau} = 10^{-5} \times e^{(-180sec/80sec)} = 10^{-5} \times e^{-2.25} = 0.1054 \times 10^{-5} = 1.054 \times 10^{-6}$

QUESTION A.019 [1.0 point]

The neutron microscopic cross-section for absorption σ_a generally …

a. increases as neutron energy increases

b. decreases as neutron energy increases

c. increases as target nucleus mass increases

d. decreases as target nucleus mass increases

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

QUESTION A.020 [1.0 point]

Reactor Power increases from 15 watts to 65 watts in 30 seconds. The period of the reactor is:

a. 7 seconds

b. 14 seconds

c. 21 seconds

d. 28 seconds

Answer A.020 c
Reference: Burn, R., *Introduction to Nuclear Reactor Operations,* © 1988, §
$P = P_0 e^{t/\tau}$, $\ln(65/15) = 30\text{sec}/\tau$ $\tau = (30 \text{ sec})/(\ln 4.3333) = 20.456$

END OF Section A ℞ Theory, Thermo & Fac. Operating Characteristics

Section B - Normal/Emergency Procedures and Radiological Controls

QUESTION B.001 [1.0 point]

Which TWO of the following types of experiments **MUST** be specifically approved by the Radiation Safety Committee to be performed?

a. Experiments containing more than 25 milligrams of explosive materials and fueled experiments worth more than 100 watts.

b. Experiments containing explosive materials less than 25 milligrams and fueled experiments with material worth less than 100 watts.

c. Experiments containing very small masses of materials corrosive to reactor components without corrosion resistant encapsulation and low reactivity worth fueled experiments.

d. Experiments containing less than 25 milligrams of explosive materials and all experiments containing large masses of corrosive materials without corrosion resistant encapsulation.

Answer: B.001 a
Reference: Technical Specifications § 5.7.2 (1), (2) and (3).

QUESTION B.002 [2.0 points, 0.5 each]

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.002 a, 20; b, 1; c, 1; d, 10
Reference: 10CFR20.100x

Section B - Normal/Emergency Procedures and Radiological Controls

QUESTION B.003 [2.0 points, 0.5 each]

Match the radiation reading from column A with its corresponding radiation area classification (per 10 CFR 20) listed in column B.

	COLUMN A		COLUMN B
a.	10 mRem/hr	1.	Unrestricted Area
b.	150 mRem/hr	2.	Radiation Area
c.	10 Rem/hr	3.	High Radiation Area
d.	550 Rem/hr	4.	Very High Radiation Area

Answer: B.003 a, 2; b, 3; c, 3; d, 4
Reference: 10 CFR 20.1003, Definitions

QUESTION B.004 [1.0 point]

N^{16}has a half life of about 7 seconds. After 70 seconds (10 half-lives) the amount of N^{16} remaining is approximately _______ of the original amount.

a. One-Tenth

b. One-Twentieth

c. One-Thousandth

d. One-Millionth

Answer: B.004 c
Reference: $A = A_0 (½)^{10} = 1/1024 \approx 1/1000$

Section B - Normal/Emergency Procedures and Radiological Controls

QUESTION B.005 [2.0 points, ½ point each]

Identify each of the following actions as either a channel **CHECK**, a channel **TEST**, or a channel **CAL**ibration.

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

b. Prior to the day's operation, you turn the Log Count Rate selector switch to 10^2, 10^3, and 10^4, verifying that the meter and recorder follow.

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

d. During a reactor shutdown you note a -80 second period on Nuclear Instrumentation.

Answer: B.005 a, Check; b, Test; c, Cal; d, Check
Reference: Technical Specification 1.3 Definitions, p. 2.

QUESTION B.006 [1.0 point]

Per the Emergency plan, "If an emergency situation requires personnel to search for and remove injured person(s) or entry is necessary to prevent conditions that would probably injure numbers of people, a planned emergency exposure to the whole body could be allowed up to ____ to save a life.

a. 25 rem

b. 50 rem

c. 75 rem

d. 100 rem

Answer: B.006 c
Reference: Emergency Plan § 7.4.6 4th ¶, p. 18.

Section B - Normal/Emergency Procedures and Radiological Controls

QUESTION B.007 [1.0 point]

Technical Specification 5.4.1 requires "the neutron multiplication factor of the fully loaded storage pit shall not exceed ____ under any conditions."

a. 0.80

b. 0.85

c. 0.90

d. 0.95

Answer: B.007 c
Reference: Technical Specification 5.4.1

QUESTION B.008 [1.0 point]

According to Technical Specification 3.7.1 "Experiments worth more than _____ delta k/k shall be inserted or removed with the reactor shutdown.

a. 0.05

b. 0.4

c. 1.2

d. 1.5

Answer: B.008 b
Reference: Technical Specification 3.7.1 (3)

QUESTION B.009 [1.0 point]

In case of an emergency the **NORMAL** Emergency Support Center (evacuation not required) …

a. Nuclear Engineering Department Office (Room 101, 102, 102A, Fulton Hall).

b. Health/Information Security Building, Campus Police Main Office.

c. Physics Building, Main Office (Room 102).

d. Reactor Control Room.

Answer: B.009 c
Reference: Emergency Plan, § 8.1, *Emergency Support Center, p. 21.*

Section B - Normal/Emergency Procedures and Radiological Controls

QUESTION B.010 [1.0 point]

Which ONE of the following Emergency classifications is **NOT** used at UMRR?

a. Notification of Unusual Event

b. Alert

c. Site Area Emergency

d. General Emergency

Answer: B.010 d
Reference: Emergency Plan, §§ 4.1 through 4.3.

QUESTION B.011 [1.0 point]

A small radioactive source is to be stored in the reactor building. The source reads 2 Rem/hr at 1 foot. Assuming no shielding is to be used, a Radiation Area barrier would have to be erected from the source at least a distance of approximately:

a. 400 feet

b. 40 feet

c. 20 feet

d. 10 feet

Answer: B.011 c
Reference:

$$\frac{DR_1}{X_2^2} = \frac{DR_2}{X_1^2} X_2^2 = \frac{DR_1}{DR_2} X_1^2 = \frac{2000}{5} \times 1^2 = 400 ft^2 X_2 = 20 ft$$

Section B - Normal/Emergency Procedures and Radiological Controls

QUESTION B.012 [1.0 point]

The control element drop times were last measured on July 31, 2003. Which one of the following dates is the latest the maintenance should have been performed again without exceeding a Technical Specifications requirement?

a. Dec. 15, 2003

b. Mar. 15, 2004

c. Oct. 31, 2004

d. July 31, 2005

Answer: B.012 b
Reference: T.S. §§ 1.3 Definitions, p. 7, and 4.2.1 Specification (1), p. 27.

QUESTION B.013 [1.0 point]

You must have the Health Physicist (or their designee) present to handle a radioactive sample reading greater than …

a. 250 mrem/hr @ 1 foot

b. 100 mrem/hr @ 1 foot

c. 75 mrem/hr @ 1 foot

d. 50 mrem/hr @ 1 foot

Answer: B.013 b
Reference: SOP 601, “Handling Radioactive Samples” § C.2 (a), (b), (c) and (d)

Section B - Normal/Emergency Procedures and Radiological Controls

QUESTION B.014 [1.0 point, ¼ each]

Match the Federal Regulation chapter in column A with the requirements covered in column B.

	Column A		Column B
a.	10 CFR 20	1.	Operator Licenses
b.	10 CFR 50	2.	Facility Licenses
c.	10 CFR 55	3.	Radiation Protection
d.	10 CFR 73	4.	Special Nuclear Material

Answer: B.014 a, 3; b, 2; c, 1; d, 4
Reference: Facility License and 10 CFR Parts 20, 50, 55 and 73

QUESTION B.015 [1.0 point]

In order to remove one control rod for maintenance, you must remove fuel until there is less than _____ % of a critical mass.

a. 75

b. 50

c. 33

d. 25

Answer: B.015 b
Reference: SOP-302

Section C - Facility and Radiation Monitoring Systems

QUESTION B.016 [1.0 point]

Per the Technical Specifications, ventilation fan operation is required when ......

a. the reactor is critical

b. the reactor is at full power

c. the control rods are latched

d. the reactor power level exceeds 20 Kilowatts

Answer: B.016 b
Reference: Technical Specification 3.5
QUESTION B.017 [1.0 point]

What type of waste is allowed in the designated radwaste can?

a. gloves worn to extract an experiment with no detectable activity
b. gloves worn to extract an experiment with detectable activity
c. liquids with no detectable activity
d. glass with detectable activity

Answer: B.017 b
Reference: SOP-600, B.12

END OF Section B - Normal/Emergency Procedures and Radiological Controls

Section C - Facility and Radiation Monitoring Systems

QUESTION C.001 [2.0 points, ½ each]

Match the purification system functions in column A with the purification component listed in column B

	Column A		Column B
a.	remove floating dust, bug larvae, etc.	1.	Demineralizer (Ion Exchanger)
b.	remove dissolved impurities	2.	Skimmer
c.	remove suspended solids	3.	Filter
d.	maintain pH		

Answer: C.001 a, 2; b, 1; c, 3; d, 1
Reference: SAR § 5.2, pp. 5-1 – 5-3, also Figure 22, p. 5-4.

QUESTION C.002 [1.0 point]

The gas used to move pneumatic tube “rabbit” samples into and out of the reactor is …

a. H_2

b. Air

c. CO_2

d. N_2

Answer: C.002 d
Reference: SAR § 4.3, p. 4-5.

Section C - Facility and Radiation Monitoring Systems

QUESTION C.003 [1.0 point]

The Ventilation system consists of three fans mounted on the Reactor Building roof. On a Building Evacuation Alarm from the Reactor Bridge Radiation Area Monitor, the

a. All three fans will secure automatically.

b. All three fans must be secured by the Reactor Operator.

c. The two normal exhaust fans will secure automatically, the emergency exhaust fan will start automatically.

d. The Reactor Operator must secure the two normal exhaust fans and start the emergency exhaust fan.

Answer: C.003 b
Reference: SOP-501

QUESTION C.004 [1.0 point]

Which ONE of the following is the reason that primary temperature is maintained below 57°C (135°F)? This temperature is based upon …

a. a jump in the diffusion of N^{16} from the pool.

b. the bath temperature coefficient changes from negative to positive.

c. the purification system filter melts.

d. the upper limit of the effective temperature range for the ion exchange resin.

Answer: C.004 d
Reference: SAR § 5.2, p. 5-3.

Section C - Facility and Radiation Monitoring Systems

QUESTION C.005 [1.0 point]

Inadvertent movement of the reactor bridge will result in …

a. illumination of a status light only.

b. a rod rundown.

c. a reactor scram.

d. an evacuation alarm.

Answer: C.005 c
Reference: SAR § 3.2.6, p. 3.19.

QUESTION C.006 [1.0 point]

Which ONE of the following is the method used to minimize mechanical shock to the control rods on a scram?

a. A small spring located at the bottom of the rod.

b. A piston attached to the upper end of the safety rod enters a special damping cylinder as the rod approaches the full insert position.

c. An electrical-mechanical brake energizes when the rod down limit switch is energized.

d. A piston (part of the connecting rod) drives air out of a dashpot as the rod nears the bottom of travel.

Answer: C.006 b
Reference: SAR § 3.2.3, p. 3-13

Section C - Facility and Radiation Monitoring Systems

QUESTION C.007 [2.0 points, ⅓ each]

Correctly identify the correct protective action {items 1 through 4} with each of the following situations {a. through g.}. Items 1 through 4 may be used more than once.

1. Scram
2. Rundown
3. Rod Withdrawal Prohibit
4. Operator Response

a. Period < 30 seconds
b. Log N and Period Amp. Not Operative
c. Effluent Pool Demineralizer Conductivity high
d. High Neutron Flux in Beam Room
e. Safety Rods Below Shim Range
f. Reg rod on insert limit in auto control

Answer: C.007 a. 3; b. 1; c. 4; d. 4; e. 3; f. 2,
Reference: SAR page 3-41, Table IX

QUESTION C.008 [1.0 point]

The heat capacity of the reactor pool is sufficient to cool the reactor for ______, with the reactor operating at full power (200 Kilowatts. Assumption: Starting bulk temperature = 20°C. Note 135°F = 57.2°C.

a. about 10 Minutes
b. about an Hour
c. about a Day (24 hours)
d. about a Week (168 hours)

Answer: C.008 c
Reference: SAR, § 3.4.7, p. 3-28.

Section C - Facility and Radiation Monitoring Systems

QUESTION C.009 [1.0 point]

An experimenter drops and breaks open a sample vial in a laboratory room. He immediately runs out of the room and closes the door. You are called in to assist in the cleanup. Prior to opening the door you would take a reading using a(n)

a. Ion Chamber portable radiation detector to determine the radiation field strength.

b. Geiger-Müller portable radiation detector to determine the radiation field strength.

c. Ion Chamber portable radiation detector to determine whether contamination is present.

d. Geiger-Müller portable radiation detector to determine whether contamination is present.

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

QUESTION C.010 [1.0 point]

Each shim/safety rods consists of a grooved,

a. hafnium rod.

b. boron-carbide rod.

c. boral (boron and aluminum alloy) rod.

d. boron steel rod.

Answer: C.010 d
Reference: SAR § 3.2.3, p. 3-11.

Section C - Facility and Radiation Monitoring Systems

QUESTION C.011 [1.0 point]

A sample placed in which ONE of the following positions will have the greatest effect on core reactivity?

a. Thermal Column

b. Pneumatic Transfer system

c. Core Access Element

d. Beam Tube

Answer: C.011 b or c
Reference: SAR § 4 Experimental Facilities (pp. 4-1 through 4-6, and § 3.2.4, Core Access and Isotope Production Elements p. 3-17.

QUESTION C.012 [1.0 point]

A student operating the reactor attempts to withdraw all four control rods simultaneously. Which ONE of the following describes the correct system response?

a. All four control rods will withdraw.

b. An interlock will prevent all four control rods from withdrawing.

c. The three shim/safety rods will withdraw, an interlock will prevent the regulating rod from withdrawing.

d. The regulating rod will withdraw, an interlock will prevent the three shim/safety rods from withdrawing.

Answer: C.012 c
Reference: SAR 3.5.5, page 3-36

Section C - Facility and Radiation Monitoring Systems

QUESTION C.013 [1.0 point]

Which ONE of the following methods is used to compensate for gamma radiation in a Compensated Ion Chamber?

a. Pulses smaller than a height (voltage) are stopped by a pulse-height discriminator circuit from entering the instrument channel's amplifier.

b. The chamber contains two concentric tubes one of which detects both neutrons and gammas the other only gammas, the signals are added electronically to subtract the gamma signal, leaving only the signal due to neutrons.

c. The signal travels through a Resistance-Capacitance (RC) circuit, converting the signal to a power change per time period effectively deleting the signal due to gammas.

d. A compensating voltage equal to a predetermined "source gamma level" is fed into the pre-amplifier electronically removing source gammas from the signal. Fission gammas are proportional to reactor power and therefore not compensated for.

Answer: C.013 b
Reference: Standard NRC question

QUESTION C.014 [1.0 point]

Which ONE of the following parameters is NOT measured in the Purification System?

a. Pressure

b. Flow Rate

c. Conductivity

d. pH

Answer: C.17 d
Reference: SAR § 5.2, Figure 22, p. 5-4.

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QUESTION C.015 [1.0 point]

Which ONE of the listed radioisotopes is best detected by the Continuous Air Monitor?

a. Rb^{88}

b. N^{16}

c. Ar^{41}

d. Xe^{136}

Answer: C.015 a
Reference: SAR § 3.6.2, 7th ¶. (Designed to detect particulate **NOT** gaseous radioactivity.)

QUESTION C.016 [1.0 point]

The Pneumatic Tube system consists of two rabbit tubes. One of these tubes is lined to prevent sample activation by thermal neutrons. This tube is lined with ...

a. Boron

b. Cadmium

c. Carbon

d. Hafnium

Answer: C.015 b
Reference: SAR § 4.3 1st ¶.

QUESTION C.017 [1.0 point] QUESTION DELETED

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.017 b
Reference: SAR Figure 22, also SOP 301

Section C - Facility and Radiation Monitoring Systems

QUESTION C.018 [1.0 point]

The automatic controller will shift from automatic to manual, without operator action, anytime the difference between power level and demand exceeds the ± __% variation limit.

a. 1

b. 2

c. 3

d. 5

Answer: C.018 b
Reference: SAR 3.5.5 page 3-36

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