July 21, 2015

Dr. Donald Wall, Director
Nuclear Radiation Center
Washington State University
50 Roundtop Drive
Pullman, WA 99164-1300

SUBJECT: EXAMINATION REPORT, NO. 50-027/OL-15-02, WASHINGTON STATE UNIVERSITY

Dear Dr. Wall:

During the week of June 22, 2015, the U.S. Nuclear Regulatory Commission (NRC) administered an operator licensing examination at your Washington State University TRIGA Reactor. The examination was conducted according to NUREG-1478, "Operator Licensing Examiner Standards for Research and Test Reactors," Revision 2, published in June 2007. Examination questions and preliminary findings were discussed with you and Mr. C. Corey Hines 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 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 Public Electronic Reading Room). The NRC is forwarding the individual grades to you in a separate letter which will not be released publicly. If you have any questions concerning the examination, please contact Mr. Phillip T. Young at 301-415-4094, or by email at Phillip.Young@nrc.gov.

Sincerely,

/RA/

Kevin, Hsueh, Chief
Research and Test Reactors Oversight Branch
Division of Policy and Rulemaking
Office of Nuclear Reactor Regulation

Docket No. 50-027

Enclosures: 1. Examination Report NO. 50-027/OL-15-02
2. Facility comments with resolution
3. Written examination with facility comments incorporated

cc: Mr. C. Corey Hines, Assistant Director, Reactor Operations

cc: w/o enclosures: See next page

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ADAMS Accession No.: ML15182A261 **NRR 079**

OFFICE	NRR/DPR/PROB	NRR/DPR/PROB	NRR/DPR/PROB
NAME	PYoung	NParker	KHsueh
DATE	07/02/15	07/01/15	07/21/15

OFFICIAL RECORD COPY

Washington State University Docket No. 50-027

cc:

Director
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Chair, Reactor Safeguards Committee
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Test, Research and Training
Reactor Newsletter
P.O. Box 118300
University of Florida
Gainesville, FL 32611-8300

EXAMINATION REPORT NO: 50-027/OL-15-02

FACILITY: Washington State University

FACILITY DOCKET NO.: 50-027

FACILITY LICENSE NO.: R-76

SUBMITTED BY: **R/A Patrick Isaac Acting for** 07/02/2015
Phillip T. Young, Chief Examiner Date

SUMMARY:

During the week of June 22, 2015, the NRC administered operator licensing examinations to four Reactor Operator and one Senior Reactor Operator candidates. All candidates passed the examinations and will be issued licenses to operate the Washington State University reactor.

REPORT DETAILS

1. Examiner: Phillip T. Young, Chief Examiner

2. Results:

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

3. Exit Meeting:

   Dr. Donald Wall, Director, Nuclear Radiation Center, Washington State University
   Mr. C. Corey Hines, Assistant Director, Reactor Operations, Washington State University
   Mr. Phillip T. Young, NRC, Chief Examiner

   The NRC examiner thanked the facility for their support in the administration of the examinations and noted how well the candidates were prepared. Mr. Phillip Young thanked the facility for their comments on the written examination.

FACILITY COMMENTS WITH NRC RESOLUTION

Question: B.07
You are reviewing the weekly survey records performed by a qualified radiation monitor, who had performed a weekly survey at the Nuclear Radiation Center. If it was determined that there were excessive dose levels existing at the Nuclear Radiation Center, which of the following determinations would be the most correct?
a. Swipe results which measured $1x10^{-4}$ µCi/cm^2 in the radiochem lab.
b. 110 mrem/hr in a posted high radiation area.
c. 70 mrem/hr in a posted radiation area.
d. 20 mrads/hr in a posted radiation area.

Answer: B.07 c. REF: SOP-16 "Standard Procedure for Health Physics Surveys"

Comment: Both (b) and (c) are correct

Justification: Per SOP-16 (Rev0.1) Section C.3.a(1), Excessive dose rates: "greater than 50 mRem/hr in a posted radiation area, high radiation area, or very high radiation area."

NRC Resolution: The facility comment is accepted, the answer key will reflect both b. and c. as correct answers.

Question: B.016
Before entering to the experimental facility, you see a sign at the door "CAUTION, RADIATION AREA". You would expect that radiation level in the facility could result in an individual receiving a dose equivalent of:
a. 2 mRem/hr at 30 cm from the source
b. 5 mRem/hr at 30 cm from the source
c. 100 mRem/hr at 30 cm from the source
d. 500 mRem/hr at 30 m from the source

Answer: B.16 b. REF: 10 CFR 20.1003 and 10CFR 20.1902

Comment: Change the answer key to reflect correct answers (b) and (c).

Justification: 10CFR20.1003

NRC Resolution: The facility comment is accepted, the answer key will reflect both b. and c. as correct answers.

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

FACILITY: Washington State University

REACTOR TYPE: Pool Type, Modified TRIGA
DATE ADMINISTERED: 6/23/2015

CANDIDATE: _____

INSTRUCTIONS TO CANDIDATE:
Answers are to be written on the answer sheet provided. Attach the answer sheets to the examination. Points for each question are indicated in brackets for each question. A 70% in each section is required to pass the examination. Examinations will be picked up three (3) hours after the examination starts.

Category Value	% of Total	% of Candidates Score	Category Value	Category
20.00	33.3			A. Reactor Theory, Thermodynamics and Facility Operating Characteristics
20.00	33.3			B. Normal and Emergency Operating Procedures and Radiological Controls
20.00	33.3			C. Facility and Radiation Monitoring Systems
60.00	100.0			TOTALS

All work done on this examination is my own. I have neither given nor received aid.

_____
Candidate's Signature

NRC RULES AND GUIDELINES FOR LICENSE EXAMINATIONS

During the administration of this examination the following rules apply:

1. Cheating on the examination means an automatic denial of your application and could result in more severe penalties.

2. After the examination has been completed, you must sign the statement on the cover sheet indicating that the work is your own and you have neither received nor given assistance in completing the examination. This must be done after you complete the examination.

3. Restroom trips are to be limited and only one candidate at a time may leave. You must avoid all contacts with anyone outside the examination room to avoid even the appearance or possibility of cheating.

4. Use black ink or dark pencil only to facilitate legible reproductions.

5. Print your name in the blank provided in the upper right-hand corner of the examination cover sheet and each answer sheet.

6. Mark your answers on the answer sheet provided. USE ONLY THE PAPER PROVIDED AND DO NOT WRITE ON THE BACK SIDE OF THE PAGE.

7. The point value for each question is indicated in [brackets] after the question.

8. If the intent of a question is unclear, ask questions of the examiner only.

9. When turning in your examination, assemble the completed examination with examination questions, examination aids and answer sheets. In addition turn in all scrap paper.

10. Ensure all information you wish to have evaluated as part of your answer is on your answer sheet. Scrap paper will be disposed of immediately following the examination.

11. To pass the examination you must achieve a grade of 70 percent or greater in each category.

12. There is a time limit of three (3) hours for completion of the examination.

13. When you have completed and turned in you examination, leave the examination area. If you are observed in this area while the examination is still in progress, your license may be denied or revoked.

$$\dot{Q} = \dot{m}\, c_{\bar{p}}\, \Delta T = \dot{m}\, \Delta H = UA\, \Delta T$$

$$\lambda_{eff} = 0.1\ seconds^{-1}$$

$$SUR = 26.06\left[\frac{\lambda_{eff}\,\rho}{\beta - \rho}\right] \qquad SCR = \frac{S}{-\rho} \approx \frac{S}{1 - K_{eff}} \qquad CR_1(1 - K_{eff_1}) = CR_2(1 - K_{eff_2})$$

$$CR_1(-\rho_1) = CR_2(-\rho_2)$$

$$M = \frac{1 - K_{eff_0}}{1 - K_{eff_1}} \qquad M = \frac{1}{1 - K_{eff}} = \frac{CR_1}{CR_2}$$

$$P = P_0\, 10^{SUR(t)} \qquad P = P_0\, e^{\frac{}{\mathrm{T}}} \qquad P = \frac{\beta(1-\rho)}{\beta - \rho} P_0$$

$$SDM = \frac{(1 - K_{eff})}{K_{eff}} \qquad \mathrm{T} = \frac{\ell^*}{\rho - \bar{\beta}} \qquad \mathrm{T} = \frac{\ell^*}{\rho} + \left[\frac{\bar{\beta} - \rho}{\lambda_{eff}\,\rho}\right]$$

$$\Delta\rho = \frac{K_{eff_2} - K_{eff_1}}{k_{eff_1} x\, K_{eff_2}} \qquad T_{‰} = \frac{0.693}{\lambda} \qquad \rho = \frac{(K_{eff} - 1)}{K_{eff}}$$

$$DR = DR_0\, e^{-\lambda t} \qquad DR = \frac{6CiE(n)}{R^2} \qquad DR_1 d_1^{\,2} = DR_2 d_2^{\,2}$$

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

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

1 Curie = 3.7 x 10^{10} dis/sec
1 Horsepower = 2.54 x 10^3 BTU/hr
1 BTU = 778 ft-lbf
1 gal (H_2O) ≈ 8 lbm
c_P = 1.0 BTU/hr/lbm/ºF

1 kg = 2.21 lbm
1 Mw = 3.41 x 10^6 BTU/hr
ºF = 9/5 °C + 32
ºC = 5/9 (°F - 32)
c_p = 1 cal/sec/gm/ºC

Section A - Reactor Theory, Thermodynamics and Facility Operating Characteristics

QUESTION A.001 [1.0 point]

What is the kinetic energy range of a thermal neutron?

a. > 1 MeV

b. 100 KeV – 1 MeV

c. 1 eV – 100 KeV

d. < 1 eV

Answer: A.01 d.
REF: DOE Fundamentals Handbook, Volume 1, Module 2, *Neutron Moderation*, pg. 23

QUESTION A.002 [1.0 point]

You've just increased power at a research reactor. As a result fuel temperature increased from 100°C to 120°C. For this reactor the fuel temperature coefficient (α_{tf}) is -0.01% k/k/°C, and the average rod worth for the regulating rod is 0.05% k/k/inch. How far and in what direction must you move the regulating rod to compensate? (Assume all other factors which could affect reactivity remain unchanged.)

a. 2 inches inward

b. 2 inches outward

c. 4 inches inward

d. 4 inches outward

Answer: A.02 d.
REF: DOE Handbook volume 2, module 3, pg. 26
-0.0001k/k/°C * 20°C = -0.002k/k. To compensate must add +0.002k/k.
(0.002k/k) / (0.0005%k/k/inch) = 4 inches in the positive (outward) direction.

QUESTION A.003 [1.0 point]

Following 8 hours at 1 MW, the reactor operator reduces reactor power to 50%. Rod control is placed in manual mode and all rod motion is stopped. Which one of the following describes the response of reactor power, without any further operator actions, and the PRIMARY reason for its response?

a. Power decreases due to the buildup of xenon.

b. Power increases due to the burnout of xenon.

c. Power increases due to the burnout of samarium.

d. Power decreases due to the buildup of samarium.

Answer: A.03 a.
REF: Burn, R., Introduction to Nuclear Reactor Operations, © 1988, §§ 8.1 —8.4,
pp. 8-3 — 8-14.

QUESTION A.004 [1.0 point]

Which ONE of the following statements describes the subcritical reactor response as Keff approaches unity?

a. A LARGER change in neutron level results from a given change in Keff and a SHORTER period of time is required to reach the equilibrium neutron level for a given change in Keff.

b. A LARGER change in neutron level results from a given change in Keff and a LONGER period of time is required to reach the equilibrium neutron level for a given change in Keff.

c. A SMALLER change in neutron level results from a given change in Keff and a SHORTER period of time is required to reach the equilibrium neutron level for a given change in Keff.

d. A SMALLER change in neutron level results from a given change in Keff and a LONGER period of time is required to reach the equilibrium neutron level for a given change in Keff.

Answer: A.04 b.
REF: Burn, R., Introduction to Nuclear Reactor Operations, © 1988, Chapt. 5, pp. 5-1 — 5-28

QUESTION A.005 [1.0 point]

During a startup you increase reactor power from 100 watts to 195 watts in a minute. Which ONE of the following is reactor period?

a. 30 seconds.

b. 60 seconds.

c. 90 seconds.

d. 120 seconds.

Answer: A.05 c.
REF: $P = P_0 e^{t/\tau}$ —> $\tau = t/\ln(P/P_0)$ $\tau = 60/\ln(195/100) = 60/\ln(1.95) = 89.84 \approx 90$ sec.

QUESTION A.006 [1.0 point]

Which ONE of the reactions below is an example of a photoneutron source?

a. ${}_{92}U^{238} \rightarrow {}_{35}Br^{87} + {}_{57}La^{148} + 3n + \gamma$

b. ${}_{51}Sb^{123} + n \rightarrow {}_{51}Sb^{124} + \gamma$

c. ${}_{1}H^{2} + \gamma \rightarrow {}_{1}H^{1} + n$

d. ${}_{4}Be^{9} + \alpha \rightarrow {}_{6}C^{12} + n$

Answer: A.06 c.
REF: R. R. Burn, Introduction to Nuclear Reactor Operations, page 5-3.

QUESTION A.007 [1.0 point]

In a just critical reactor, adding one dollar worth of reactivity will cause:

a. A sudden drop in neutron flux.

b. The reactor period to be equal to $(\beta-\rho)/\lambda\rho$.

c. All prompt neutron term to become unimportant.

d. The resultant period to be a function of the prompt neutron lifetime.

Answer: A.07 d.
REF Introduction to Nuclear Operation, Reed Burn, 1988, Sec 4.2, page 4-4

QUESTION A.008 [1.0 point]

Which ONE of the following statements best describes on how moderator temperature affects the core operating characteristics?

a. Increase in moderator temperature will increase the neutron multiplication factor due to the resonance escape probability increase.

b. Increase in moderator temperature will increase the neutron multiplication factor due to the fast non leakage probability decrease.

c. Increase in moderator temperature will decrease the neutron multiplication factor due to the reproduction factor increase.

d. Increase in moderator temperature will decrease the neutron multiplication factor due to the resonance escape probability decrease.

Answer: A.08 d.
REF: Burn, R., Introduction of Nuclear Reactor Operations, © 1982, Sec 3.3.1

QUESTION A.009 [1.0 point]

The neutron microscopic cross-section for absorption σa generally:

a. increases as neutron energy increases

b. decreases as target nucleus mass increases

c. increases as target nucleus mass increases

d. decreases as neutron energy increases

Answer: A.09 d.
REF: Burn, R., Introduction to Nuclear Reactor Operations, © 1982

QUESTION A.010 [1.0 point]
Which ONE of the following factors in the “six factor” formula is the MOST affected by the CONTROL RODS?

a. Fast fission factor

b. Reproduction factor

c. Thermal utilization factor

d. Resonance escape probability

Answer: A.10 c.
REF: Burn, R., Introduction to Nuclear Reactor Operations, © 1982, Sec 3.2.2,page 3-18.

QUESTION A.011 [1.0 point]
Which ONE of the following is the most correct reason for having an installed neutron source within the core? An installed neutron source is very important during startup because without of a neutron source...

a. the chain reaction in the reactor core would NOT start.

b. the startup channel would NEVER indicate neutron population.

c. the compensating voltage on the source range detector doesn’t work.

d. the reactor could result in a sudden increase in power if the control rods were pulled out far enough.

Answer: A.11 d.
REF: Burn, R., Introduction to Nuclear Reactor Operations, © 1982, Page 4-21.

QUESTION A.012 [1.0 point]
The number of neutrons passing through a one square centimeter of target material per second is the definition of:

a. Neutron Flux (nv)

b. Neutron Density (nd)

c. Neutron Population (np)

d. Neutron Impact Potential (nip)

Answer: A.12 a.
REF: DOE Handbook Vol. 2

QUESTION A.013 [1.0 point]

A reactor is subcritical with a K_{eff} of 0.955. A positive reactivity of $5.00 is inserted into the core (β = 0.007 delta k/k). At this point, the reactor is:

a. supercritical.

b. exactly critical.

c. prompt critical.

d. subcritical.

Answer: A.13 d.
REF: Lamarsh, Introduction to Nuclear Engineering, 2nd Edition, pg. 282.
$5.00 = 0.035 delta k/k. Reactor is initially subcritical by 0.045 delta k/k.

QUESTION A.014 [1.0 point]

The _____ of the six factor formula will _____ due to the insertion of control rods in the core.

a. reproduction factor; increases

b. resonance escape probability; decreases

c. fast non-leakage probability; increases

d. thermal utilization factor; decreases

Answer: A.14 d.
REF: Burn, R., Introduction to Nuclear Reactor Operations, 1988, page 3-17.

QUESTION A.015 [1.0 point]

During a fuel loading of the core, as the reactor approaches criticality, the value of 1/M:

a. increases toward unity.

b. decreases toward unity.

c. increases toward infinity.

d. decreases toward zero.

Answer: A.15 d.
REF: Burn, R., Introduction to Nuclear Reactor Operations, 1988, page 5-16.

QUESTION A.016 [1.0 point]

The following shows part of a decay chain for the radioactive element Radon (Rn). This decay chain is a good example of ___ decay.

$$^{222}_{86}Rn \rightarrow ^{3.8\,d}\,^{218}_{84}Po$$

a. Alpha

b. Beta

c. Gamma

d. Neutron

Answer: A.16 a.
REF: Nuclides and Isotopes: Chart of the Nuclides. Lockheed Martin 16th Ed.

QUESTION A.017 [1.0 point]

Which of the following is the most penetrating form of radiation?

a. Alpha

b. Beta

c. Gamma

d. Neutron

Answer: A.17 c .
REF: Bevelacqua, J. 2009. *Basic Health Physics*. p.391

QUESTION A.018 [1.0 point]

According to the WSU SAR the predominant and most significant effect that pulsing has on the reactor and/or its associated components is?

a. Higher personnel dose associated with an increase in neutron flux.

b. Higher general area radiation levels associated with higher concentrations of Nitrogen-16.

c. Radial differential expansion in the middle region of a new, unpulsed fuel rod.

d. Uneven control blade temperatures in the core region that will cause axial strain and subsequent warping over time.

Answer: A.18 c.
REF: WSU SAR, Section 6.0 Safety Analysis

QUESTION A.019 [1.0 point]

Which ONE of the following is a correct statement of why delayed neutrons enhance the ability to control reactor power?

a. There are more delayed neutrons than prompt neutrons.

b. Delayed neutrons are born at higher energy levels than prompt neutrons.

c. Delayed neutrons increase the average neutron lifetime.

d. Delayed neutrons readily fission in U-238.

Answer: A.19 c.
REF: DOE Manual, Section 3

QUESTION A.020 [1.0 point]

A nuclear reactor is subcritical with a startup in progress. Which one of the following conditions will result in a critical rod position that is lower than the estimated critical rod position?

a. A malfunction with the rod control system, where the withdrawal speed is faster than its typical setting.

b. A malfunction with the rod control system, where the withdrawal speed is slower than its typical setting.

c. The temperature of the secondary water supply has dropped 10 C since the last reported startup.

d. A student carrying a sample containing 100 ppm boron inadvertently drops it into the pool (assume uniform dispersion).

Answer: A.20 c.
REF: DOE Handbook Vol II

END OF SECTION A

QUESTION B.001 [1.0 point]

A Limiting Condition for Operation (LCO) at the WSU TRIGA for pulsing operation is for the maximum reactivity inserted during pulse mode operation is to ensure the peak fuel temperature in any fuel rod does not exceed 830 °C. Which of the following is the most correct statement regarding the basis for this LCO?

a. The temperature limit as read by the instrumented fuel element prevents catastrophic fuel melt and cladding failure from excessive core temperatures.

b. When the temperature of the instrumented fuel element reaches the setting of 880°C, a reactor scram will occur to prevent exceeding the safety limit, thus there is a safety margin of 50°C.

d. The temperature limit ensures that minimum departure from nucleate boiling is not exceeded during the pulse, ensuring that an adequate margin exists on the cladding surface for heat transfer.

e. It is the optimal temperature for reducing the pressure buildup of H_s gas, thereby reducing the overall swelling and distortion of the cladding and entire fuel rod.

Answer: B.01 d.
REF: WSU TS 3.1.2

QUESTION B.002 [1.0 point]

According to facility Technical Specifications, which one of the following at the WSU Nuclear Radiation Center would most likely be considered a reportable occurrence?

a. A tornado hits the University, causing a campus wide loss of electricity.

b. A pneumatic sample is loaded in the core, which causes an unexplained change in a $1.50 worth of reactivity.

c. An anonymous phone caller informs you that he has witnessed people smuggling irradiated material out of the facility and into unmarked vans.

d. The reactor it temporarily left unattended for five minutes while it is in an unsecured condition.

Answer: B.02 b.
REF: WSU TS Definition of “Reportable Occurrence”

QUESTION B.003 [1.0 point]
Per WSU Technical Specifications, all fuel elements shall be stored in a geometrical array where the k-effective is _____ for all conditions of moderation.

a. < 0.5

b. < 0.6

c. < 0.8

d. < 0.9

Answer: B.03 c.
REF: TS 5.5

QUESTION B.004 [1.0 point]
Which of the following types of events is considered an Unusual Event (Class 1 Emergency) at the WSU Nuclear Radiation Center?

a. An explosion that occurs at the reactor bay loading dock.

b. An earthquake that causes structural damage to the confinement structure.

c. Transient rod stuck in the UP position.

d. An individual enters a high radiation area without wearing dosimetry.

Answer: B.04 b.
REF: WSU E-Plan Implementing Procedures

QUESTION B.005 [1.0 point]
What is the annual adult occupational dose limit to the whole body?

a. 5 mrem

b. 500 mrem

c. 2 rem

d. 5 rem

Answer: B.05 d.
REF: 10 CFR 20

QUESTION B.006 [1.0 point]
How many hours per calendar quarter must you perform the functions of an RO to maintain an active RO license?

a. 4

b. 5

c. 6

d. 8

Answer: B.06 a.
REF: 10CFR55.53(e)

QUESTION B.007 [1.0 point]
You are reviewing the weekly survey records performed by a qualified radiation monitor, who had performed a weekly survey at the Nuclear Radiation Center. If it was determined that there were excessive dose levels existing at the Nuclear Radiation Center, which of the following determinations would be the most correct?

a. Swipe results which measured $1x10^{-4}$ $\mu Ci/cm^2$ in the radiochem lab.

b. 110 mrem/hr in a posted high radiation area.

c. 70 mrem/hr in a posted radiation area.

d. 20 mrads/hr in a posted radiation area.

Answer: B.07 ~~c.~~ b. and c. per facility comment.
REF: SOP-16 "Standard Procedure for Health Physics Surveys"

QUESTION B.008 [1.0 point]
Which ONE of the following is the MAIN reason why the limitation on the total radioactive inventory of iodine isotopes is less than 1.5 Ci in the fueled experiment? If the total radioactive inventory of iodine isotopes is greater than 1.5 Ci :

a. it would exceed a boiling point of 60 °C.

b. the reactivity worth would exceed a secured limit of $2.0.

c. the reactivity worth would exceed an unsecured limit of $1.0.

d. it would exceed in an air effluent release limit specified in 10 CFR 20.

Answer: B.08 d.
REF: Technical Specification, Section 3.6 (Basis)

QUESTION B.009 [1.0 point]

You use a survey instrument with a window probe to measure the beta-gamma dose rate from an irradiated experiment. The dose rate is 200 mrem/hour with the window opened and 140 mrem/hour with the window closed. The gamma dose rate is:

a. 60 mrem/hour

b. 140 mrem/hour

c. 200 mrem/hour

d. 340 mrem/hour

Answer: B.09 b.
REF: Basic Radiation Instrumentation

QUESTION B.010 [1.0 point]

Per WSU Technical Specifications, what is the MINIMUM level of management who shall be present at the facility during all control rod relocations within the reactor core?

a. Reactor Operator

b. Senior Reactor Operator

c. Reactor Facility Director

d. The Reactor Operations Committee

Answer: B.10 b.
REF: Technical Specifications, Section 6.2.3

QUESTION B.011 [1.0 point]

You are leading a tour of the facility for a freshman nuclear engineering class. The reactor is operating at a certain power level where radiation levels at the pool reads 5 mrem/hr by the area monitoring equipment. How long can this group stay before they exceed **their** 10 CFR 20 limit?

a. 100 hrs

b. 20 hrs

c. 1 hr

d. 0.4 hrs

Answer: B.11 d.
REF: 10 CFR 20
No member of the public can receive more than 2.0 mrem in any one hour, so this limit would be reached first.100 mrem dose limit to members of the public (10 CFR 20)
2 mrem/(5 mrem/hr)= 0.4 hrs

QUESTION B.012 [1.0 point]
Which of the following answers best describes a time when an SRO is **NOT** required to be present at the facility?

a. Any startup after the initial startup of the day.

b. Performing a reactor pulse from an initial power level of 500 kW.

c. Loading six samples into the vertical rotator tubes with a combined worth of $0.75.

d. Shuffling spare fuel in the storage racks adjacent to the reactor core.

Answer: B.12 c.
REF: SOP No. 4, TS 3.6 and 6.2.3

QUESTION B.013 [1.0 point]
Which of the following examples of experiments would **NOT** be considered an Operational Experiment?

a. Flux wire irradiations that have a dose rate of 30 mrem/hr on contact.

b. Prompt neutron lifetime determination using the pulse method.

c. Calibrating a control element by a continuous pull method to determine the doubling time.

d. A reactor power calibration with the pool divider wall installed on the East side of the pool divider.

Answer: B.13 a.
REF: SOP No. 3

QUESTION B.014 [1.0 point]
The guidance that discusses how access is specifically maintained at the Nuclear Radiation Center can be found in _____.

a. Technical Specifications

b. Administrative Procedures

c. 10 CFR 50.59

d. Emergency Plan

Answer: B.14 b.
REF: AP No.4

QUESTION B.015 [1.0 point]

Provide the correct class of emergency if a fire or explosion in a reactor-related area that cannot be immediately extinguished and which has the potential of adversely affecting the reactor.

a. Safety Event

b. Unusual Event

c. Alert

d. Site Area Emergency

Answer: B.15 c.
REF: Emergency Plan, Section 4.0

QUESTION B.016 [1.0 point]

Before entering to the experimental facility, you see a sign at the door "CAUTION, RADIATION AREA". You would expect that radiation level in the facility could result in an individual receiving a dose equivalent of:

a. 2 mRem/hr at 30 cm from the source

b. 5 mRem/hr at 30 cm from the source

c. 100 mRem/hr at 30 cm from the source

d. 500 mRem/hr at 30 m from the source

Answer: B.16 b.
REF: 10 CFR 20.1003 and 10CFR 20.1902

QUESTION B.017 [1.0 point]

During an emergency with expected airborne radio nuclides in the pool room, which ONE of the following correctly describes the procedure to identify airborne radio nuclides? (Identify exact nuclides presented in the pool room)

a. The reactor bridge radiation monitor will identify the exact nuclides in the pool room

b. You enter the pool room and use portable meter for identification of the nuclides

c. Use a high volume air sampler to collect particulates on a filter paper, and then count it on a multichannel analyzer

d. Read a peak energy reading on exhaust gas monitor, and then compare it with the maximum allowable concentration as specified in Appendix B, Table II of 10 CFR 20 for identification

Answer: B.17 ~~c.~~ b. and c. per facility comment.
REF: EP 7.2.1

QUESTION B.018 [1.0 point]
What is the MINIMUM staffing requirement to be present at the facility for fuel accountability?

a. Senior Reactor Operator ONLY
b. Reactor Facility Director ONLY
c. Senior Reactor Operator and non-licensed staff member
d. Senior Reactor Operator and Reactor Operator

Answer: B.18 d.
REF: Administrative Procedure # 9, Section E

QUESTION B.019 [1.0 point]
Per WSU Emergency Classification, failure of an in-core experiment with a minor release of radioactive material is an example of:

a. normal operation
b. Safety Event – (non-reactor related)
c. Unusual Event – (reactor related)
d. Alert

Answer: B.19 c.
REF: Emergency Plan, 4.3

QUESTION B.020 [1 point, 0.25 point each]
Match the items listed in Column A with the proper definition in Column B. Each item can be used only once.

Column A	Column B
a. Emergency Plan	1. Area for which offsite emergency planning is performed.
b. Emergency Planning Zone	2. Instructions that detail the implementation actions and methods required to achieve the objectives of the emergency plan.
c. Emergency Classes	3. Provides the basis for actions to cope with an emergency.
d. Emergency Procedure	4. Grouped by severity level for which predetermined emergency measures should be taken or considered.

Answer: B.20 a. = 3 b.=1 c. = 4 d. =2
REF: Emergency Plan 2.0

END OF SECTION B

QUESTION C.001 [1.0 point]

Which ONE of the following correctly describes the Pool Level Alarm? When the pool level falls _____ inches below the normal operating level, it will initiate a signal alarm at_____.

a. 4, a monitored remote location ONLY

b. 8, the reactor control console ONLY

c. 4, the reactor control console and at a monitored remote location

d. 8, the reactor control console and at a monitored remote location

Answer: C.01 d.
REF: TS 3.2.4

QUESTION C.002 [1.0 points, 0.125 each]

Match the inputs listed in column A with their responses listed in column B. (Items in column B may be used more than once or not at all). Assume the reactor is in operation.

Column A	Column B
a. Log Power = 125 % full power	1. Indicate only
b. H.V. failure in Safety Channel #2	2. Interlocks
c. Pool water conductivity = 1 micomho/cm	3. Reactor automatically scrams
d. Withdrawal of blade #1 while in the Pulse mode	
e. Seismic Switch relay actuates	
f. Low pulse air pressure	
g. Pool water temperature = 40 °C	
h. Preset timer = 10 sec	

Answer: C.02 a. = 3; b. = 3; c. = 1; d. = 2; e. = 3; f. = 1, g. = 1; h. = 3
REF: TS table 3.2 and SAR 7.4

QUESTION C.003 [1.0 point]

Which of the following is a correct statement regarding a function of the Wide-range safety channel?

a. Provides a scram signal in the event of the loss of voltage to the power range channels

b. Prevents withdrawal of standard control and regulation elements in pulse mode

c. Provides a scram signal in the event reactor period (as read by the Reactor Operator) is 2 seconds

d. Prevents pulsing the transient rod if the current reactor power (as read by the Reactor Operator) is 5 kW

Answer: C.03 d.
REF: WSU SAR. June 2002, Section 7.4

QUESTION C.004 [1.0 point]

Complete the following statement. "The normal means of de-ionized make-up water is added via a _____ located at (in) _____."

a. Solenoid valve, Room 201-C

b. Manual operated valve, Room 101-A

c. Fire hose, reactor pool deck

d. Solenoid valve, the recirculating pump suction

Answer: C.04 d.
REF: WSU SAR. June 2002, Section 5.5

QUESTION C.005 [1.0 point]

You have just completed a power calibration and are comparing the actual and indicated power levels for the uncompensated ion detector. At what difference in reading (i.e., the margin of error) between the indicated and actual is acceptable where **no adjustment** is required?

a. 2%

b. 3%

c. 5%

d. 10%

Answer: C.05 a.
REF: SOP 20 "Standard Procedure for Performing Reactor Power Calibrations"

QUESTION C.006 [1.0 point]
Which of the following control elements at the WSU NRC is considered non-scrammable?

a. Safety Blade #1

b. Safety Blade #2

c. Transient Rod

d. Regulating (control) Rod.

Answer: C.06 d.
REF: WSU SAR. June 2002, Section 4.2.2

QUESTION C.007 [1.0 point]
The Pulse Channel consists of:

a. Fission Chamber, Pre-AMP, and Safety #1 Monitor

b. Fission Chamber, Pre-AMP, and Wide Range Linear Monitor

c. Compensated Ion Chamber detector and a NMP 1000 channel

d. Uncompensated Ion Chamber detector and a NPP 1000 channel

Answer: C.07 d.
REF: SAR Figure 7-6

QUESTION C.008 [1.0 point]
Which ONE of the following is the correct source to be used for the calibration of the Ar-41 monitor?

a. P-10

b. C-14

c. Cl-36

d. Sr-90

Answer: C.08 a.
REF: SOP # 7, MAINTENANCE OF THE EXHAUST GAS MONITOR - Section B.4

QUESTION C.009 [1.0 point]
The _____ detector for the WSU TRIGA contains a very thin layer of U-235 which provides an input signal to the_____.

a. Compensated Ion Chamber, Linear Power Channel

b. Ion Chamber, Safety Channel 1

c. Uncompensated Ion Chamber, Safety Channel 2

d. Fission Chamber, Log Power Channel

Answer: C.09 d.
REF: WSU SAR. June 2002, Section 7.3.1, Figure 7-4

QUESTION C.010 [1.0 point]
You are the reactor operator with the reactor operating steady state full power. Which of the following would best describe the reactor system/ facility response if the boron neutron capture facility's treatment room access door were inadvertently opened?

a. A reactor scram will occur and the core bridge will move to the retracted position.

b. The building evacuation alarm will sound, the reactor will scram and the ventilation system will line up for emergency exhaust.

c. A BNC lockdown will occur, initiating a control blade withdrawal inhibit and the core bridge will move to the retracted position.

d. An alarm displaying the status of the BNCF treatment room access door illuminates and sounds on the control panel, prompting you to manually scram the reactor

Answer: C.10 a.
REF: WSU SAR. June 2002, Appendix 16A

QUESTION C.011 [1.0 point]
Identify which of the following would be a correct, expected response if radiation levels at the reactor bridge exceed the preset high radiation level?

a. There will be a control blade inhibit signal will occur, preventing the outward travel of control blades.

b. The ARIES system will automatically lineup the electrical distribution to power selected system components.

c. The diffuser pump will start automatically.
d. The cooling tower will secure automatically.

Answer: C.11 d.
REF: NRC Exam OL-12-01; WSU SAR. 6/2002, Page 5-10, & Sections 7.3.1, 13.1.2

QUESTION C.012 [1.0 point]

Per WSU Technical Specifications, which ONE of the following can cause a control rod interlock when the PULSE mode is selected?

a. Standard rod drive DOWN and control rod DOWN.

b. Power level at 2 kW and Pneumatic cylinder UP.

c. Preset timer sets at 10 sec and Pneumatic cylinder UP.

d. Pneumatic cylinder DOWN and Transient rod DOWN.

Answer: C.12 b.
REF: TS Table 3.3

QUESTION C.013 [1.0 point]

During a reactor operation, you discover the Continuous Air Monitor (CAM) pump failure. Other monitors are operating. Which ONE of the following is the best action?

a. Continue to operate because the pump failure does NOT affect the operations of the CAM

b. Continue to operate because the Area Radiation and Exhaust Gas Radiation Monitors are still working

c. Shutdown the reactor; immediately report the result to the supervisor because the CAM is inoperable due to a pump failure; and the CAM failure considers a Tech Spec violation

d Shutdown the reactor, immediately report the result to the U.S. NRC because it is a reportable occurrence

Answer: C.13 c.
REF: TS 3.5.1 , maintenance not being performed.

QUESTION C.014 [1.0 point]

Complete the following statement. “With the reactor at power in accordance with SOP #4 if pool water becomes greater than ____, the reactor operator shall rundown the reactor?”

a. 10° C

b. 25° C

c. 50° C

d. 70° C.

Answer: C.14 c.
REF: SOP #2 Standard Procedure for Startup, Operation, and Shutdown of the Reactor

QUESTION C.015 [1.0 point]

The reactor is shutdown and you are assisting the SRO with the control rod drive removal for inspection and subsequent replacement? During this operation, how much (i.e., reactivity) must the reactor be kept subcritical, without xenon, and assuming that any experiment in the reactor may be removed?

a. $2.00

b. $5.00

c $6.00

d. $8.00

Answer: C.15 b.
REF: SOP # 11 Standard Procedure for Maintenance of the Control Elements

QUESTION C.016 [1.0 point]

The main mode of heat transfer for the reactor fuel is from the _____?

a. Forced cooling of the primary pump

b. Secondary water system

c. Natural circulation of the pool

d. Make up water added to the pool

Answer: C.16 c.
REF: WSU SAR.

QUESTION C.017 [1.0 point]

During reactor operation, a leak develops in the SECONDARY to PRIMARY heat exchanger. Which ONE of the following conditions correctly indicates a leak in the heat exchanger?

a. Pool water conductivity will increase and Pool water level will increase

b. Pool water conductivity will decrease and Pool water level will decrease

c. Pool water conductivity will increase and Pool water level will decrease

d. Pool water conductivity will decrease and Pool water level will increase

Answer: C.17 a.
REF: SAR Section 5.3

QUESTION C.018 [1.0 point]

Which ONE of the following best describes on how the Uncompensated Ion Chamber (UIC) and Compensated Ion Chamber (CIC) operate?

a. The CIC has two chambers, both can sense gamma rays but only one is coated with boron-10 for (n,α) reaction; whereas the UIC has only one chamber coated with boron-10 for (n,α) reaction.

b. The CIC has two chambers, one is coated with U-235 for fission reaction and the other is coated with boron-10 for (n,α) reaction; whereas the UIC has only one chamber coated with U-235 for fission reaction.

c. The CIC has only one chamber coated with boron-10 for (n,α) reaction; whereas the UIC has two chambers, one is coated with U-235 for fission reaction and the other is coated with boron-10 for (n,α) reaction.

d. The CIC has only one chamber coated with U-235 for fission reaction, whereas the UIC has two chambers, both can sense gamma rays but only one is coated with boron-10 for (n,α) reaction.

Answer: C.18 a.
REF: Training Manual, Section 5.1

QUESTION C.019 [1.0 point]

If a rupture occurred in the pool water outlet pipe, what would prevent all the water from draining out of the pool?

a. A check valve at the outlet to the primary pump

b. Water from the primary make-up water system

c. A siphon break

d. The minimal elevation difference between the pipe and top of the pool

Answer: C.19 c.
REF: WSU SAR. Section 5.3

QUESTION C.020 [1.0 point]

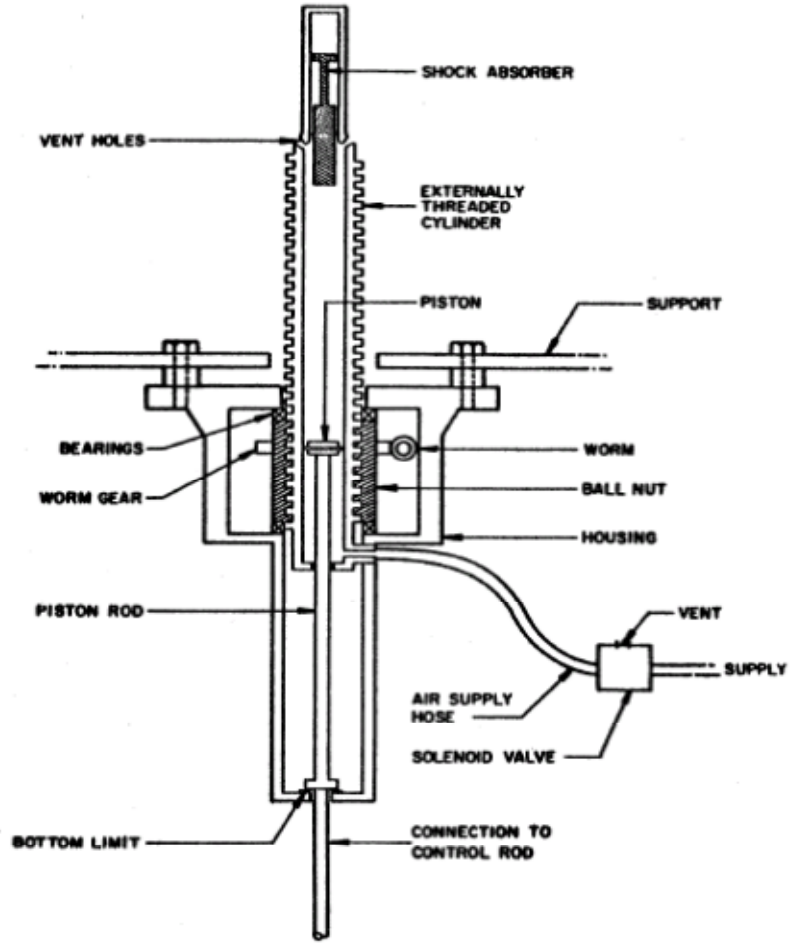
Using the associated diagram, which of the following answers best describes a correct functional process of the transient rod drive mechanism and its associated components?

a. Once the transient rod has been pulsed, the three-way solenoid valve is de-energized and the rod is driven to the bottom limit by the worm gear motor and worm assembly.

b. If power is de-energized to the three-way solenoid valve, the air supply valve shuts and the pressure in the cylinder relieves through vent holes at the top of the cylinder.

c. The ball-nut assembly is rotated by a worm gear driven motor thereby raising or lowering the cylinder independently of the piston and control rod.

d. The indicator for the down position of the transient rod is actuated when the small bar attached to the bottom of the air cylinder comes in contact with the down limit switch.



Answer: C.20 c.
REF: WSU SAR. June 2002, Section 4.2.2; Figure 4-17

END OF SECTION C

END OF WRITTEN EXAMINATION