UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

May 8, 2025

Jerry Newhouse, Director
Reed College
Reed Research Reactor
3203 Southeast Woodstock Boulevard
Portland, OR 97202-8199

SUBJECT: EXAMINATION REPORT NO. 50-288/OL-25-02, REED COLLEGE

Dear Jerry Newhouse:

During the weeks of March 24, 2025, and March 31, 2025, the U.S. Nuclear Regulatory Commission (NRC) administered an operator licensing examination at your Reed College research reactor. The examination was conducted according to NUREG-1478, "Operator Licensing Examiner Standards for Research and Test Reactors," Revision 2. Examination questions and preliminary findings were discussed with those members of your staff identified in the enclosed report at the conclusion of the examination.

In accordance with Title 10 of the *Code of Federal Regulations,* Section 2.390, a copy of this letter and the enclosures will be available electronically for public inspection in the NRC Public Document Room or from the Publicly Available Records component of NRC's Agencywide Documents Access and Management System (ADAMS). ADAMS is accessible from the NRC website at http://www.nrc.gov/reading-rm/adams.html. The NRC is forwarding the individual grades to you in a separate letter which will not be released publicly. Should you have any questions concerning this examination, please contact Amy Beasten at (301) 415-8341 or via email at Amy.Beasten@nrc.gov.

Sincerely,

Signed by Brown, Tony
on 05/08/25

Tony Brown, Chief
Non-Power Production and Utilization Facility
Oversight Branch
Division of Advanced Reactors and Non-Power
Production and Utilization Facilities
Office of Nuclear Reactor Regulation

Docket No. 50-288

Enclosures:
1. Examination Report No. 50-288/OL-25-02
2. Written examination

cc: w/enclosures to GovDelivery Subscribers

SUBJECT: EXAMINATION REPORT NO. 50-288/OL-25-02, REED COLLEGE DATED: MAY 8, 2025

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

REPORT NO.: 50-288/25-02

FACILITY DOCKET NO.: 50-288

FACILITY LICENSE NO.: R-112

FACILITY: Reed Research Reactor (RRR)

EXAMINATION DATES: Weeks of March 24, 2025 and March 31, 2025

SUBMITTED BY: 
Name, Chief Examiner 4/17/2025
Date

SUMMARY:
During the weeks of March 24 and March 31, 2025, the NRC administered operator licensing examinations to 13 Reactor Operator (RO) candidates. One RO failed Category A of the written exam but passed the operating test; one RO failed Category B of the written exam but passed the operating test; one RO failed Category C of the written exam but passed the operating test; one RO failed Category A and B of the written examination but passed the operating test; and three ROs failed the written examinations overall but passed the operating tests. All remaining RO candidates passed all applicable portions of the examinations and tests.

REPORT DETAILS

1. Examiners: Amy Beasten, PhD, Chief Examiner, NRC
Michele DeSouza, Chief Examiner, NRC
Maggie Goodwin, Reactor Engineer, NRC

2. Results:

	RO PASS/FAIL	SRO PASS/FAIL	TOTAL PASS/FAIL
Written	6/7	0/0	6/7
Operating Tests	13/0	0/0	13/0
Overall	6/7	0/0	6/7

3. Exit Meeting:
Amy Beasten, PhD, Chief Examiner, NRC
Michele DeSouza, Chief Examiner, NRC
Maggie Goodwin, Reactor Engineer, NRC
Jerry Newhouse, Facility Director, Reed Research Reactor

Prior to administration of the written examination, based on facility comments, adjustments were accepted. Comments provided corrections and additional clarity to questions/answers and identified where changes were appropriate based on current facility conditions.

Upon completion of all operator licensing examinations, the NRC examiner met with facility staff representatives to discuss the results. At the conclusion of the meeting, the NRC examiner thanked the facility for their support in the administration of the examination.

U.S.NRC

UNITED STATES NUCLEAR REGULATORY COMMISSION

Protecting People and the Environment

Reed Research Reactor

Operator Licensing Examination

Week of March 24, 2025

Enclosure 2

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

FACILITY: Reed Research Reactor

REACTOR TYPE: TRIGA

DATE ADMINISTERED:

CANDIDATE: _____

INSTRUCTIONS TO CANDIDATE:
Answers are to be written on the Answer sheet provided. Attach all Answer sheets to the examination. Point values are indicated in parentheses for each question. A 70% in each category and a 70% overall are required to pass the examination. Examinations will be picked up three (3) hours after the examination starts.

CATEGORY VALUE	% OF TOTAL	CANDIDATE'S SCORE	% OF CATEGORY VALUE	CATEGORY
20.00	33.0	_____	_____	A. REACTOR THEORY, THERMODYNAMICS, AND FACILITY OPERATING CHARACTERISTICS
20.00	33.0	_____	_____	B. NORMAL AND EMERGENCY OPERATING PROCEDURES AND RADIOLOGICAL CONTROLS
20.00	33.0	_____	_____	C. FACILITY AND RADIATION MONITORING SYSTEMS
60.00		_____	_____%	TOTALS
		FINAL GRADE		

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 and a 70 percent or greater overall.

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

Category A: Reactor Theory, Thermodynamics, and Facility Operating Characteristics

A N S W E R S H E E T

Multiple Choice (Circle or X your choice)
If you change your answer, write your selection in the blank.

A01 a b c d ___

A02 a ___ b ___ c ___ d ___

A03 a b c d ___

A04 a b c d ___

A05 a b c d ___

A06 a b c d ___

A07 a b c d ___

A08 a b c d ___

A09 a b c d ___

A10 a b c d ___

A11 a b c d ___

A12 a b c d ___

A13 a b c d ___

A14 a b c d ___

A15 a b c d ___

A16 a b c d ___

A17 a b c d ___

A18 a b c d ___

A19 a b c d ___

A20 a b c d ___

(***** END OF CATEGORY A *****)

Category B: Normal/Emergency Operating Procedures and Radiological Controls

A N S W E R S H E E T

Multiple Choice (Circle or X your choice)
If you change your answer, write your selection in the blank.

B01 a b c d ___

B02 a b c d ___

B03 a b c d ___

B04 a b c d ___

B05 a b c d ___

B06 a b c d ___

B07 a b c d ___

B08 a b c d ___

B09 a b c d ___

B10 a b c d ___

B11 a b c d ___

B12 a b c d ___

B13 a b c d ___

B14 a b c d ___

B15 a b c d ___

B16 a b c d ___

B17 a _____ b _____ c _____ d _____

B18 a b c d ___

B19 a b c d ___

B20 a b c d ___

(***** END OF CATEGORY B *****)

Category C: Facility and Radiation Monitoring Systems

A N S W E R S H E E T

Multiple Choice (Circle or X your choice)
If you change your answer, write your selection in the blank.

C01 a b c d ___

C02 a b c d ___

C03 a b c d ___

C04 a b c d ___

C05 a b c d ___

C06 a b c d ___

C07 a b c d ___

C08 a b c d ___

C09 a b c d ___

C10 a b c d ___

C11 a b c d ___

C12 a b c d ___

C13 a b c d ___

C14 a b c d ___

C15 a b c d ___

C16 a b c d ___

C17 a b c d ___

C18 a b c d ___

C19 a b c d ___

C20 a b c d ___

(***** END OF CATEGORY C *****)
(********** END OF EXAMINATION **********)

Category C: Facility and Radiation Monitoring Systems

EQUATION SHEET

$$Q = \dot{m} c_P \Delta T = \dot{m} \Delta H = UA\Delta T$$

$$P = P_0 \, e^{t/T}$$

$$SUR = 26.06\left[\frac{\lambda_{eff}\rho + \beta}{\beta - \rho}\right]$$

$$P = \frac{\beta(1-\rho)}{\beta - \rho} P_0$$

$$M = \frac{1 - K_{eff_1}}{1 - K_{eff\,2}}$$

$$T = \frac{\ell^*}{\rho} + \left[\frac{\beta - \rho}{\lambda_{eff}\rho}\right]$$

$$\rho = \frac{K_{eff} - 1}{K_{eff}}$$

$$DR = \frac{6\,Ci\,E(n)}{R^2}$$

$$P_{\max} = \frac{(\beta - \rho)^2}{(2\alpha\beta)}$$

$$SCR = \frac{S}{-\rho} \cong \frac{S}{1 - K_{eff}}$$

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

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

$$SDM = \frac{1 - K_{eff}}{K_{eff}}$$

$$T_{\frac{1}{2}} = \frac{0.693}{\lambda}$$

$$DR = DR_0 \, e^{-\lambda t}$$

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

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

$$\ell^* = 1 \times 10^{-4} \sec$$

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

$$P = P_0 \, 10^{SUR(t)}$$

$$T = \frac{\ell^*}{\rho - \beta}$$

$$\Delta\rho = \frac{K_{eff_2} - K_{eff_1}}{K_{eff_1} K_{eff_2}}$$

$$DR_1 d_1^{\,2} = DR_2 d_2^{\,2}$$

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

1 Curie = 3.7 x 10^{10} dis/sec

1 Horsepower = 2.54 x 10^3 BTU/hr

1 BTU = 778 ft-lb

1 gal (H_2O) ≈ 8 lb

c_P = 1.0 BTU/hr/lb/°F

1 kg = 2.21 lb

1 Mw = 3.41 x 10^6 BTU/hr

°F = 9/5 °C + 32

°C = 5/9 (°F - 32)

c_p = 1 cal/sec/gm/°C

Category A: Reactor Theory, Thermodynamics, and Facility Operating Characteristics

QUESTION A.01 [1.0 point]
Which ONE of the following factors in the Six Factor Formula is NOT impacted by lowering TRIGA U-235 fuel enrichment?

a. Fast Fission Factor

b. Thermal Utilization Factor

c. Thermal Non-Leakage Probability

d. Resonance Escape Probability

QUESTION A.02 [1.0 point, 0.25 each]
Match the neutron interaction type in Column A with the neutron action/result in Column B. Answers in Column B may be used once, more than once, or not at all.

Column A	Column B
a. Inelastic Scattering	1. Neutron Producing
b. Fission	2. Neutron Absorbing
c. Radiative Capture	3. No change in number of neutrons
d. Charged-Particle Reactions	

QUESTION A.03 [1.0 point]
The process through which heat is transferred from the fuel to a fluid moving over it due to differences in temperature is known as _____.

a. Circulation

b. Conduction

c. Radiation

d. Convection

QUESTION A.04 [1.0 point]
If k_{eff} is 1.0065 and $\beta_{eff} = \rho = 0.0065$, what is the status of the reactor?

a. The reactor is supercritical on delayed and prompt neutrons.

b. The reactor is critical on prompt neutrons alone.

c. The reactor is subcritical but approaching criticality.

d. The reactor is critical on delayed and prompt neutrons.

QUESTION A.05 [1.0 point]
During the initial rise to power, the nuclear instruments show that when K_{eff} is 0.85, the count rate is 1280 cps. Once reactivity has been added, what count rate would correspond with a K_{eff} of 0.95?

a. 2270 cps

b. 3310 cps

c. 3840 cps

d. 4530 cps

QUESTION A.06 [1.0 point]
During normal day to day operations at a research and test reactor, which ONE of the following isotopes would not directly or indirectly contribute to a decrease in core excess reactivity?

a. Krypton-84

b. Xenon-135

c. Samarium-149

d. Iodine-135

QUESTION A.07 [1.0 point]
Why are uncompensated ion chambers ineffective at monitoring reactor at power levels below the 10 kW range?

a. The voltage applied to the detector is too small to register a signal until the neutron population in the core reaches the 10 kW range.

b. The detector is far enough away from the core that the neutron population must be large enough to be detected in the sensitive region.

c. The gamma and neutron signals are close enough in magnitude to result in an inaccurate neutron population readout.

d. The neutron signal below 10 kW is predominantly from residual decay heat which is too low energy to register on the detector.

QUESTION A.08 [1.0 point]
Which ONE of the following is a characteristic of an effective core reflector?

a. A low resistance to radiation damage.

b. A low thermal conductivity.

c. A high scattering to absorption cross section ratio.

d. A small crystal expansion structure.

QUESTION A.09 [1.0 point]
Which ONE of the following is NOT a possible effect of control rod shadowing?

a. Decrease in bulk pool water temperature.

b. Increase in time needed for in-core irradiation of a fixed experiment.

c. Decrease in indicated reactor power.

d. Increase in fuel temperature.

QUESTION A.10 [1.0 point]
The instantaneous energy released from fission is equal to _____.

a. the difference in thermal energy of the incident nucleus and the neutron.

b. the difference in binding energy between the initial neutron and U-235 atom and the fission products.

c. the average energy of all prompt neutrons generated per fission.

d. the mass of released neutrons multiplied by the speed of light.

QUESTION A.11 [1.0 point]
The rate at which power decreases after a scram is limited by _____:

a. the presence of a graphite reflector.

b. the peak fuel temperature.

c. the time spent at power above the point of adding heat.

d. the fission product decay of the longest-lived delayed neutron precursor.

Category A: Reactor Theory, Thermodynamics, and Facility Operating Characteristics

QUESTION A.12 [1.0 point]
Assuming a β of 0.07, how much reactivity is required to increase K_{eff} from 0.85 to 1.12?

a. $0.28

b. $2.14

c. $4.05

d. $5.38

QUESTION A.13 [1.0 point]
Which ONE of the following best describes the relationship between the macroscopic cross section and mean free path of a neutron in the core?

a. The macroscopic cross section is energy dependent and therefore has no impact on probability of interaction.

b. The greater the macroscopic cross section, the greater the distance the neutron must travels before interaction can occur.

c. The greater the macroscopic cross section, the shorter the distance the neutron travels before interaction occurs.

d. The smaller the macroscopic cross section, the smaller the distance the neutron travels before interaction occurs.

QUESTION A.14 [1.0 point]
Which ONE of the following statements best describes the reason boron is commonly used in control rods?

a. The Lithium-Alpha reaction with neutrons is used to generate charged particles that lower the neutron population in the core.

b. The high absorption to scattering cross section ratio ensures neutrons are removed from the core thus lowering reactivity.

c. The relatively low dose rate when irradiated means that they can be easily removed from the core for inspection and maintenance.

d. The relatively high melting point compared to cadmium that ensures the control rods will maintain their structural integrity in the event of a meltdown.

QUESTION A.15 [1.0 point]
Which ONE of the following statements best describes Internal Conversion?

a. An orbital election is absorbed by the nucleus, converts a proton into a neutron and a neutrino, and leaves the nucleus in an excited state.

b. The excitation energy of a nucleus is used to eject an orbital election.

c. A neutron is ejected from the nucleus of a metastable isotope.

d. A neutron in the nucleus changes to a proton, emitting an electron.

QUESTION A.16 [1.0 point]
Which ONE of the following statements best describes the relationship between the flux and fuel temperature profiles in the core?

a. Fuel temperature and core flux are both greatest in the center of the core.

b. Fuel temperature and neutron flux are both greatest at the top of the active fuel region, regardless of location within the core.

c. Fuel temperature is greatest at the center of the core, but neutron flux is greatest at the periphery of the core away from the control rods.

d. Fuel temperature and neutron flux are uniform throughout the core, except in the vicinity of the control rods, where both decrease.

QUESTION A.17 [1.0 point]
Which ONE of the following nuclear reactions is NOT an example of an exothermic reaction?

a. The fission of Uranium-235.

b. An elastic scattering collision between a neutron and oxygen atom.

c. The inelastic scattering of a neutron and a water molecule. s

d. The neutron activation and decay of Nitrogen-16.

QUESTION A.18 [1.0 point]
If the Startup Rate (SUR)of a reactor is 2.6 decades per minute, how long will it take for reactor power to increase from 1.8 kW to 225 kW? Note: Startup Rate is defined as the number of decades reactor power increases in one minute where a decade is a power increase by a factor of 10.

a. 0.8 minutes

b. 2.2 minutes

c. 3.9 minutes

d. 5.7 minutes

QUESTION A.19 [1.0 point]
Which ONE of the following statements BEST describes the Liquid-Drop Model of a nucleus?

a. The density of a nucleus remains constant regardless of atomic number, much like a drop of water has a constant density regardless of how large it gets.

b. The size on an atom's nucleus compared to the size of the whole atom is similar to the size of a drop of water compared to an ocean.

c. The energy required to displace all the subatomic particles is similar to the energy required to disperse all the water molecules in a drop of water.

d. The travel path of an atom in a reactor when traced, matches the flow of a single drop of water.

QUESTION A.20 [1.0 point]
When describing the forces incident on a ground state nucleus, the attractive _____ forces are greater than the repulsive _____ forces.

a. magnetic; nuclear

b. nuclear; electrostatic

c. kinetic; potential

d. binding; separating

(***** END OF CATEGORY A *****)

Category B: Normal/Emergency Operating Procedures and Radiological Controls

QUESTION B.01 [1.0 point]
Which ONE of the following scenarios does NOT have an emergency classification?

a. A loss of electrical power caused by an intruder.

b. A fire within the facility extinguished after 30 minutes.

c. A sudden abnormal increase in the reactor pool water level.

d. A primary pipe break in the reactor room with Continuous Air Monitor alarm at 8.8 E-4 µCi/ml.

QUESTION B.02 [1.0 point]
In accordance with the Reed Radioactive Materials Policy, which ONE of the following people CANNOT be an Authorized User of radioactive material?

a. An incoming student who is about to turn 18.

b. A visiting researcher with no prior experience handling radioactive material.

c. Reed College students participating in a Physics lab class that utilizes the reactor.

d. A former Reactor Operator from Reed who is visiting to conduct an experiment.

QUESTION B.03 [1.0 point]
Which ONE of the following individuals may approve restarting the reactor after an Unexplained Scram?

a. Operator of Record

b. Senior Reactor Operator of Record

c. Reactor Operations Committee

d. Reactor Operations Manager

QUESTION B.04 [1.0 point]
The slow and fast alarms on the Continuous Air Monitor come from the average radionuclide concentration over _____ and _____, respectively.

a. 30 minutes; 1 minute

b. 45 minutes; 5 minutes

c. 60 minutes; 5 minutes

d. 120 minutes; 15 minutes

Category B: Normal/Emergency Operating Procedures and Radiological Controls

QUESTION B.05 [1.0 point]
Which ONE of the following events would require an immediate scram?

a. Loss of building ventilation.

b. Loss of Regulating Rod Cont/ON light on console with no other loss of indication.

c. Discovery that Core Excess is greater than $3.00.

d. Civil Unrest on Campus approximately 500 feet from the reactor.

QUESTION B.06 [1.0 point]
In accordance with Technical Specifications, the absolute value of the reactivity worth of any single UNSECURED experiment shall be less than _____ to prevent _____.

a. $1.00; damage to reactor components resulting from failure of an experiment.

b. $1.00; an inadvertent prompt criticality from occurring.

c. $2.00; damage to reactor components resulting from failure of an experiment.

d. $2.00; an inadvertent prompt criticality from occurring.

QUESTION B.07 [1.0 point]
When calculating Core Excess at 5 W, it is discovered that core excess is $0.30 greater than the previous day. You take all of the following steps EXCEPT:

a. Scram the reactor.

b. Check pool temperature to verify primary coolant is functioning.

c. Check range and percent power to verify correct steady-state power level.

d. Compare control rod heights recorded on the stamp to current control rod heights.

QUESTION B.08 [1.0 point]
A radiation worker is conducting work in the reactor bay and inadvertently drops a sample releasing Plutonium-239 into the air. They breathe in the equivalent of an internal dose of 100 rem. If the weighting factor of bone is 0.01, which ONE of the following statements is TRUE?

a. They violated both Organ Dose and TEDE limits.

b. They did not violate either Organ Dose or TEDE dose limits.

c. They violated their Organ Dose limit but not their TEDE limit.

d. They violated their TEDE limit but not their Organ Dose limit.

Category B: Normal/Emergency Operating Procedures and Radiological Controls

QUESTION B.09 [1.0 point]
Which ONE of the following scenarios would NOT be required to undergo the 10 CFR 50.59 process?

a. Amending the fuel inspection procedure to remove spelling mistakes.

b. Running an experiment in the central thimble that required it to be filled with gaseous nitrogen.

c. Amending the Technical Specifications to change a quarterly surveillance to a monthly surveillance.

d. Adding a step to the control rod reactivity worth measurement procedure to allow the operator to try a new method for determining reactivity worths.

QUESTION B.10 [1.0 point]
In accordance with Standard Operating Procedure 33, "Nuclear Instrumentation," all of the following events could potentially result in incorrect data collection during a power calibration EXCEPT:

a. Running the Rotating Rack (Lazy Susan) with no samples.

b. Running the primary and secondary cooling system.

c. Adding water to the tank then immediately turning off the primary pump.

d. Starting the calibration with pool temperatures at 35° C.

QUESTION B.11 [1.0 point]
All of the following conditions would require the use of Standard Operating Procedure 21, "Same Day Startup Checklist," EXCEPT:

a. Restarting the reactor after adding water to the tank.

b. Restarting the reactor following a campus wide electrical outage.

c. Restarting the reactor to perform rod drop measurements after maintenance on the control rod drives.

d. Restarting the reactor after restoring power to nuclear instrumentation following a loss of high voltage scram.

Category B: Normal/Emergency Operating Procedures and Radiological Controls

QUESTION B.12 [1.0 point]
In accordance with 10 CFR 20, which ONE of the following scenarios would NOT be allowed?

a. Personnel working in an area where the radiation dose exceeds 5 mrem per hour.

b. Allowing a visiting researcher to receive a radiation dose of 50 mrem over a 6-month period.

c. A 17-year-old Reactor Operator trainee received a dose of 400 mrem in the 9 months before turning 18.

d. Giving an hour-long tour to a State Senator in an area where the dose received in an hour is greater than 5 mrem.

QUESTION B.13 [1.0 point]
Which ONE of the following actions would NOT be considered in keeping with As Low as Reasonably Achievable (ALARA)?

a. Leaving samples in the Lazy Susan until they need to be removed either according to the irradiation request or due to other experiments needing the facility.

b. Setting a radioactive source down in a secure location to answer questions before continuing to move the source.

c. Investigating why someone received a dose in excess of 10mrem in a single exposure.

d. Using tongs to move radioactive material in a fume hood.

QUESTION B.14 [1.0 point]
In accordance with Emergency Implementation procedure C, in the event that an operator finds an unmarked package in the facility which ONE of the following actions is NOT required?

a. Call 6666 to report the package.

b. Take the Daily Clipboard, Main Logbook, and Visitor Log when exiting the facility.

c. Take a photo of the package to show any security or law enforcement staff.

d. Evacuate the facility and check labs and bathrooms to ensure all individuals have left.

Category B: Normal/Emergency Operating Procedures and Radiological Controls

QUESTION B.15 [1.0 point]
While surveying one of the reactor bay experimental workbenches, you discover a pair of tongs in an area where the background radiation is 150 cpm. In accordance with SOP 50, "Health Physics", what would the radiation on the tongs have to be in order for them to be considered contaminated?

a. 250 cpm

b. 300 cpm

c. 350 cpm

d. The tongs are contaminated regardless of background radiation levels.

QUESTION B.16 [1.0 point]
In accordance with Technical Specifications, which ONE of the following experiments would NOT be allowed in the reactor core?

a. An unsecured experiment utilizing 10 mg of gunpowder.

b. A secured experiment worth -$1.50.

c. An experiment using 5 mg of TNT in a container rated to a detonation pressure of up to 8 mg.

d. A secured doubly encapsulated experiment containing hydrochloric acid.

QUESTION B. 17 [1.0 point]
For each of the following activities, categorize them as either a Channel Check, Test, or Calibration.

a. Sending a signal to the Percent Channel to mimic and initiate a high-power scram.

b. Moving the nuclear instrumentation to ensure the digital power readout matches the calculated power based on the change in temperature of the bulk water.

c. Measurement of the control rod drop times.

d. Looking at the Radiation Area Monitors to see if the readouts match previous dose rates at full power.

Category B: Normal/Emergency Operating Procedures and Radiological Controls

QUESTION B.18 [1.0 point]
In accordance with Standard Operating Procedure 41, “Area Monitors,” why is it necessary to take 10 readings and use the average when calibrating a Radiation Area Monitor?

a. To account for the fluctuations seen in radiation detection.

b. To allow for the detector to “warm up” and provide an accurate readout.

c. To factor in the dead-time associated with Energy Compensated Geiger-Mueller detectors.

d. To ensure that the radioactive source used has not decayed significantly.

QUESTION B.19 [1.0 point]
If an experiment housed in an aluminum capsule is emitting a dose rate of 80 mrem/hr at 30 cm, what is the minimum decay time required to no longer require a radiation area posting? Note: half-life of aluminum is 2.25 minutes.

a. 2.25 minutes

b. 9.00 minutes

c. 30.75 minutes

d. 60.00 minutes

QUESTION B.20 [1.0 point]
In accordance with Standard Operating Procedure 32, “Ventilation,” who is allowed to perform the work?

a. Maintenance Staff

b. Any individual assigned by the Operations Supervisor that is RAM Handling Certified

c. Only members of operations staff

d. Only the On Duty Supervisor

(***** END OF CATEGORY B *****)

Category C: Facility and Radiation Monitoring Systems

QUESTION C.01 [1.0 point]
Which ONE of the following scenarios would be considered a violation of the Technical Specifications?

a. Moving fuel with the ventilation in isolation mode to locate a damaged element.

b. Operating with a control rod that has visible deep gouges from constant contact with the guide tube.

c. Operating with the Reactor Top Radiation Area Monitor inoperable for two weeks before replacement.

d. Irradiating an experiment where if the encapsulation fails, the gases released would result in an uptake of 4 rem.

QUESTION C.02 [1.0 point]
When the Reactor Building Ventilation is placed in Isolation Mode, all of the following statements are true EXCEPT:

a. Differential reactor bay pressure will remain negative.

b. Airflow out of the reactor bay will decrease.

c. The fan in the control room will continue running.

d. All ventilation dampers will close.

QUESTION C.03 [1.0 point]
Where in the core would an experiment be placed if it required irradiation in the greatest possible flux?

a. Pneumatic Specimen Tube

b. Rotating Rack

c. Central Thimble

d. Pool Floor

Category C: Facility and Radiation Monitoring Systems

QUESTION C.04 [1.0 point]
Which ONE of the following is utilized to limit the maximum power level of the reactor?

a. The amount of fuel loaded into the core.

b. The use of graphite dummy elements in the core.

c. The minimum number of control rods required for operation.

d. Limits placed on the maximum allowable pool water temperature.

QUESTION C.05 [1.0 point]
Which ONE of the following would NOT indicate that the resin in the demineralizer has been depleted?

a. The difference between the inlet and outlet conductivity is decreasing.

b. The temperature of the water in the demineralizer increases.

c. The radiation dose rate near the resin is increasing.

d. The flow rate through the demineralizer is decreasing.

QUESTION C.06 [1.0 point]
In accordance with the Reed Safety Analysis Report, which ONE of the following statements is INCORRECT with regards to the automatic rod control?

a. It can vary the speed at which the rod moves based on the reactor period and proximity to demand power.

b. It disables manual control and uses a servo to keep the percentage of the current decade within 2% of the demand.

c. If the motor down or up limit switches are actuated, the rod will no longer move automatically.

d. The automatic control rod cannot be moved up or down by the operator.

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QUESTION C.07 [1.0 point]
Which ONE of the following characteristics of the Reed Research Reactor is NOT an administrative control used to prevent the fuel from exceeding the Safety Limit?

a. Having a core excess of less than $3.00.

b. Limiting the amount of fuel used in the core loading.

c. The negative temperature coefficient of the fuel.

d. Setting the maximum steady-state power level to 250 kW.

QUESTION C.08 [1.0 point]
Which ONE of the following would indicate that the reactor has NOT responded properly to a manual scram?

a. Bulk water temperature in the tank starts to decrease while the primary and secondary cooling system are running.

b. Cont/On Console lights are illuminated for all control rods.

c. Control Rod Position Indication is decreasing.

d. Radiation Area Monitors above the reactor show a decrease in radiation dose.

QUESTION C.09 [1.0 point]
Which ONE of the following characteristics of the control rod system allows for the rapid insertion of control rods in the event of a scram?

a. The use of borated graphite to absorb neutrons.

b. The use of holes bored into the control rod guide tube to allow for the displacement of water.

c. The use of rack and pinion drives instead of worm gears to allow the control rod drive to move more quickly.

d. The use of electromagnets to attach the control rods to the drives instead of pressurized air.

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QUESTION C.10 [1.0 point]
An operator is moving fuel in the core as a part of the fuel inspection when they inadvertently drop an element on the bottom of the tank. Which ONE of the following would indicate that the element has been ruptured?

a. A decrease in the inlet water conductivity of the demineralizer.

b. An increase in the radiation dose rate above the reactor top.

c. A decrease then plateau in the reactor period indication.

d. An increase then decrease in the power level indicated by the log channel.

QUESTION C.11 [1.0 point]
Which ONE of the following would indicate a potential violation of the Safety Limit?

a. A bulging of the fuel element in B-3 that prevents the element from seating properly in the core.

b. Rust spotted on the fuel element in E-6 caused by aluminum filings in the core.

c. Uniform discoloration on all fuel elements.

d. Scratches spotted above the active fuel region on the fuel element in D-4.

QUESTION C.12 [1.0 point]
The slow and fast alarm concentration limits for the Continuous Air Monitors are based on _____:

a. the 10 CFR 20 DAC limit for Ar-41.

b. the 10 CFR 20 limit for Radiation Areas.

c. the 10 CFR 20 DAC limit for Cs-137.

d. the 10 CFR 20 limit for members of the public.

Category C: Facility and Radiation Monitoring Systems

QUESTION C.13 [1.0 point]
In accordance with the Reed Research Reactor Technical Specifications limit on maximum excess reactivity, which ONE of the following would make the core excess more negative and the shutdown margin less positive?

a. Adding experiments with a negative reactivity worth.

b. Increasing the average bulk water temperature by 5^{O}° C during full power operations.

c. Increasing the fuel loading in the core by adding 4 new fuel elements.

d. Decreasing the flow rate of the primary cooling system through the heat exchanger.

QUESTION C.14 [1.0 point]
While removing samples from the Rotating Rack (Lazy Susan), the sample retrieval device fails, and the sample is dropped on the reactor top. Which ONE of the following detectors would be used to verify that the area has been sufficiently decontaminated?

a. REM Ball

b. Ion Chamber

c. Thermoluminescent Device

d. Geiger-Mueller Detector

QUESTION C.15 [1.0 point]
Which ONE of the following detectors can be used to determine if contamination is from fission fragments?

a. Liquid Scintillator

b. Geiger-Mueller Detector

c. High Purity Germanium Detector (HPGe)

d. Fission Chamber

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QUESTION C.16 [1.0 point]
Which ONE of the following would indicate a buildup of sediment and debris in the secondary cooling system side of the heat exchanger?

a. A decrease in the conductivity of the water in the reactor pool.

b. An increase in the secondary cooling differential pressure.

c. A decrease in the flow rate of the primary cooling system.

d. A decrease in the secondary cooling water temperature.

QUESTION C.17 [1.0 point]
Which ONE of the following systems CANNOT be used to verify reactor shutdown in the event that facility power is lost?

a. Control Rod Positions to indicate that control rods have dropped.

b. Log Power Channel to verify power is decreasing.

c. Continuous Air Monitors to verify loss of Nitrogen-16 generation.

d. Percent Power Channel to verify power is decreasing.

QUESTION C.18 [1.0 point]
When not in use as a neutron beam, the Central Thimble is filled with water to _____:

a. prevent excessive generation of Ar-41.

b. maintain a temperature equilibrium within the reactor pool.

c. allow for aquatic experiments to be performed.

d. prevent inadvertent neutron flux shadowing.

QUESTION C.19 [1.0 point]
Corrosion on the fuel is mitigated by _____:

a. keeping the pool temperature below 40° C.

b. running the skimmer and demineralizing system.

c. maintaining a banked core when operating.

d. turning off the tank lights at night to prevent excessive heating.

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QUESTION C.20 [1.0 point]

Which ONE of the following helps to ensure that the Safety Limit is NOT violated?

a. Limiting the minimum pressure differential for the reactor building.

b. Limiting the conductivity of the reactor pool water.

c. Limiting the rate at which a control rod is inserted into the core.

d. Limiting the reactivity worth of a single experiment to $1.00.

(***** END OF CATEGORY C *****)
(********** END OF EXAMINATION **********)

Category A: Reactor Theory, Thermodynamics, and Facility Operating Characteristics

A.01
Answer: c
Reference: Lamarsh, *Introduction to Nuclear Engineering*, p. 249

A.02
Answer: a. 3; b. 1; c. 2; d. 2
Reference: Lamarsh, *Introduction to Nuclear Engineering*, p. 44-45

A.03
Answer: d
Reference: Lamarsh, *Introduction to Nuclear Engineering*, p. 353

A.04
Answer: b
Reference: Glasstone & Sesonske, *Nuclear Reactor Engineering*, p. 248

A.05
Answer: c
Reference: $CR_1*(1-K_{eff1}) = CR_2*(1-K_{eff2})$

$$CR2 = \frac{CR1 * (1 - k_{eff1})}{(1 - K_{eff2})}$$

$$CR2 = \frac{1278 * 0.15}{0.05}$$

$$CR_2 = 3840$$

A.06
Answer: a
Reference: Burn, *Introduction to Nuclear Reactor Operations*, p. 8-1

A.07
Answer: c
Reference: Reed Research Reactor Safety Analysis Report 7.2.3.3

A.08
Answer: c
Reference: DOE Fundamentals Handbook, Vol. 2, Module 4, p. 25

A.09
Answer: a
Reference: Burn, *Introduction to Nuclear Reactor Operations*, p. 7-12

A.10
Answer: b
Reference: DOE Fundamentals Handbook, Vol. 1, Module 1, p. 57-59

A.11
Answer: d
Reference: Burn, *Introduction to Nuclear Reactor Operations*, p. 4-13

A.12
Answer: c
Reference: $\Delta\rho = \frac{K_{eff2} - K_{eff1}}{K_{eff1} * K_{eff2}}$ and $\$ = \frac{\rho}{\beta}$

$$\Delta\rho\ (in\ \$) = (\frac{1.12 - 0.85}{0.85 * 1.12})/0.07$$
$$\Delta\rho = 4.05$$

A.13

Answer: c
Reference: Burn, *Introduction to Nuclear Reactor Operations*, p. 2-43

A.14
Answer: b
Reference: Lamarsh, *Introduction to Nuclear Engineering*, p. 119

A.15
Answer: b
Reference: Lamarsh, *Introduction to Nuclear Engineering*, pages 16, 44, & 45

A.16
Answer: a
Reference: Burn, *Introduction to Nuclear Reactor Operations*, p. 9-12

A.17
Answer: b
Reference: Duderstadt & Hamilton p. 16

A.18
Answer: a
Reference: $P = P_0 10^{SUR*t}$

$$\log\left(\frac{225}{1.8}\right) = SUR * t$$
$$t = \frac{\log\left(\frac{225}{1.8}\right)}{2.6}$$
$$t = 0.8065$$

A.19
Answer: a
Reference: Lamarsh, *Introduction to Nuclear Engineering*, p. 11

A.20
Answer: b
Reference: DOE Fundamentals Handbook, Vol. 1, Module 1, p. 49

(***** END OF CATEGORY A *****)

Category B: Normal/Emergency Operating Procedures and Radiological Controls

B.01
Answer: c
Reference: Reed Research Reactor Emergency Implementation Procedures

B.02
Answer: a
Reference: Reed College Radioactive Materials Policy and Procedure Manual 12.3

B.03
Answer: d
Reference: Reed Research Reactor SOP 2, "Scram or Dropped Rod"

B.04
Answer: a
Reference: Reed Research Reactor Training Lecture 7, "Radiation Detectors"

B.05
Answer: c
Reference: Reed Research Reactor Standard Operating Procedure 1 "Reactor Operation" Step 1.8.21

B.06
Answer: b
Reference: Reed Research Reactor Technical Specifications 3.6.1

B.07
Answer: b
Reference: Reed Research Reactor SOP 1, "Reactor Operation"

B.08
Answer: c
Reference: DDE = 0 CDE = 100 rem with a Tissue Weighting factor of 0.01
Organ Dose = DDE+CDE = 0+100 rem. 10 CFR 20 limit is 50 rem.
TEDE = DDE + CEDE = 0+(100*0.01) = 1 rem. 10 CFR 20 limit is 5 rem.

B.09
Answer: a
Reference: 10 CFR 50.59

B.10
Answer: a
Reference: Reed Research Reactor Standard Operating Procedure 33, "Nuclear Instrumentation"

B.11
Answer: a
Reference: Reed Research Reactor SOP 21, "Same Day Startup Checklist"

B.12
Answer: d
Reference: 10 CFR 20.1301 and 10 CFR 20.1207

Category B: Normal/Emergency Operating Procedures and Radiological Controls

B.13
Answer: c
Reference: Reed Research Reactor, "Radioactive Materials Policy and Procedure Manual," p. 34

B.14
Answer: c
Reference: Reed Research Reactor Emergency Implementation Procedures C

B.15
Answer: a
Reference: 100 cpm above background is contaminated.
250 cpm – 100 cpm = 150 cpm
Reed Research Reactor Training Lecture 5 "Health Physics 2"

B.16
Answer: c
Reference: Reed Research Reactor Technical Specifications 3.6.1 and T.S. 3.6.2

B.17
Answer: a. Test; b. Calibration; c. Test; d. Check
Reference: Reed Research Reactor Technical Specifications 4.2 and T.S. 4.5

B.18
Answer: a
Reference: Reed Research Reactor SOP 41, "Area Monitors"

B.19
Answer: b
Reference: $D = D_0 e^{-\lambda t}$ *where* D_0 *is* $80\frac{mrem}{hr}$ D *is* $5\frac{mrem}{hr}$ *and* $\lambda = \frac{\ln(2)}{half-life = 2.25\ minutes}$

$5 = 80 * e^{\frac{-\ln(2)}{2.25}t}$

$\ln\left(\frac{5}{80}\right) = -\frac{\ln(2)}{2.25} * t$

$-\ln(2) * t = \ln\left(\frac{5}{80}\right) * 2.25$

$t = \frac{-2.25 * \ln\left(\frac{5}{80}\right)}{\ln(2)}$

$t = 9.0$

Also: 80/2 = 40 (1 half-life), 40/2 – 20 (2 half-lives), 20/2 = 10 (3 half-lives), 10/2 = 5 (4 half-lives) 4*2.25 minutes = 9

B.20
Answer: b
Reference: Reed Research Reactor SOP 34, "Ventilation"

(***** END OF CATEGORY B *****)

Category C: Facility and Radiation Monitoring Systems

C.01
Answer: b
Reference: Reed Research Reactor Technical Specifications 2.5.1, 3.2.1, 3.4, & 3.6.3

C.02
Answer: d
Reference: Reed Research Reactor SOP 32, “Ventilation”

C.03
Answer: c
Reference: Reed Research Reactor Safety Analysis Report 1.3.8
SOP 16, “Near Core Irradiation”

C.04
Answer: a
Reference: Reed Research Reactor Safety Analysis Report 3.1

C.05
Answer: b
Reference: Reed Research Reactor Safety Analysis Report 5.2.4

C.06
Answer: a
Reference: Reed Research Reactor Safety Analysis Report 7.3

C.07
Answer: c
Reference: Reed Research Reactor Safety Analysis Report 1.2.1 and 3.1
Reed Research Reactor Technical Specifications 2.1 and 3.1.1

C.08
Answer: b
Reference: Reed Research Reactor Training Lecture 8 “Console, Control Rods, and Core Neutron Detectors”

C.09
Answer: b
Reference: Reed Research Reactor Safety Analysis Report 4.2.6

C.10
Answer: b
Reference: Reed Research Reactor SOP 35, “Fuel and Core”

C.11
Answer: a
Reference: Reed Research Reactor Technical Specifications 3.1.4

C.12
Answer: a
Reference: Reed Research Reactor Training Lecture 7, “Radiation Detectors”

Category C: Facility and Radiation Monitoring Systems

C.13
Answer: a
Reference: Reed Research Reactor Technical Specifications 3.1.3

C.14
Answer: d
Reference: Reed Research Reactor Training Lecture 5, “Health Physics 2”

C.15
Answer: c
Reference: Reed Research Reactor Training Lecture 5, “Health Physics 2”

C.16
Answer: b
Reference: Reed Research Reactor SOP 31, “Secondary Cooling System and Cooling Tower”

C.17
Answer: a
Reference: Reed Research Reactor Emergency Implementation Procedure M “Loss of Electrical Power”

C.18
Answer: a
Reference: Reed Research Reactor SOP, 14 “Central Thimble”

C.19
Answer: b
Reference: Reed Research Reactor Safety Analysis Report 5.2

C.20
Answer: d
Reference: Reed Research Reactor Safety Analysis Report 4.6.2.3

(***** END OF CATEGORY C *****)
(********** END OF EXAMINATION **********)