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

July 9, 2026

Dr. Steven R. Reese, Director
Oregon State University
100 Radiation Center
Corvallis, OR 97331-5903

SUBJECT: EXAMINATION REPORT NO. 50-243/OL-26-01, OREGON STATE UNIVERSITY

Dear Dr. Reese:

During the week of June 8, 2026, the U.S. Nuclear Regulatory Commission (NRC) administered an operator licensing examination at your Oregon State University TRIGA Nuclear 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 Michele DeSouza at (301) 415-0747, or via email at Michele.DeSouza@nrc.gov.

Sincerely,

Signed by Duane Hardesty
on 07/09/26

Duane A. Hardesty, Chief
Non-Power Production and Utilization
Facilities Branch
Division of Licensing Projects II
Office of Nuclear Reactor Regulation

Docket No. 50-243

Enclosures:
1. Examination Report No. 50-243/OL-26-01
2. Written examination

cc: w/ enclosures to GovDelivery Subscribers

SUBJECT: EXAMINATION REPORT NO. 50-243/OL-26-01, OREGON STATE UNIVERSITY DATED: JULY 9, 2026

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

REPORT NO.: OL-26-01

FACILITY DOCKET NO.: 50-243

FACILITY LICENSE NO.: R-106

FACILITY: Oregon State University TRIGA Nuclear Research Reactor

EXAMINATION DATE(S): Week of June 8, 2026

SUBMITTED BY:

Michele C. DeSouza, Chief Examiner — June 14, 2026 (Date)

SUMMARY:
During the week of June 8, 2026, the NRC administered operator licensing examinations to four Reactor Operator (RO) candidates. All candidates passed all applicable portions of the examinations and tests.

REPORT DETAILS

1. Examiner: Michele C. DeSouza, Chief Examiner, NRC

2. Results:

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

3. Exit Meeting:
   Michele C. DeSouza, NPUF Chief Examiner, NRC
   Celia Oney, Reactor Supervisor, OSTR
   Anthony Cook, Senior Reactor Operator, OSTR
   Zane Tucker, Assistant Director/Reactor Administrator, OSTR
   Dr. Steven Reese, Radiation Center Director, OSTR

Prior to administration, adjustments to the written exam were accepted based on facility comments. These 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.

Oregon State University TRIGA Nuclear Research Reactor

Operator Licensing Examination

Week of June 8, 2026

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

FACILITY: Oregon State University

REACTOR TYPE: TRIGA

DATE ADMINISTERED: June 9, 2026

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 <u>only</u> 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. Answers written on the line will be taken as the final answer. 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 overall.

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

Candidate Name:____________________________

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

A N S W E R   S H E E T

Multiple Choice (Circle your choice, or write on the line)
If you change your answer, write your selection on the line. Answers written on the line will be taken as the final answer.

A01 a b c d ___

A02 a b c d ___

A03 a b c d ___

A04 a __________ b __________ c __________ d __________ (0.50 each)

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 __________ (0.25 each)

A17 a b c d ___

A18 a b c d ___

A19 a b c d ___

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

Candidate Name:___________________________

Category B: Normal/Emergency Operating Procedures and Radiological Controls

A N S W E R   S H E E T

Multiple Choice (Circle your choice, or write on the line)
If you change your answer, write your selection on the line. Answers written on the line will be taken as the final answer.

B01 a b c d ___

B02 a __________ b __________ c __________ d __________ (0.25 each)

B03 a __________ b __________ c __________ d __________ (0.50 each)

B04 a b c d ___

B05 a __________ b __________ c __________ d __________ (0.25 each)

B06 a b c d ___

B07 a b c d ___

B08 a b c d ___

B09 a __________ b __________ c __________ d __________ (0.25 each)

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 ___

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

Candidate Name:___________________________

Category C: Facility and Radiation Monitoring Systems

A N S W E R   S H E E T

Multiple Choice (Circle your choice, or write on the line)
If you change your answer, write your selection on the line. Answers written on the line will be taken as the final answer.

C01 a b c d ___

C02 a b c d ___

C03 a __________ b __________ c __________ d __________ (0.25 each)

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 **********)

EQUATION SHEET

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

1 kg = 2.21 lb

1 Horsepower = 2.54 x 10^3 BTU/hr

1 Mw = 3.41 x 10^6 BTU/hr

1 BTU = 778 ft-lb

°F = 9/5 °C + 32

1 gal (H_2O) ≈ 8 lb

°C = 5/9 (°F - 32)

c_P = 1.0 BTU/hr/lb/°F

c_p = 1 cal/sec/gm/°C

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

QUESTION A.01 [1.00 point]
Which ONE of the following defines the term ‘effective multiplication factor’?

a. Rate of change of reactor power in neutron per second.

b. Fractional change in neutron population per generation.

c. Number of neutrons by which neutron population changes per generation.

d. Change in the number of neutrons per second that causes a fission event.

QUESTION A.02 [1.00 point]
Which ONE of the following is the mechanism by which a nucleus can gain stability by converting a neutron to a proton or proton to a neutron?

a. Alpha decay

b. Beta decay

c. Gamma decay

d. Photoelectric effect

QUESTION A.03 [1.00 point]
Which ONE of the following is the stable reactor period that will result in a power rise from 15% to 75% in 55 seconds?

a. 19.6 seconds

b. 28.1 seconds

c. 34.2 seconds

d. 54.5 seconds

QUESTION A.04 [2.00 points, 0.50 each]
Match the reaction type in Column A with the equation in Column B. Options in Column B may be used once, more than once, or not at all.

Column A	Column B
a. Alpha decay	1. $^{14}_{6}\mathrm{C} \rightarrow {}^{14}_{7}\mathrm{N} + \mathbf{X}$
b. Beta-plus decay	2. $^{13}_{7}\mathrm{N} \rightarrow {}^{13}_{6}\mathrm{C} + \mathbf{X}$
c. Beta-minus decay	3. $^{40}_{19}\mathrm{K} + \mathbf{X} \rightarrow {}^{40}_{18}\mathrm{Ar}$
d. Electron capture	4. $^{234}_{92}\mathrm{U} \rightarrow {}^{230}_{90}\mathrm{Th} + \mathbf{X}$

QUESTION A.05 [1.00 point]
Which ONE of the following isotopes is considered a fertile material that can capture a neutron to eventually form a fissile fuel?

a. Uranium-235

b. Thorium-232

c. Plutonium-239

d. Uranium-233

QUESTION A.06 [1.00 point]
During a reactor startup, criticality occurred at a lower rod height than the previous startup. Which ONE of the following explanations could be the reason for the change?

a. Nuclear Instrumentation drift.

b. Moderator temperature was higher on initial startup.

c. The startup source was inserted into the core.

d. An experiment with negative reactivity was added.

QUESTION A.07 [1.00 point]
Which ONE of the following factors in the six-factor formula is LEAST affected by changes in the moderator?

a. Fast fission factor (ε)

b. Reproduction factor (η)

c. Resonance escape probability (ρ)

d. Thermal non-leakage probability (l_t)

QUESTION A.08 [1.00 point]
What is the remaining power following a prompt drop in reactor power following a control rod insertion worth $0.58 into a critical reactor? Assume β_{eff} = 0.0075

a. 24.42%

b. 36.19%

c. 49.64%

d. 63.29%

QUESTION A.09 [1.00 point]
Which ONE of the following statements best describes the importance of a negative temperature coefficient of reactivity?

a. As fuel temperature increases, moderator temperature increases rapidly through conduction heat transfer, adding negative reactivity.

b. An increase in reactor power causes an increase in fuel temperature which results in a negative reactivity addition, causing the power increase to slow or stop.

c. As fuel temperature increases, the concentration of fission product poisons in the fuel matrix increases, adding negative reactivity through increased neutron absorption.

d. As fuel temperature increases, U-235 in the fuel is consumed, causing Pu-239 to form which becomes additional sources of fission causing control rods to be withdrawn farther, adding negative reactivity.

QUESTION A.10 [1.00 point]
During normal reactor operations, how does the differential control rod worth change when it is continuously withdrawn from full insert to full withdrawn?

a. It remains completely constant from initial pull to fully withdrawn.

b. It starts high at the bottom, decreases in the middle, and goes back up at the top.

c. It starts low at the bottom, peaks near the core centerline, and drops back to near zero at the top.

d. It continuously increases from the bottom of the core all the way to the top of the core.

QUESTION A.11 [1.00 point]
An experimenter inserts an experiment into the core, and the count rate increases from 100 cps to 104 cps. Given the initial k_{eff} of the shutdown reactor was 0.92, what is the worth of the experiment in dollars/cents ($)? Assume βeff = 0.0075

a. $0.13

b. $0.28

c. $0.37

d. $0.48

QUESTION A.12 [1.00 point]
Which ONE of the following provides an example of a critical reactor?

a. The effective multiplication factor k_{eff} is exactly equal to 1.0, and the reactor power level is increasing at a constant, linear rate.

b. The production rate of prompt neutrons exactly balances all neutron losses, while delayed neutrons are entirely ignored.

c. The reactor has reached a high enough power level to generate readable thermal-hydraulic feedback, stabilizing the core temperature.

d. The rate of neutron production from all fission events is exactly equal to the total rate of neutron leakage and absorption, resulting in a self-sustaining chain reaction at a steady power level.

QUESTION A.13 [1.00 point]
Which ONE of the following statements best describes calculation of shutdown margin?

a. Calculate the total negative reactivity of all control rods fully inserted into the core, including the single highest-worth control rod.

b. Subtract the total positive reactivity worth of all in-core experiments from the total negative reactivity worth of the regulating rod.

c. Calculate the reactivity of the core assuming all control rods are fully inserted, minus the negative reactivity worth of the single highest-worth control rod assumed to be fully withdrawn.

d. Calculate the amount of positive reactivity required to bring the reactor exactly to a prompt-critical state from its current shutdown configuration.

QUESTION A.14 [1.00 point]
As new fuel is being loaded into the core, the reactor operator is using a 1/M plot to monitor core loading. Which ONE of the following conditions could result in the reactor reaching critical mass at a value greater than the predicted critical mass?

a. The detector and source are too far from each other.

b. Too much time elapses between subsequent core loadings.

c. The detector is located so that core load starts away from the detector and subsequent loading proceeds towards the detector.

d. The detector is located so that core load starts at a point close to the detector and subsequent loadings move farther from the detector.

QUESTION A.15 [1.00 point]
There is a cooling malfunction that results in a rapid drop in pool temperature and lowers core moderator temperature. If the reactor was operating at a constant steady state power level, how would the temperature decrease affect core reactivity and what is the primary mechanism driving the response?

a. Positive reactivity is inserted because a cooler, denser moderator slows down neutrons more effectively, increasing thermal utilization (f).

b. Negative reactivity is inserted because a cooler, denser moderator causes a significant increase in fast neutron leakage (L_f).

c. Negative reactivity is inserted because the cooler moderator causes the fuel atoms to undergo greater Doppler broadening, increasing resonance absorption.

d. Positive reactivity is inserted because a cooler moderator shifts the thermal neutron spectrum to a higher average energy, increasing the reproduction factor (n).

QUESTION A.16 [1.00 point, 0.25 each]
For each scenario in Column A, identify the direction in Column B that control rods would need to be moved at Oregon State to maintain constant reactor power. Answers in Column B may be used once, more than once, or not at all.

Column A	**Column B**
a. Buildup of Xe-135	1. Insert
b. Burnup of U-238	2. Withdraw
c. Removal of neutron source	3. No movement
d. Fuel temperature decrease	

QUESTION A.17 [1.00 point]
Which ONE of the following best explains the reason why prompt neutrons are not solely used to control a reactor and requires the presence of thermal neutrons?

a. Prompt neutrons have a much smaller fission cross-section than thermal delayed neutrons, meaning prompt neutrons cannot maintain a steady-state chain reaction without fading out.

b. Prompt neutrons are physically repelled by control rod materials like cadmium or boron, preventing them from being absorbed during a rod insertion or scram.

c. Thermal neutrons carry significantly more kinetic energy than prompt fast neutrons, providing the necessary thermal-hydraulic force needed to physically move the control rod banks.

d. The prompt neutron lifetime is so incredibly short (on the order of microseconds) that any positive reactivity change would cause power to escalate exponentially faster than mechanical control systems can physically respond.

QUESTION A.18 [1.00 point]
Which ONE of the following is the principal source of heat in the reactor after a shutdown from an extended full power operation?

a. Decay of fission fragments

b. Production of delayed neutrons

c. Subcritical reaction of photo neutrons

d. Spontaneous fission of uranium-238

QUESTION A.19 [1.00 point]
Which ONE of the following describes the reason fission products like Xenon-135 and Samarium-149 have an impact in reactor design and operation?

a. Xenon-135 and Samarium-149 burn up causes an increase in the thermal flux.

b. Xenon-135 and Samarium-149 will cause an increase in excess positive reactivity in the core.

c. Xenon-135 and Samarium-149 have large absorption cross sections resulting in a large removal of neutrons from the reactor.

d. Xenon-135 and Samarium-149 produce fast fission neutrons resulting in the net increase in the fast neutron population of the reactor core.

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

Category B: Normal/Emergency Operating Procedures and Radiological Controls

QUESTION B.01 [1.00 point]
In accordance with the OSTR Emergency Plan, which ONE of the following statements best describes the Emergency Planning Zone?

a. The operations boundary of the facility itself, including no offsite or public areas.

b. The exact physical footprint of the OSU campus boundary, excluding private residential zones.

c. The perimeter of the 100-meter exclusion area immediately surrounding the Radiation Center fencing.

d. A 1-mile radius centered on the OSTR building, extending into the surrounding City of Corvallis.

QUESTION B.02 [1.00 point, 0.25 each]
In accordance with OSTR Technical Specifications, match the surveillance activity in Column A with the required surveillance interval in Column B. Options in Column B may be used once, more than once, or not at all.

Column A	Column B
a. Control rod reactivity worth determination.	1. Semi-annually
b. Transient rod drive cylinder and air supply inspection.	2. Annually
c. Control rod drive visual deterioration inspection.	3. Biennially
d. Monitoring channel power level calorimetric calibration	

QUESTION B.03 [2.00 points, 0.50 each]
In accordance with 10 CFR 20, match the radiation readings from Column A with its corresponding radiation area posting in Column B. Assume all distances at 30 cm unless specified. Answers may be used once, more than once, or not at all.

Column A	Column B
a. 20 mR/hr	1. Unrestricted Area
b. 2 mR/hr	2. Radiation Area
c. 520 Rad/hr at 1 m	3. High Radiation Area
d. 5 R/hr	4. Very High Radiation Area

QUESTION B.04 [1.00 point]
The exposure rate for a point source is 195 mR/hr at a distance of 3 meters. What is the exposure rate at a distance of 6 meters?

a. 12.15 mR/h

b. 48.75 mR/hr

c. 78.80 mR/hr

d. 91.25 mR/hr

QUESTION B.05 [1.00 point, 0.25 each]
In accordance with OSTROP 1, Annunciator Response Procedures, identify each of the circumstances below as the expected automatic reactor response as a: ‘1 - scram’, ‘2 - interlock’ or ‘3 – no response’. Answers may be used once, more than once, or not at all.

a. pulse $1.25.

b. percent power channel is 104%.

c. reactor period is 3 seconds.

d. neutron measuring channel high voltage is 20%.

QUESTION B.06 [1.00 point]
Which ONE of the following two combinations are used to determine an individual’s Total Effective Dose Equivalent (TEDE)?

a. Shallow-Dose Equivalent (SDE) and Committed Dose Equivalent (CDE)

b. Deep-Dose Equivalent (DDE) and Committed Effective Dose Equivalent (CEDE)

c. Lens Dose Equivalent (LDE) and Deep-Dose Equivalent (DDE)

d. Deep-Dose Equivalent (DDE) and Committed Dose Equivalent (CDE)

QUESTION B.07 [1.00 point]
Which ONE of the following conditions would be a violation of 10 CFR Part 55?

a. Your last medical exam was 20 months ago.

b. Last quarter, you were the console operator for 6 hours.

c. Your last operating test was 14 months ago.

d. Your last written examination was 12 months ago.

QUESTION B.08 [1.00 point]
In accordance with OSTROP 11, Fuel Element Handling Procedures, which ONE of the following is NOT required to be present?

a. A licensed Reactor Operator

b. A licensed Senior Reactor Operator (SRO)

c. A trained fuel handler overseen by an SRO

d. A Senior Health Physicist

QUESTION B.09 [1.00 point, 0.25 each]
In accordance with the OSTR Emergency Plan, match the emergency event in Column A with the event classification in Column B. Options in Column B may be used once, more than once, or not at all.

Column A	**Column B**
a. An earthquake which causes cracks in the reactor tank with a loss of 80% of water.	1. Class O
b. Tornado affecting the Corvallis area.	2. Class I
c. A person has a stroke in the reactor control room.	3. Class II
d. Fire in the Radiation Center Complex lasting more than ten minutes.	

QUESTION B.10 [1.00 point]
In accordance with OSTR Technical Specifications, all of the following conditions are permissible during operation EXCEPT:

a. Calculated reactivity with all control rods fully withdrawn is $6.75.

b. Continuous air particulate radiation monitor is non-operational but the exhaust gas radiation monitor is operational.

c. Water temperature at the exit of the reactor pool is 125°F.

d. Conductivity is 4 μmhos-cm.

QUESTION B.11 [1.00 point]
In accordance with 10 CFR 20, which ONE of the following correctly defines the effective dose equivalent (EDE)?

a. The sum of the effective dose equivalent (for external exposures) and the committed effective dose equivalent (for internal exposures).

b. The sum of the products of the dose equivalent to the organ or tissue and the weighting factors applicable to each of the body organs or tissues that are irradiated.

c. The concentration of a given radionuclide in air which, if breathed by the reference man for a working year of 2,000 hours under conditions of light work, results in an intake of one ALI.

d. The sum of the products of the weighting factors applicable to each of the body organs or tissues that are irradiated and the committed dose equivalent to these organs or tissues.

QUESTION B.12 [1.00 point]
In accordance with OSTR Emergency Response Implementing Procedure A, Explosion or Fire, the Emergency Coordinator should take all of the following actions EXCEPT:

a. Notify offsite emergency authorities.

b. Ensure life safety and evacuation.

c. Attempt to aggressively fight the fire.

d. Evaluate the Emergency Action Levels.

QUESTION B.13 [1.00 point]
In accordance with OSTROP 22, Emergency Power System, which ONE of the following is the core component that must be maintained during a prolonged blackout?

a. To provide electrical power to the primary cooling pumps to prevent bulk coolant boiling and potential fuel element melting.

b. To supply high-voltage electrical power to the control rod magnet coils to physically force the safety rods to remain latched inside the core.

c. To power the auxiliary pool purification system to prevent a rapid build-up of corrosive nitrates in the primary water loop.

d. To power the ventilation BAS interface and area/air radiation monitors to ensure control room habitability and monitoring of potential airborne releases.

QUESTION B.14 [1.00 point]
In accordance with OSTR Technical Specifications, all of the following experiments would be allowed to be conducted while the reactor is operating EXCEPT:

a. A single secured experiment installed in the core with a total reactivity worth of $2.25.

b. A single unsecured sample with a reactivity of $0.45.

c. A single secured experiment clamped in the central thimble with a reactivity worth of $0.95.

d. Two experiments, loaded into two separate irradiation facilities simultaneously, with a total reactivity worth of $2.55.

QUESTION B.15 [1.00 point]
Which ONE of the following changes would NOT require a 10 CFR 50.59 evaluation?

a. An administrative update to the Safety Analysis Report to correct spelling and formatting errors.

b. A modification to eliminate paper logbook requirements and move to digital log keeping.

c. Changing the console high power scram setpoint on the percent power channel detector from 104% to 110%.

d. Moving the cadmium lined in-core irradiation tube (CLICIT) from the B ring to the C ring.

QUESTION B.16 [1.00 point]
A 4.5 curie source emits a 6 MeV gamma 80% of the time. The source will be placed in the reactor storage room. How far from the source should a high radiation area sign be posted?

a. 12 feet

b. 26 feet

c. 36 feet

d. 42 feet

QUESTION B.17 [1.00 point]
In accordance with the OSTR Emergency Plan, all of the following are responsibilities of the Emergency Coordinator EXCEPT:

a. Making the final decision for a full evacuation of the Radiation Center building complex and obtain accountability numbers.

b. Making the official declaration of an Emergency Class based on the active Emergency Action Levels.

c. Acting as the primary public relations officer to conduct live news media briefings.

d. Notification of the class of emergency to appropriate NRC and Oregon Department of Energy sections.

QUESTION B.18 [1.00 point]
In accordance with OSTROP 8, Reactor Power Calibration Procedures, which ONE of the following is how the operator accounts for the primary pool water purification (cleanup) loop?

a. The primary cleanup loop must remain running at maximum flow to prevent localized boiling near the fuel elements during data collection.

b. The primary cleanup loop must be secured and isolated to prevent the pump's mechanical heat input and core-bypass flow from distorting the temperature differential calculations.

c. The cleanup loop demineralizer columns must be bypassed, but the pump must remain operational to inject auxiliary cooling into the experimental thimbles.

d. The cleanup loop must be realigned to discharge directly into the bulk shield tank to artificially raise the core inlet temperature baseline.

QUESTION B.19 [1.00 point]
In accordance with Oregon State Technical Specifications, which ONE of the following is an example of a record required to be maintained for five years?

a. Experiments performed with the reactor

b. Radiation exposures for all personnel monitored

c. Gaseous and liquid radioactive effluents released to the environment

d. Records of retraining and requalification of certified reactor operators and senior reactor operators

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

Category C: Facility and Radiation Monitoring Systems

QUESTION C.01 [1.00 point]
In accordance with the OSTR Technical Specifications, which ONE of the following statements best describes the purpose of the Primary Water Activity Monitor?

a. Identify a major breakdown of the primary water cleanup demineralizer resins which would cause a rapid release of sodium-24 back into the pool.

b. Detect fission product leakage escaping from a compromised fuel element cladding break into the primary water.

c. Prevent localized boiling near the center thimble effectively preventing concentrations of nitrogen-16 bubbles.

d. Recognize a significant drop in the secondary cooling system thereby exposing components to air.

QUESTION C.02 [1.00 point]
In accordance with the OSTR Safety Analysis Report, all of the following would be indications of a loss of reactor coolant EXCEPT:

a. High hold up tank level.

b. Low reactor tank level.

c. Increased radiation levels.

d. Low cooling tower water level.

QUESTION C.03 [1.00 point, 0.25 each]
In accordance with the OSTR Safety Analysis Report, match the detector type in Column A with the correct function in Column B. Options in Column B may be used once, more than once, or not at all.

Column A	Column B
a. Area Radiation Monitor	1. Measures gross particulate and gaseous fission products directly above the reactor tank.
b. Continuous Air Monitor	2. Measures real-time ambient gamma dose-rate fields at fixed structural points around the reactor bay and console.
c. Stack Exhaust Monitor	3. Continually measures radiological effluents released from the facility building to trigger automatic building confinement isolation.
d. Primary Water Monitor	4. Monitors bulk fluid radioactivity to immediately detect potential fuel element cladding failures.

QUESTION C.04 [1.00 point]
In accordance with the OSTROP 4, Startup and Shutdown Procedures, which ONE of the following is the correct response if the daily core excess and shutdown margin are not as expected based on prior operation history?

a. Operations may continue indefinitely provided core excess reactivity remains beneath $7.55 and shutdown margin is greater than $0.55.

b. The reactor must be scrammed within 10 minutes of completing core excess and shutdown margin calculations.

c. The Duty SRO must be informed prior to continuing with operations.

d. The operator must shutdown and restart the reactor and conduct a secondary core excess and shutdown margin calculation.

QUESTION C.05 [1.00 point]
In accordance with the OSTR Safety Analysis Report, which ONE of the following is the primary regulatory safety objective of maintaining the constant negative differential pressure?

a. To prevent the uncontrolled, ground-level leakage of airborne radioactive materials to the unrestricted environment.

b. To suppress the production rate of nitrogen-16 by reducing the ambient oxygen density above the pool surface.

c. To increase natural thermal circulation through the reactor core by elevating localized evaporative cooling rates.

d. To structurally protect the building's exterior containment siding from buckling outward during an overpressurization event.

QUESTION C.06 [1.00 point]
In accordance with the OSTR Safety Analysis Report, which ONE of the following statements best describes the design of the wide-range log channel?

a. A proportional detector lined with B-10.

b. A compensated ion chamber.

c. A fission chamber lined with highly enriched uranium.

d. An uncompensated ion chamber.

Category C: Facility and Radiation Monitoring Systems

QUESTION C.07 [1.00 point]
In accordance with the OSTR Technical Specifications, if loss of the continuous particulate air monitor occurs, which ONE of the following statements is the operational protocol to continue safe operations?

a. The reactor must be scrammed immediately, as the CAM provides a non-bypassable safety system protective action that drops the control rods.

b. Operations may continue for up to 90 days without restriction, provided that the Area Radiation Monitors (ARMs) remain operational to detect airborne particulate spikes.

c. Operations may continue for a period of up to 30 days, provided a suitable replacement is identified within 1 hour.

d. The reactor may only operate in Pulsing Mode, where short-duration transients negate the necessity of real-time air sampling.

QUESTION C.08 [1.00 point]
In accordance with the OSTR Safety Analysis Report, all of the following are gaseous radioactive effluents produced during normal operation EXCEPT:

a. H-3

b. N-16

c. Ar-41

d. Rn-222

QUESTION C.09 [1.00 point]
In accordance with the OSTR Safety Analysis Report, which ONE of the following is the physical placement requirement and what is the safety function of the suction and discharge piping siphon breaks?

a. They must be located exactly at the core grid plate level; to rapidly flood the experimental thimbles during a primary pump casing failure.

b. They must be positioned within the secondary loop heat exchanger; to prevent higher-pressure secondary water from siphoning into the radioactive primary tank.

c. They must be located at least 14 feet above the top of the core; to introduce air into the lines and stop an inadvertent pipe break from draining the pool below a safe shielding level.

d. They must be attached directly to the primary cooling pump discharge check valves; to vent accumulated radiolytic hydrogen and nitrogen gases during full-power operations.

QUESTION C.10 [1.00 point]
In accordance with the OSTROP 17, Reactor Room Ventilation System Procedures, which ONE of the following statements would NOT confirm the reactor ventilation system is operating in its normal ventilation configuration?

a. The reactor bay supply and exhaust fans are running continuously.

b. The pneumatic ventilation isolation dampers are physically open to the standard stack plenum.

c. the mechanical ventilation status indicators on the fan control panel show a positive differential room pressure.

d. The ventilation low flow annunciator is clear.

QUESTION C.11 [1.00 point]
In accordance with OSTROP 16, Annual Surveillance and Maintenance Procedures and OSTROP 17, Reactor Room Ventilation System Procedure, which ONE of the following best describes the required results when performing the Ventilation System Shutdown Check?

a. The isolation dampers must automatically close within 1.0 second, and the backup diesel generator must immediately pick up the primary cooling pump load.

b. The isolation dampers must fail completely open to maximize exhaust air dispersion out of the main stack, and the room pressure must shift to a positive differential state.

c. The ventilation supply and exhaust dampers close within 60 seconds, both the supply and exhaust fans shut down, and the “ventilation system fans off”, “abnormal bay static pressure” and “ventilation low flow” annunciators activate.

d. The ventilation system must completely de-energize to establish a static air-tight containment seal inside the reactor bay.

QUESTION C.12 [1.00 point]
In accordance with the OSTR Safety Analysis Report, which ONE of the following statements best describes the OSTR standard control rod drives?

a. A high-torque hydraulic piston

b. A variable-speed AC synchronous motor

c. A fraction-horsepower, reversible DC motor coupled to an electromagnet

d. A high-precision digital stepper motor

Category C: Facility and Radiation Monitoring Systems

QUESTION C.13 [1.00 point]
In accordance with OSTR Technical Specifications, which ONE of the following conditions will trigger a Rod Withdrawal Prohibit, blocking the operator from withdrawal of the standard control rods?

a. Wide-Range Log Power Channel drops below 2 cps.

b. Fuel element temperature exceeds 400°C.

c. Primary bulk water temperature exceeds 120°F.

d. The Continuous Air Monitor (CAM) registers a high-activity alarm in the Reactor Bay.

QUESTION C.14 [1.00 point]
Which ONE of the following statements best describes how primary coolant temperature is measured?

a. A thermocouple detects changes in pool temperature by measuring the voltage difference between two wires of dissimilar metals.

b. A resistance temperature detector detects changes in pool temperature by measuring changes in resistance to the flow of electricity resulting from changes in temperature of the resistive metal element.

c. A semiconductor-based temperature sensor detects changes in pool temperature by utilizing two identical diodes with temperature-sensitive voltage vs current characteristics that are used to monitor changes in temperature.

d. A thermistor detects changes in pool temperature by using a thermally sensitive resistor that exhibits a continuous, small, incremental change in resistance correlated to variations in temperature.

QUESTION C.15 [1.00 point]
Which ONE of the following channels is grounded in pulse mode?

a. Safety Power Channel

b. Linear Channel

c. Log-N Channel

d. Period Channel

QUESTION C.16 [1.00 point]
In accordance with the OSTR Safety Analysis Report, which ONE of the following scram indications is required in all effective modes of operation?

a. Period

b. Preset timer

c. Power level

d. High voltage

QUESTION C.17 [1.00 point]
In accordance with OSTR Safety Analysis Report, which ONE of the following demonstrates an indication of a clogged demineralizer?

a. High radiation at the demineralizer

b. High radiation downstream of demineralizer

c. High flow rate through the demineralizer

d. High pressure upstream of the demineralizer

QUESTION C.18 [1.00 point]
In accordance with OSTROP 2, Reactor Startup Checklist Procedures, which ONE of the following is NOT normally checked on the Continuous Air Monitor (CAM) during a routine startup?

a. Flow rate

b. Oil level

c. Filter paper

d. Background reading

QUESTION C.19 [1.00 point]
In accordance with the OSTR Safety Analysis Report, which ONE of the following design mechanisms minimizes mechanical structural shock when the control rod scram?

a. A mechanical spring shock absorber positioned at the base of the core grid plate that compresses upon impact.

b. An electric-brake assembly that dynamically energizes the drive motor circuits the moment the rod-down limit switch trips.

c. A hydraulic dashpot assembly where an attached piston drives primary pool water out of a tight-tolerance cylinder during the final inches of travel.

d. A pneumatic air-snubber chamber located above the pool bridge that vents high-pressure compressed air through a specialized exhaust orifice.

QUESTION C.20 [1.00 point]
In accordance with the OSTR Safety Analysis Report, which ONE of the following statements best describes the primary radiological concern resulting from a complete loss of pool water and how fuel integrity is maintained?

a. Radioactive tritium gas dissolved in the pool water will flash to steam and cause an immediate containment building overpressurization.

b. The core will undergo a rapid power excursion (criticality event) because the loss of water removes the negative temperature reactivity feedback effects.

c. Fuel cladding melt will occur within 60 seconds due to the complete loss of convective heat transfer, requiring immediate activation of an emergency core spray system.

d. High direct radiation dose rates (shine) will project upward from the unshielded, shutdown core into the Reactor Bay, but the fuel elements will remain safely cooled by passive air convection.

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

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

A.01
Answer: b.
Reference: Burn, *Introduction to Nuclear Reactor Operations*, Section 1.3.1, p. 1-5

A.02
Answer: b.
Reference: DOE Fundamentals Handbook, Volume 1, Module 1, p 24

A.03
Answer: c.
Reference: $P = P_0 e^{t/T}$
$T = t / (\ln(P/P_0)$
$T = 55/\ln(75/15)$
$T = 55/(\ln(1.609))$
$T = 34.2$ seconds

A.04
Answer: a. 4; b. 2; c. 1; d. 3
Reference: DOE Fundamentals Handbook, Volume 1, Module 1, p. 24-25

A.05
Answer: b.
Reference: https://www.nrc.gov/reading-rm/basic-ref/glossary/fertile-material

A.06
Answer: b.
Reference: Standard NRC question

A.07
Answer: b.
Reference: DOE Fundamentals Handbook, Volume 2, Module 3, p. 2-9

A.08
Answer: d.
Reference: $\frac{P_1}{P_0} = \frac{\beta_{eff} \cdot (1-p)}{\beta_{eff} - p}$
p = - \$0.58 x β_{eff} = - \$0.58 x 0.0075 = - 0.00435
P_1/P_0 = 0.00755 / 0.0075 – (-0.00435) = 0.0075 / 0.01185 = 0.63291 = 63.29%
OR P_1/P_0 = 1 / 1-(-0.58) = 1 / 1.58 = 0.63291 = 63.29%

A.09
Answer: b.
Reference: DOE Fundamentals Handbook, Volume 2, Module 3

A.10
Answer: c.
Reference: DOE Fundamentals Handbook, Volume 1, Module 1, p. 51

A.11
Answer: d.
Reference: $CR_1 / CR_o = (1 - K_{eff1}) / (1 - K_{eff2})$
$104/ 100 = (1 - 0.92) / (1 - K_{eff2})$
$1.04 = (0.0800 / (1 - K_{eff2})$
$1 - K_{eff2} = 0.0800 / 1.04 = 0.7692$
Therefore $K_{eff2} = 0.92308$
$\Delta\rho = (K_{eff2} - K_{eff1}) / (K_{eff2} * K_{eff1})$
$\Delta\rho = (0.92308 - 0.92) / (0.92308 * 0.92)$
$\Delta\rho = + 0.00308\ \Delta k/k$
$\Delta k / \beta_{eff} = 0.00308 / 0.0075 = \$0.41$

A.12
Answer: d.
Reference: DOE Fundamentals Handbook, Volume 2, Module 4, p. 1

A.13
Answer: c.
Reference: DOE Fundamentals Handbook, Volume 2, Module 4, p. 27-28

A.14
Answer: c.
Reference: Burn, *Introduction to Nuclear Reactor Operations,* Section 5.5, p. 5-18

A.15
Answer: a.
Reference: DOE Fundamentals Handbook, Volume 2, Module 3, p. 24-28

A.16
Answer: a. 2 (Withdraw); b. 2 (Withdraw); c. 1 (Insert); d. 1 (Insert)
Reference: Burn, *Introduction to Nuclear Reactor Operations*, p. 7-17

A.17
Answer: d.
Reference: DOE Fundamentals Handbook, Volume 2, Module 4, p. 9-12

A.18
Answer: a.
Reference: DOE Fundamentals Handbook, Volume 1, Module 1, p. 61

A.19
Answer: c.
Reference: DOE Fundamentals Handbook, Volume 2, Module 3, p. 34

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

Category B: Normal/Emergency Operating Procedures and Radiological Controls

B.01
Answer: a.
Reference: OSTR SAR 13 and OSTR Emergency Response Plan 2.0

B.02
Answer: a. 2 (Annually); b. 1 (Semi-annually); c. 3 (Biennially); d. 2 (Annually)
Reference: OSTR Technical Specifications 4.1 and 4.2

B.03
Answer: a. 2 (Radiation Area); b. 1 (RA); c. 4 (VHRA); d. 3 (HRA)
Reference: 10 CFR 20.1003 and 20.1004

B.04
Answer: b.
Reference: $I_2 = I_1 D_1^2 / d_2^2$
$I_2 = (195 \text{ mR/hr})(3\text{m})^2 / 6\text{m})^2$
$I_2 = 48.75 \text{ mR/hr}$

B.05
Answer: a. 1-scram; b. 3-no response; c. 3-no response; d. 1-scram
Reference: OSTROP 1, Annunciator Response Procedures

B.06
Answer: b.
Reference: 10 CFR 20.1003

B.07
Answer: c.
Reference: 10 CFR Part 55

B.08
Answer: d.
Reference: OSTROP 11, Fuel Element Handling Procedures

B.09
Answer: a. 3 (Class II); b. 2 (Class I); c. 1 (Class O); d. 2 (Class I)
Reference: OSTR Emergency Plan Table 5.1

B.10
Answer: c.
Reference: OSTR Technical Specifications 3.1.3, 3.7.1, and 5.2

B.11
Answer: b.
Reference: 10 CFR 20.1003

B.12
Answer: c.
Reference: OSTR Emergency Response Implementing Procedure A, Explosion or Fire

Category B: Normal/Emergency Operating Procedures and Radiological Controls

B.13
Answer: d.
Reference: OSTROP 22, Emergency Power System

B.14
Answer: d.
Reference: OSTR Technical Specifications 3.8.1

B.15
Answer: a.
Reference: 10 CFR 50.59; Standard NRC question

B.16
Answer: c.
Reference: I=6CEn=R/hr@ft.
6*4.5Ci x 6 Mev x 80% = 129.6 R/hr @ $(1ft)^2$ =
129.6 R/hr = 0.1 R/hr @ D2
$\sqrt{1296}$ R/hr = 36 ft.

B.17
Answer: c.
Reference: OSTR Emergency Response Plan 2.0

B.18
Answer: b.
Reference: OSTROP 8

B.19
Answer: a.
Reference: OSTR Technical Specifications 6.8.1

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

Category C: Facility and Radiation Monitoring Systems

C.01
Answer: b.
Reference: OSTR Technical Specifications 3.3

C.02
Answer: d.
Reference: OSTR SAR 5, 8, and 13

C.03
Answer: a. 2; b. 1; c. 3; d. 4
Reference: OSTR SAR 4, 5, 7, and 11

C.04
Answer: c.
Reference: OSTROP 4, Reactor Operations Procedures, II

C.05
Answer: a.
Reference: OSTR Technical Specifications 5.5

C.06
Answer: c.
Reference: OSTR SAR 7

C.07
Answer: c.
Reference: OSTR Technical Specifications 3.7.1

C.08
Answer: d.
Reference: OSTR SAR 11

C.09
Answer: c.
Reference: OSTR Technical Specifications 3.3.b

C.10
Answer: c.
Reference: OSTROP 17, Reactor Room Ventilation System Procedures

C.11
Answer: c.
Reference: OSTR 17, Reactor Room Ventilation System Procedure, II.A

C.12
Answer: c.
Reference: OSTR SAR 7

C.13
Answer: a.
Reference: OSTR Technical Specifications 3.2.3

Category C: Facility and Radiation Monitoring Systems

C.14
Answer: a.
Reference: OSTR SAR 7.3 and 7.5

C.15
Answer: d.
Reference: OSTR Training Manual Volume 2

C.16
Answer: d.
Reference: OSTR Technical Specifications Table 3.3.3-1 and SAR 7

C.17
Answer: d.
Reference: OSTR Technical Specifications 3.3 and SAR 5

C.18
Answer: b.
Reference: OSTROP 2, Reactor Startup Checklist Procedures

C.19
Answer: c.
Reference: OSTR SAR 4

C.20
Answer: d.
Reference: OSTR SAR 13.2.2

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