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

March 8, 2024

Rowdy Davis, Reactor Administrator
Nuclear Engineering Department
1 University of New Mexico, MSC-01-1120
Albuquerque, NM 87131-0001

SUBJECT: EXAMINATION REPORT NO. 50-252/OL-24-01, UNIVERSITY OF NEW MEXICO

Dear Rowdy Davis:

During the week of January 15, 2024, the U.S. Nuclear Regulatory Commission (NRC) administered an operator licensing examination at your University of New Mexico reactor. The examinations were 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 C. DeSouza at 301-415-0747 or via email at Michele.DeSouza@nrc.gov.

Sincerely,

Signed by Tate, Travis
on 03/08/24

Travis L. Tate, 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. 50-252

Enclosures:
1. Examination Report No. 50-252/OL-24-01
2. Written examination

cc: w/enclosures to GovDelivery Subscribers

SUBJECT: EXAMINATION REPORT NO. 50-252/OL-24-01, UNIVERSITY OF NEW MEXICO DATED: MARCH 8, 2024

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

REPORT NO.: 50-252/OL-24-01

FACILITY DOCKET NO.: 50-252

FACILITY LICENSE NO.: R-102

FACILITY: University of New Mexico

EXAMINATION DATES: January 18, 2024

SUBMITTED BY: _____ 02/02/2024
Michele C. DeSouza, Chief Examiner Date

SUMMARY:

During the week of January 15, 2023, the NRC administered operator licensing examinations to two 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	2/0	NA	2/0
Operating Tests	2/0	NA	2/0
Overall	2/0	NA	2/0

3. Exit Meeting:

Rowdy Davis, Reactor Administrator, University of New Mexico
Michele C. DeSouza, Chief Examiner, NRC
Tuan D. Le, Reactor Engineer (RTR Examiner), NRC
Travis L. Tate, Branch Chief, NRC

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.

University of New Mexico

Operator Licensing Examination

Week of January 15, 2024

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

FACILITY: University of New Mexico

REACTOR TYPE: AGN-201M

DATE ADMINISTERED: 01/18/2024

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 is 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	33.3	_____	_____	A. REACTOR THEORY, THERMODYNAMICS AND FACILITY OPERATING CHARACTERISTICS
20.00	33.3	_____	_____	B. NORMAL AND EMERGENCY OPERATING PROCEDURES AND RADIOLOGICAL COGE NTROLS
20.00	33.3	_____	_____	C. FACILITY AND RADIATION MONITORING SYSTEMS
60.00		_____ FINAL GRADE	_____	% TOTALS

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

_____
Candidate's Signature

Category A: Reactor Theory, Thermodynamics, & 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 _____ (0.25 each)

B12 a b c d ___

B13 a b c d ___

B14 a b c d ___

B15 a _____ b _____ c _____ d _____ (0.25 each)

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 _____ (0.50 each)

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 _____ (0.25 each)

C19 a b c d ___

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

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 an overall 70 percent or greater.

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

EQUATION SHEET

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

1 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 isotopes has the LARGEST thermal neutron microscopic cross section?

a. Xenon-135

b. Uranium-235

c. Uranium-238

d. Samarium 149

QUESTION A.02 [1.0 point]
Match each term in column A with the correct definition in column B. (Answers used only once)

Column A		Column B	
a.	Prompt Neutron	1.	A neutron in equilibrium with its surroundings.
b.	Fast Neutron	2.	A neutron born directly from fission.
c.	Thermal Neutron	3.	A neutron born due to decay of a fission product.
d.	Delayed Neutron	4.	A neutron at an energy level greater than its surroundings.

QUESTION A.03 [1.0 point]
Five minutes after shutting down the reactor, reactor power is 3×10^6 counts per minute (cpm). Which ONE of the following is the count rate you would expect three minutes later?

a. 1×10^6 cpm

b. 8×10^5 cpm

c. 5×10^5 cpm

d. 3×10^5 cpm

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

QUESTION A.04 [1.0 point]
Which ONE of the following describes the difference between reflectors and moderators?

a. Reflectors decrease core leakage while moderators thermalize neutrons.

b. Reflectors shield against neutrons while moderators decrease core leakage.

c. Reflectors decrease thermal leakage while moderators decrease fast leakage.

d. Reflectors thermalize neutrons while moderators decrease core leakage.

QUESTION A.05 [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

QUESTION A.06 [1.0 point]
An element decays at a rate of 20% per day. What is its half-life?

a. 3 hr

b. 75 hr

c. 108 hr

d. 158 hr

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

QUESTION A.07 [1.0 point]
Which ONE of the following algebraic terms is the effective multiplication factor (K_{eff})?

a. $\frac{\text{Number of neutrons produced from all fission}}{\text{Number of neutrons in the previous generation}}$

b. $\frac{\text{Number of neutrons produced from fast fission}}{\text{Number of neutrons produced from thermal fission}}$

c. $\frac{\text{Number of neutrons absorbed in the fuel}}{\text{Number of neutrons absorbed by fission products}}$

d. $\frac{\text{Neutron production from fission in one generation}}{[(\text{Neutrons absorption in the preceding generation}) + (\text{Neutrons leakage in the preceding generation})]}$

QUESTION A.08 [1.0 point]
Which of the following changes in reactor power would take the LONGEST time? Assume the reactor is on a constant period.

a. 100 mW to 400 mW

b. 400 mW to 500 mW

c. 1 W to 3.5 W

d. 3.5 W to 4.5 W

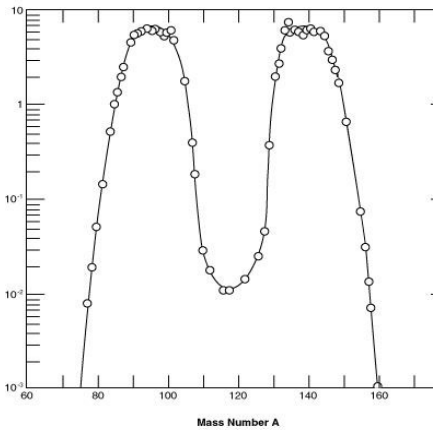
QUESTION A.09 [1.0 point]
The following graph for U-235 depicts……

a. neutron energy distribution in the moderator.

b. axial flux distribution in the core.

c. radial flux distribution in the core.

d. fission product yield distribution.



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

QUESTION A.10 [1.0 point]
The total amount of reactivity added by inserting or withdrawing a control rod from a reference height to any other rod height is called_____.

a. differential rod worth

b. shutdown reactivity

c. integral rod worth

d. reference reactivity

QUESTION A.11 [1.0 point]
Which ONE of the following factors is affected MOST by an increase in fission product poisoning?

a. Resonance Escape Probability

b. Fast Fission Factor

c. Thermal Utilization Factor

d. Reproduction Factor

QUESTION A.12 [1.0 point]
At the beginning of a reactor startup, K_{eff} is 0.90 with a count rate of 30 count per second (cps). Power is increasing to a new, steady value of 60 cps. The new K_{eff} is:

a. 0.910

b. 0.925

c. 0.950

d. 0.975

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

QUESTION A.13 [1.0 point]
What happens to reactor power when a neutron startup source is added to a critical reactor (K = 1)?

a. Increase

b. Decrease

c. Not Change

d. Decrease and Increase

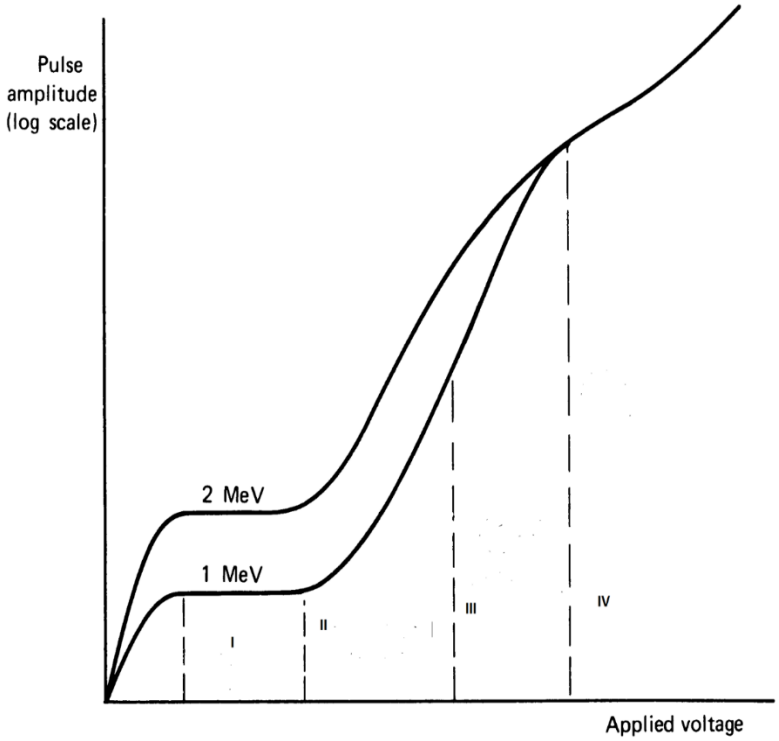
QUESTION A.14 [1.0 point]
The graph below depicts the different regions of operation for a gas-filled detector. Which ONE of the following labels is the Geiger-Mueller region?

a. I

b. II

c. III

d. IV



QUESTION A.15 [1.0 point]
Which ONE of the following conditions will INCREASE the core excess reactivity of a reactor?

a. Moderator temperature is higher than normal. (assume negative temperature coefficient).

b. Insertion of a negative reactivity worth experiment.

c. Burnup of a burnable poison.

d. Fuel depletion.

QUESTION A.16 [1.0 point]
The term "Shutdown Margin" describes:

a. the time required for the blades to fully insert.

b. the departure from $K_{eff} = 1.00$.

c. the amount of reactivity by which the reactor is subcritical.

d. the amount of reactivity inserted by all the rods except the most reactive blade and the regulating rod.

QUESTION A.17 [1.0 point]
Some references list the delayed neutron fraction for U^{235} (β) as 0.0065. The UNM SAR lists β for the core as 0.0075. The β in the SAR is more commonly referred to as $\beta_{effective}$. Which ONE of the following is the reason that $\beta_{effective}$ is larger than β?

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

b. Delayed neutrons are born at lower energies than prompt neutrons resulting in less leakage during slowdown to thermal energies.

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

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

QUESTION A.18 [1.0 point]
The count rate is 60 cps. An experimenter inserts an experiment into the core, and the count rate decreases to 30 cps. Given the initial K_{eff} of the reactor was 0.9, what is the worth of the experiment?

a. $\Delta\rho = - 0.14$

b. $\Delta\rho = + 0.14$

c. $\Delta\rho = - 0.42$

d. $\Delta\rho = + 0.42$

QUESTION A.19 [1.0 point]
The probability of neutron interaction per cm of travel in a material is defined as _____.

a. a neutron flux

b. a mean free path

c. a microscopic cross section

d. a macroscopic cross section

QUESTION A.20 [1.0 point]
A reactor is shutdown from an extended operation at full power, which ONE of the following is the principal source of heat in the reactor?

a. Subcritical reaction of photoneutrons.

b. Production of delayed neutrons.

c. Spontaneous fission of U^{238}.

d. Decay of fission fragments.

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

Category B: Normal/Emergency Operating Procedures and Radiological Controls

QUESTION B.01 [1.0 point]
The UNM reactor is operating at steady-state power. The staffing requirement under this circumstance is which ONE of the following?

a. At least two persons must be present. One NRC-licensed operator must be present at the reactor console.

b. Two NRC-licensed operators must be present. One of the operators must be present at the reactor console.

c. One NRC-licensed operator and a Reactor Supervisor must be present at the reactor console.

d. Only one NRC-licensed operator must be present.

QUESTION B.02 [1.0 point]
What is a minimum number of hours per calendar quarter for an operator licensee to maintain RO activity status to remain current?

a. 2

b. 4

c. 6

d. 8

QUESTION B.03 [1.0 point]
To prevent damage to the reactor or excessive release of radioactive materials in the event of an experiment failure, experiments containing corrosive materials shall:

a. be doubly encapsulated.

b. be limited to less than 10 grams.

c. not be inserted into the reactor or stored at the facility.

d. have a TEDE of less than 500 mrem over two hours from the beginning of the release.

Category B: Normal/Emergency Operating Procedures and Radiological Controls

QUESTION B.04 [1.0 point]
The Emergency Planning Zone (EPZ) has been evacuated. Which ONE of the following staff positions is responsible (by title) for authorizing reentry?

a. Senior Reactor Operator

b. Chief Reactor Supervisor

c. Director of Emergency Operations

d. Radiation Safety Officer

QUESTION B.05 [1.0 point]
Which ONE of the following is the dose rate from a 30 curie Cobalt-60 source at 5 feet? (Assume Cobalt-60 emits 2.5 Mev)

a. 0.5 rem/hr

b. 1.5 rem/hr

c. 9.0 rem/hr

d. 18 rem/hr

QUESTION B.06 [1.0 point]
Which ONE of the following is NOT considered a reportable event?

a. During the reactor operation, a student inserted an experiment that resulted in a high power scram.

b. During the reactor operation, the operator found two rods can be inserted at a time.

c. During the reactor operation, the operator found a disagreement between expected and actual critical rod positions of 0.4% $\Delta k/k$.

d. During the reactor training, a student trainee let the power drift up to the 6 Watt limit, whereupon a reactor scram occurs.

Category B: Normal/Emergency Operating Procedures and Radiological Controls

QUESTION B.07 [1.0 point]
In the event of any emergency, if the radiation level at the console exceeds _____ mR/hr, the operator should sound the evacuation alarm.

a. 25

b. 50

c. 75

d. 100

QUESTION B.08 [1.0 point]
In accordance with the UNM emergency plan, which ONE of the following instances would NOT require immediate notification of the UNM police?

a. Tornado warning on campus.

b. Bomb threat directed toward the reactor.

c. Civil disturbance directed toward the reactor.

d. Fire in the Nuclear Engineering Laboratory building lasting more than 10 minutes.

QUESTION B.09 [1.0 point]
Which ONE of the following is the 10 CFR 20 definition of total effective dose equivalent (TEDE)?

a. The sum of the deep dose equivalent and the committed effective dose equivalent.

b. The dose that your whole body receives from sources outside the body.

c. The sum of the external deep dose and the organ dose.

d. The dose to a specific organ or tissue resulting from an intake of radioactive material.

Category B: Normal/Emergency Operating Procedures and Radiological Controls

QUESTION B.10 [1.0 point]
The UNM Technical Specification basis for the shield water temperature interlock is to prevent:

a. breakdown of the graphite reflector.

b. instrument inaccuracy.

c. reactivity additions.

d. release of Ar-41.

QUESTION B.11 [1.0 point, 0.25 each]
Match the 10 CFR Part 55 requirements listed in Column A for an actively licensed operator with the correct time period from Column B. Column B answers may be used once, more than once, or not at all.

	Column A		Column B
a.	License Renewal	1.	1 year
b.	Medical Examination	2.	2 years
c.	Requalification Written Exam	3.	3 years
d.	Requalification Operating Test	4.	6 years

QUESTION B.12 [1.0 point]
In accordance with UNM Technical Specifications, control rod scram times and average reactivity insertion rates shall be measured:

a. Quarterly

b. semi-annually

c. annually

d. every two years

Category B: Normal/Emergency Operating Procedures and Radiological Controls

QUESTION B.13 [1.0 point]
Which ONE of the following materials shall not be irradiated, even if doubly encapsulated?

a. Fissionable gases

b. Fissionable liquids

c. Materials corrosive to the reactor

d. Explosive materials

QUESTION B.14 [1.0 point]
A radioactive source reads 10 Rem/hr on contact. Two hours later, the same source reads 1 Rem/hr. How long is the time for the source to decay from a reading of 10 Rem/hr to 20 mRem/hr?

a. 5 hours

b. 9 hours

c. 10 hours

d. 12 hours

QUESTION B.15 [1.0 point, 0.25 each]
Identify each of the following surveillances as a channel check (CHECK), a channel test (TEST), or a channel calibration (CAL). Write the correct answer on your answer sheet next to the space given for each example listed below.

a. During performance of the daily checklist, you compare the readings of radiation area monitor located at the lab and radiation area monitor located at reactor top.

b. During performance of the daily checklist, you press the scram button to verify a scram on the safety system channel.

c. Adjustment of the wide range monitor channel in accordance with recent data collected during a reactor power calibration.

d. You expose a 2 mCi check source to the continuous air monitor detector to verify that its output is operable.

Category B: Normal/Emergency Operating Procedures and Radiological Controls

QUESTION B.16 [1.0 point]
Reactor Operator works in a high radiation area for five (5) hours per day. The dose rate in the area is 200 mrem/hour. Which ONE of the following is the MAXIMUM number of days in which Reactor Operator may perform his duties WITHOUT exceeding 10CFR20.1201(a)(1) of TEDE 5 rems limits?

a. 5 days

b. 6 days

c. 7 days

d. 14 days

QUESTION B.17 [1.0 point]
In accordance with UNM emergency plan, which ONE of the following is the MAXIMUM exposure and intake limit for life threatening situations, or to deal with situations which are likely to lead to life-threatening situations?

a. 50 Rem

b. 45 Rem

c. 30 Rem

d. 25 Rem

QUESTION B.18 [1.0 point]
Which ONE of the following reactor conditions is a violation of UNM Technical Specifications?

a. Shutdown margin is $0.50.

b. Excess reactivity is 0.20%Δk/k.

c. Absolute reactivity is 0.55%Δk/k.

d. Shield water temperature is 16ºC.

Category B: Normal/Emergency Operating Procedures and Radiological Controls

QUESTION B.19 [1.0 point]
A radiation survey of an area reveals a general radiation reading of 1 mRem/hr. However, a small section of pipe (point source) reads 10 mRem/hr at one (1) meter. Which ONE of the following is the posting requirement for the area, in accordance with 10 CFR 20?

a. "CAUTION - RADIATION AREA"

b. "CAUTION - HIGH RADIATION AREA"

c. "CAUTION - RADIOACTIVE MATERIAL"

d. "CAUTION - AIRBORNE RADIOACTIVITY AREA"

QUESTION B.20 [1.0 point]
During UNM Annual Reactor Maintenance, select from the following the most correct answer to the statement "when shall a senior reactor operator be present?"

a. Safety Interlocks Check.

b. Whenever the console is energized.

c. Calibration of Nuclear Instrumentation.

d. Core excess reactivity and the worth of the coarse and fine control rods are measured.

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

Category C: Facility and Radiation Monitoring Systems

QUESTION C.01 [1.0 point]
During a startup you attempt to inser the safety rod # 1 and it won't move. Which ONE of the following is the cause?

a. Current reads too low on the Nuclear Instrumentation Channel #1.

b. Current reads too low on the Nuclear Instrumentation Channel #2.

c. Reactor period reads too low.

d. After the last scram, the fine rod drive is fully out.

QUESTION C.02 [1.0 point]
Which ONE of the following is NOT a control rod system interlock?

a. Reactor startup cannot commence unless both safety rods and the coarse control rod are fully withdrawn from the core.

b. At any operating power below $50x10^{-6}$ watts, only the coarse control rod can be inserted.

c. The coarse control rod cannot be inserted unless both safety rods are fully inserted.

d. Only one safety rod can be inserted at a time.

QUESTION C.03 [1.0 point]
Which ONE of the following is designed to contain fission product gases that might leak from the core?

a. Lead shielding.

b. Water shield.

c. Steel Reactor Tank.

d. Aluminum Core Tank.

Category C: Facility and Radiation Monitoring Systems

QUESTION C.04 [1.0 point]
The Low Power Interlock is controlled by power level indication from channel:

a. 1

b. 2

c. 3

d. Auxiliary Channel

QUESTION C.05 [1.0 point]
Which ONE of the following is the design features for the UNM AGN-201M Core?

a. The reactor consists of 9 fuel discs with less than 20% U-235 enrichment

b. The reactor consists of 10 fuel discs with less than 30% U-235 enrichment

c. The reactor consists of 11 fuel discs with less than 20% U-235 enrichment

d. The reactor consists of 12 fuel discs with less than 30% U-235 enrichment

QUESTION C.06 [1.0 point]
An aluminum baffle plate separates the fuel discs in the upper section of the core from the fuel discs in the lower section of the core. Of the total of _____fuel discs, ___are in the upper section and _____are in the lower section.

a. 7; 4; 3

b. 7; 3; 4

c. 9; 6; 3

d. 9; 5; 4

Category C: Facility and Radiation Monitoring Systems

QUESTION C.07 [1.0 point]
Which ONE of the following does NOT automatically cause rod magnet current deactivation?

a. Radiation level.

b. Earthquake Switch.

c. Shield tank temperature =18^{O}C.

d. Shield water level is more than 18cm below highest manhole opening.

QUESTION C.08 [1.0 point]
In the event the reactor fails to scram, the TWO design features that serve to prevent exceeding core temperature limits are the _____.

a. glory Hole Cadmium plug and thermal fuse

b. thermal fuse and large temperature coefficient

c. glory Hole Cadmium plug and volume of water shield

d. large temperature coefficient and volume of water shield

QUESTION C.09 [1.0 point]
Which ONE condition listed below will NOT cause the red light on the safety interlock indicator to illuminate?

a. Shield tank temperature exceeds 18°C.

b. Earthquake switch open.

c. Shield water low level.

d. No magnet current.

Category C: Facility and Radiation Monitoring Systems

QUESTION C.10 [1.0 point]
Where would you go to energize the ventilation system during an emergency evacuation due to high radiation levels?

a. Just inside the door to room 22 (Counting Laboratory).

b. On the reactor laboratory room wall near the east door.

c. On the reactor laboratory room wall near the north doors.

d. On the reactor room wall just inside the door to the laboratory room.

QUESTION C.11 [1.0 point]
The reactor Access Ports pass through the steel tank:

a. up to the graphite.

b. then the lead shield, and the graphite reflector.

c. then the lead shield, the graphite reflector, repeats in reverse, and then back out.

d. then the lead shield, the graphite reflector, the core, repeats in reverse, and then back out.

QUESTION C.12 [1.0 point]
All of the remote area radiation monitors (general lab, reactor top, reactor console, checkpoint three) are _____.

a. G-M detectors

b. ionization chambers

c. scintillation detectors

d. proportional counters

Category C: Facility and Radiation Monitoring Systems

QUESTION C.13 [2.0 points, 0.50 each]
Match the instrument and control system channel in column A with the correct detector listed in column B. (Note: Detectors listed in column B may be used more than once or not at all, however, there is only one answer for each channel.)

	Column A		Column B
a.	Nuclear Instrument Channel #1	1.	Boron-lined Ionization Chamber
b.	Nuclear Instrument Channel #2	2.	Gas-filled U^{235} Fission Chamber
c.	Nuclear Instrument Channel #3	3.	Geiger-Meuller Detector
d.	Auxiliary Channel	4.	Sodium Iodide Scintillation Detector

QUESTION C.14 [1.0 point]
Which ONE of the following is the approximate value for how much the reactor will be shut down by if the safety fuse were to melt?

a. 0.005 Δk/k

b. 0.010 Δk/k

c. 0.050 Δk/k

d. 0.100 Δk/k

QUESTION C.15 [1.0 point]
What material is typically placed in the glory hole to ensure the reactor stays in a sub-critical mode when no one is present?

a. Polyethylene

b. Beryllium

c. Cadmium

d. Boron

Category C: Facility and Radiation Monitoring Systems

QUESTION C.16 [1.0 point]
In order to extend the operating life of the Channel 1 source-range detector:

a. the high voltage on the detector is automatically switched off at high power when the signal from Channel 2 exceeds 5.0 x 10^{-9} Amps.

b. the detector is partially covered by a neutron-absorbing cadmium jacket.

c. the detector is moved away from the neutron flux as power increases.

d. a negative voltage is applied to the detector as power increases.

QUESTION C.17 [1.0 point]
Which ONE of the followings is the MAIN purpose of the thermal fuse?

a. measure the temperature of fuel core.

b. measure any gases released from the fuel core.

c. separate the reactor core to prevent exceeding the Safety Limit (SL.)

d. send a scram signal to the Nuclear Safety # 2 if Limiting Safety System Setting (LSSS) is exceeded.

QUESTION C.18 [1.0 point, 0.25 each]
Match the input signals listed in column A with their respective responses listed in column B. Items in column B may be used more than once or not at all.

Column A		Column B	
a.	Shield water temperature = 20 ˚C	1.	Indication only
b.	Reactor period = 30 sec	2.	Scram
c.	Nuclear Safety # 2 = 120%	3.	Interlock of licensed power
d.	Try to move coarse control rod when both safety rods are fully down		

Category C: Facility and Radiation Monitoring Systems

QUESTION C.19 [1.0 point]
When the reactor is in the Standard Loading #2 as Amended configuration, the 2 Ci Pu-Be source is located in access port _____.

a. 1

b. 2

c. 3

d. 4

(***** END OF CATEGORY C *****)
((***** END OF EXAM *****))

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

A.01
Answer: a
Reference: Burn, R., *Introduction of Nuclear Reactor Operations*, Volume 1, Section 2.7, page 2-59.

A.02
Answer: a: 2; b: 4; c: 1; d: 3
Reference: DOE Fundamentals Handbook, Nuclear Physics and Reactor Theory, Volume 1, Module 2, Paragraph "Neutron Slowing Down and Thermalization" on page 23, also Paragraph "Neutron Classification" on page 29.

A.03
Answer: d
Reference: Burn, R., *Introduction of Nuclear Reactor Operations*, Volume 2, Section 4.6.
For S/D reactor, τ = -80 seconds. Time = 180 seconds.
$P = P_0 e^{t/\tau} = 3 \times 10^6 e^{-180/80} = 3.162 \times 10^5$.

A.04
Answer: a
Reference: Burn, R., *Introduction to Nuclear Reactor Operations*, Volume 1, Section 2.8.9, page 2-63.

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

A.06
Answer: b
Reference: $A = A_o e^{-\lambda t}$ $\lambda = .693 / T2 \rightarrow \ln A/A_o = - .693\ t / T2 \rightarrow T2 = - 0.693 \cdot 24hr / \ln 0.8 =$ 75 hr.

A.07
Answer d
Reference: DOE Fundamentals Handbook, Nuclear Physics and Reactor Theory, Volume 2, Module 3, Enabling Objective 1.1, page 8.

A.08
Answer a
Reference: $P = P_0 e^{t/T}$, $P/P_0 = e^{t/T}$, $\ln (P/P_0) = t/T$. $\ln(400/100) = t/T$, $\ln (4) = t/T = 1.386$, answer (a) power manipulations would take the longest time to complete.

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

A.09
Answer d
Reference: DOE Fundamentals Handbook, Nuclear Physics and Reactor Theory, Volume 1, page 57.

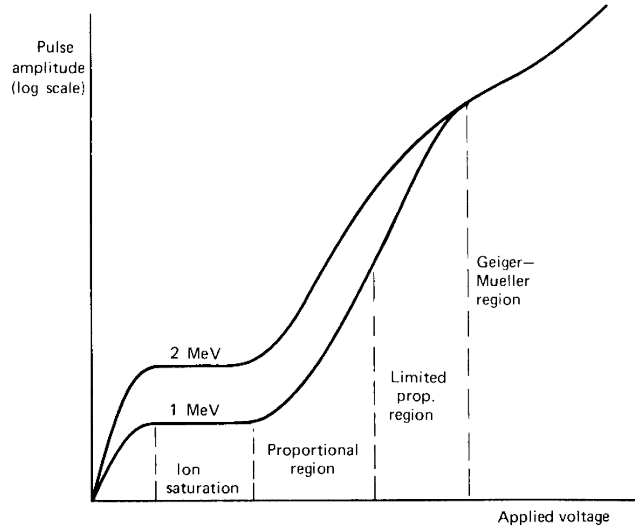
A.10
Answer: a
Reference: DOE Fundamentals Handbook, Nuclear Physics and Reactor Theory, Volume 2, Module 3, "Integral and Differential Rod Worths", pages 51 - 56.

A.11
Answer: c
Reference: DOE Handbook Nuclear Physics & Reactor Theory, Volume 2, Section "Fission Product Poisons**",** page 34.

A.12
Answer c
Reference: $(CR2/CR1) = (1-K_{eff0})/(1-K_{eff1}) = (60/30) = (0.90)(1-K_{eff1})$; $K_{eff1} = 0.95$.

A.13
Answer: a
Reference: Burn, *Introduction to Nuclear Reactor Operations*, Volume 3, Section 5.6, page 5-27.

A.14
Answer: d
Reference: NRC Standard Questions.



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

A.15
Answer: c
Reference: DOE Fundamentals Handbook Nuclear Physics and Reactor Theory, Volume 2, pages 30 - 31.

A.16
Answer: c
Reference: Burn, R., *Introduction to Nuclear Reactor Operations*, Volume 3, Section 6.2.3.

A.17
Answer: b
Reference: DOE Fundamentals Handbook, Nuclear Physics and Reactor Theory, Volume 2, Module 4, page 12.

A.18
Answer: a
Reference: $CR_1 / CR_2 = (1 - K_{eff_2}) / (1 - K_{eff_1}) \rightarrow 60 / 30 = (1 - K_{eff_2}) / (1 - 0.9)$ Therefore $K_{eff_2} = 0.8$
$\Delta\rho = K_{eff_2} - K_{eff_1} / K_{eff_2} \cdot K_{eff_1} = (0.8 - 0.9)/(0.8 \cdot 0.9) = -0.13888.$

A.19
Answer: d
Reference: Burn, R., *Introduction to Nuclear Reactor Operations,* Volume 1, Section 2.5.2, page 2-43.

A.20
Answer d
Reference: DOE Fundamentals Handbook, Nuclear Physics and Reactor Theory, Volume 1, Module 1, Enabling Objective 4.9, pages 61-62.

Category B: Normal/Emergency Operating Procedures and Radiological Controls

B.01
Answer: a
Reference: UNM Reactor Operation and Training Manual, Operating Procedures, General Operating Rules.

B.02
Answer: b
Reference: 10CFR55.53(e).

B.03
Answer: a
Reference: UNM Technical Specifications, 3.3.b Limitations on Experiments, page 11.

B.04
Answer: c
Reference: UNM Emergency Plan, Director of Emergency Operations (DEO), page 5.

B.05
Answer: d
Reference: Dose Rate = $6CiE/R^2$; Dose Rate = 6(30)(2.5)/25 ; Dose Rate = 18 rem/hr.

B.06
Answer: d
Reference: UNM Reactor Operation and Training Manual, page 32.

B.07
Answer: d
Reference: UNM Reactor Operation and Training Manual, Emergency Procedures and Radiation Monitoring Equipment.

B.08
Answer: a
Reference: UNM Emergency Plan, Section 5.0 “Emergency Action Levels”.

B.09
Answer: a
Reference: 10 CFR 20.1003 Definitions.

B.10
Answer: c
Reference: UNM Technical Specifications 3.2.

Category B: Normal/Emergency Operating Procedures and Radiological Controls

B.11
Answer: a. = 6 (4); b. = 2 (2); c. = 2 (2); d. = 1 (1)
Reference: 10 CFR 55.21, 10 CFR 55.55, 10 CFR 55.59.

B.12
Answer: c
Reference: UNM Technical Specifications 4.2.

B.13
Answer: d
Reference: UNM Technical Specifications 3.3c.

B.14
Answer: b
Reference: $DR = DR_{\circ} * e^{-\lambda t}$
The source decayed from 10 Rem/hr to 1 Rem/hr, in two hours. Calculate λ
1 rem/hr =10 rem/hr* $e^{-\lambda(2hr)}$ -->Ln(1/10) = -λ*2 --> solve for λ=0.693.
The source decayed from 10 Rem/hr to 20 mRem/hr, λ=0.693.
0.02 rem/hr =10 rem/hr* $e^{-\lambda(t)}$ -->Ln(0.2/10) = -0.693 (t)
solve for time (t): Ln(0.02/10)=-0.693 (t) → t=8.96 hours.

B.15
Answer: a: check, b: test, c: cal, d: test
Reference: UNM Technical Specifications, Definitions.

B.16
Answer: a
Reference: Using 10CFR20.1201(a)(1) of TEDE 5 Rem (5000 mr) limit, calculate MAXIMUM days for receiving total dose of (200 mr/hr. X (5hrs.per day)).
10CFR20.1201(a)(1): $\frac{[5000\ mr] \times 1\ hr \times day}{200\ mr * 5\ hr.} = 5\ days$

B.17
Answer: d
Reference: 10CFR20.1206 and UNM Emergency Plan 7.3.3

B.18
Answer: d
Reference: UNM Technical Specifications 2.2 and 3.2.

Category B: Normal/Emergency Operating Procedures and Radiological Controls

B.19

Answer: b

Reference: 10 CFR 20.1003. For a point source, 10 mrem/hr at 100 cm (1 meter) = 111. 1 mrem/hr at 30 cm.

B.20

Answer: b

Reference: UNM Reactor Operation and Training Manual – Section IV Maintenance and Inspections, B) Annual Reactor Maintenance, page 44

Category C: Facility and Radiation Monitoring Systems

C.01
Answer: b
Reference: UNM Reactor Operation and Training Manual.

C.02
Answer: b
Reference: UNM Reactor Operation and Training Manual, page 29.

C.03
Answer: d
Reference: UNM Technical Specification 5.1.b.

C.04
Answer: b
Reference: UNM SAR, Part II, Section C Reactor Control, 3 Fine Rod, page 9.

C.05
Answer: a
Reference: UNM Reactor Operation and Training Manual, page 5.

C.06
Answer: c
Reference: UNM SAR, Figure 4 - Fuel Disc Loading, page 5.

C.07
Answer: a
Reference: UNM Reactor Operation and Training Manual, 2) Safety Interlocks, page 15.

C.08
Answer: b
Reference: UNM Technical Specifications, basis for specification 2.2.b.

C.09
Answer: d
Reference: UNM Reactor Operation and Training Manual, page 28.

C.10
Answer: b
Reference: UNM Reactor Operation and Training Manual, V Emergency Procedures Evacuation step iv, page 54.

Category C: Facility and Radiation Monitoring Systems

C.11
Answer: b
Reference: UNM Reactor Operation and Training Manual**,** Figure 5, page 8.

C.12
Answer: a
Reference: UNM Reactor Operation and Training Manual, page 15.

C.13
Answer: a, 2; b, 1; c, 1; d, 1
Reference: UNM Reactor Operations and Training Manual, Instrumentation and Safety Systems, Nuclear Instrumentation, a through d, page 15.

C.14
Answer: c
Reference: UNM Technical Specifications 2.2(b).

C.15
Answer: c
Reference: UNM Reactor Operation and Training Manual, Start-Up Check-out Procedures, page 26.

C.16
Answer: a
Reference: UNM Reactor Operation and Training Manual, page 14.

C.17
Answer: c
Reference: UNM Technical Specification Section 2.2b, page 6.

C.18
Answer: a: 1; b: 1; c: 2; d: 3
Reference: UNM Technical Specifications 3.2.

C.19
Answer: b
Reference: UNM Reactor Operation and Training Manual, page 9.

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