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

April 25, 2019

Robert D. Busch, Ph.D., P.E.
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1 University of New Mexico
MSC-01-1120
Albuquerque, NM 87131-0001

SUBJECT: EXAMINATION REPORT NO. 50-252/OL-19-01, UNIVERSITY OF NEW MEXICO

Dear Dr. Busch:

During the week of March 11, 2019, the U.S. Nuclear Regulatory Commission (NRC) administered an operator licensing examination at your University of New Mexico research 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 (PARS) component of NRC's Agencywide Documents Access and Management System (ADAMS). ADAMS is accessible from the NRC Web site at http://www.nrc.gov/reading-rm/adams.html. The NRC is forwarding the individual grades to you in a separate letter which will not be released publicly. Should you have any questions concerning this examination, please contact Mr. John T. Nguyen at (301) 415-4007 or via internet e-mail John.Nguyen@nrc.gov.

Sincerely,

/RA/

Anthony J. Mendiola, Chief
Research and Test Reactors Oversight Branch
Division of Licensing Projects
Office of Nuclear Reactor Regulation

Docket No. 50-252

Enclosures:
1. Examination Report
   No. 50-252/OL-19-01
2. Written examination

cc: w/o enclosures: See next page

SUBJECT: EXAMINATION REPORT NO. 50-252/OL-19-01, UNIVERSITY OF NEW MEXICO DATED APRIL 25, 2019

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OFFICE	NRR/DLP/PROB/CE	NRR/DLP/PROB/OLA	NRR/DLP/PROB/BC
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DATE	04/02/2019	04/16/2019	04/25/2019

OFFICIAL RECORD COPY

cc:

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Deputy Secretary, Office of the Secretary
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Test, Research and Training
Reactor Newsletter
Attention: Amber Johnson
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U.S. NUCLEAR REGULATORY COMMISSION
OPERATOR LICENSING INITIAL EXAMINATION REPORT

REPORT NO.: 50-252/OL-19-01

FACILITY DOCKET NO.: 50-252

FACILITY LICENSE NO.: R-102

FACILITY: AGN

EXAMINATION DATES: March 11 - 15, 2019

SUBMITTED BY: ***/RA/*** 04/02/2019
John T. Nguyen, Chief Examiner Date

SUMMARY:
During the week of March 11, 2019, the NRC administered an operator licensing examination to four Reactor Operator (RO) and one Senior Reactor Operator Instant (SROI) candidates. One RO candidate failed both the written examination and operating test. One RO candidate failed the written examination. All other candidates passed all applicable portions of the examination.

REPORT DETAILS

1. Examiner: John T. Nguyen, Chief Examiner, NRC

2. Results:

	RO PASS/FAIL	SRO PASS/FAIL	TOTAL PASS/FAIL
Written	2/2	1/0	3/2
Operating Tests	3/1	1/0	4/1
Overall	2/2	1/0	3/2

3. Exit Meeting:
John T. Nguyen, Chief Examiner, NRC
Robert Busch, Chief Reactor Supervisor, UNMR
Ken Carpenter, Training Supervisor, UNMR

At the conclusion of the meeting, the NRC examiner thanked the facility for their support in the administration of the examination. The examiner also discussed the generic weaknesses observed during the operating test to include questions related to the nuclear instrumentation systems and neutron source.

ENCLOSURE 1

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

FACILITY: University of New Mexico

REACTOR TYPE: AGN

DATE ADMINISTERED: 3/12/2019

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
18.00	33.3	_____	_____	A. REACTOR THEORY, THERMODYNAMICS AND FACILITY OPERATING CHARACTERISTICS
18.00	33.3	_____	_____	B. NORMAL AND EMERGENCY OPERATING PROCEDURES AND RADIOLOGICAL CONTROLS
14.00	33.3	_____	_____	C. FACILITY AND RADIATION MONITORING SYSTEMS
50.00		_____ FINAL GRADE	_____ %	TOTALS

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

_____
Candidate's Signature

ENCLOSURE 2

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 ___ (0.25 each)

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 ___ (0.25 each)

A15 a b c d ___

A16 a b c d ___

A17 a b c d ___

A18 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 ___ (0.25 each)

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 ___ (0.5 each)

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

C. PLANT AND RAD 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 ___ (0.25 each)

C14 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.

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

EQUATION SHEET

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

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

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

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

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

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

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

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

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

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

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

$$CR_1(-\rho_1) = CR_2(-\rho_2)$$
$$CR_1(1 - K_{eff_1}) = CR_2(1 - K_{eff_2})$$

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

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

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

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

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

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

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

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

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

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

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

---

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

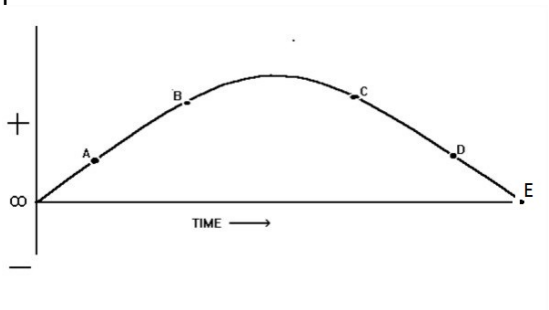
°F = 9/5 °C + 32

°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]
Shown below is a trace of reactor period as a function of time. Between points A and E reactor power is:



a. constant.

b. continually increasing.

c. increasing, then constant.

d. increasing, decreasing, then constant.

QUESTION A.02 [1.0 point]
Which ONE of the following conditions will require the control rod insertion to maintain constant power level after the following change?

a. Adding of 0.1 %Δk/k into the Access Port.

b. Decrease the shield water temperature.

c. Removal of an experiment containing borated graphite.

d. Insertion of an experiment containing xenon into the Access Port.

QUESTION A.03 [1.0 point]
The reactor is critical at 0.1 watt. A control rod is inserted a positive reactivity of 0.20% Δk/k. Which ONE of the following will be the stable reactor period as a result of this reactivity insertion? Given beta effective = 0.0078

a. 10 seconds

b. 29 seconds

c. 42 seconds

d. 80 seconds

QUESTION A.04 [1.0 point]
Which ONE of the following types of neutrons has a mean neutron generation lifetime of about 12 seconds?

a. Prompt

b. Delayed

c. Fast

d. Thermal

QUESTION A.05 [1.0 point]
Which type of neutron interaction (light nuclei) is most important in moderating fast neutrons to thermal energies?

a. Radiative capture

b. Elastic scattering

c. Inelastic scattering

d. Charged particle reactions

QUESTION A.06 [1.0 point, 0.25 each]
Match the term listed in Column A with its corresponding unit listed in column B (use only once).

	Column A	Column B
a.	1 barn	1. cm^{-1}
b.	Macroscopic Cross Section	2. $10^{-24}\ cm^2$
c.	Neutron Flux	3. Neutrons / cm^2 /sec
d.	Reaction Rate	4. Fissions / cm^3 sec

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

QUESTION A.07 [1.0 point]
Reactor power is 0.1 watt. Reactor Operator inserts a sample worth of 0.06 %Δk/k into the reactor core. Which ONE of the following best describes the reactor kinetic? The reactor is:

a. subcritical

b. critical

c. supercritical

d. prompt critical

QUESTION A.08 [1.0 point]
If the multiplication factor, k, is increased from 0.800 to 0.950, the amount of reactivity added is:

a. 0.50 Δk/k

b. 0.197 Δk/k

c. 0.150 Δk/k

d. -0.150 Δk/k

QUESTION A.09 [1.0 point]
Several processes occur that may increase or decrease the available number of neutrons. SELECT ONE of the following six-factor formula term that describes an INCREASE in the number of neutrons during the cycle.

a. Thermal Non-leakage Probability.

b. Resonance Escape Probability.

c. Thermal Utilization Factor.

d. Reproduction Factor.

QUESTION A.10 [1.0 point]
Given a source strength of 2000 neutrons per second (N/sec) and a multiplication factor of 0.6, which ONE of the following is the expected stable neutron count rate?

a. 3333 N/sec

b. 5000 N/sec

c. 33333 N/sec

d. 50000 N/sec

QUESTION A.11 [1.0 point]
Reactor power is rising on a 20 second period. Approximately how long will it take for power to double?

a. 14 seconds

b. 29 seconds

c. 55 seconds

d. 72 seconds

QUESTION A.12 [1.0 point]
The reactor is critical and increasing in power. Power has increased from 20 mW to 40 mW in 10 seconds. How long will it take at this rate for power to increase from 0.040 W to 1 W?

a. 26 seconds

b. 46 seconds

c. 66 seconds

d. 80 seconds

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

QUESTION A.13 [1.0 point]
Which one of the following is the principal source of heat in the reactor after a shutdown from extended operation at full power?

a. Production of delayed neutrons

b. Subcritical reaction of photoneutrons

c. Spontaneous fission of U^{238}

d. Decay of fission fragments

QUESTION A.14 [1.0 point, 0.25 each]
A fissile material is one that will be fission upon absorption of a thermal neutron. A fertile material is one that absorbs a neutron and becomes a fissile material. Identify each of the listed isotopes as either fissile or fertile.

a. Th-232

b. U-235

c. U-238

d. Pu-239

QUESTION A.15 [1.0 point] **Additional answer key was added during the administration of the examination**

Which one of the following factors in the "four factor" formula is the most strongly affected by the control rod material?

a. Fast fission factor (ε)

b. Thermal utilization factor (f)

c. Reproduction factor (η)

d. Resonance escape probability (p)

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

QUESTION A.16 [1.0 point]
Which ONE of the following is the stable reactor period which will result in a power rise from 10% to 100% power in 10 seconds?

a. 4 seconds

b. 10 seconds

c. 24 seconds

d. 43 seconds

QUESTION A.17 [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 to three minutes later?

a. 1×10^6 cpm

b. 8×10^5 cpm

c. 5×10^5 cpm

d. 3×10^5 cpm

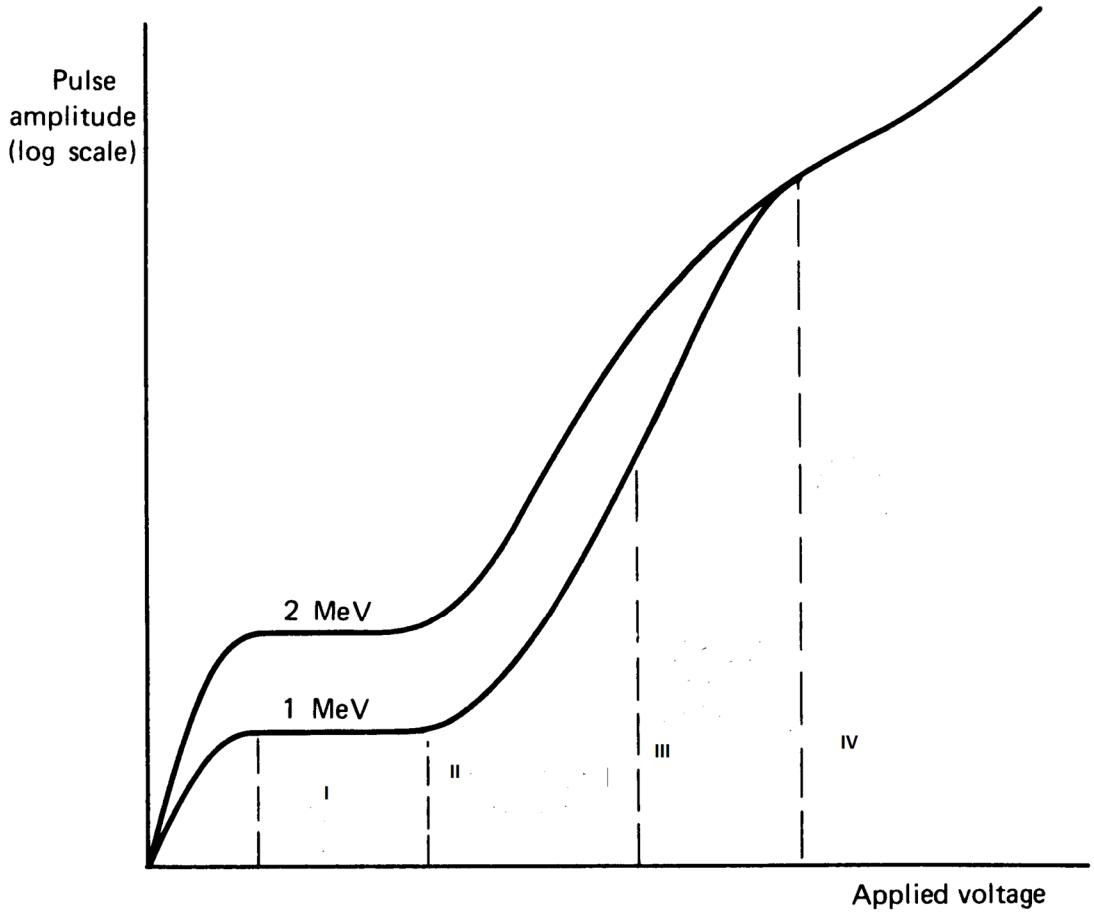
QUESTION A.18 [1.0 point]
Graph below depicts the different regions of operation for gas-filled detectors. Which ONE of the following labels is the Geiger-Mueller region?

a. I

b. II

c. III

d. IV



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

Category B: Normal/Emergency Operating Procedures and Radiological Controls

QUESTION B.01 [1.0 point]
Per UNMR Technical Specifications, temporary procedure changes which do NOT change the intent of the original procedure or involve a 10CFR50.59 review may be approved as a MINIMUM by the:

a. Senior Reactor Operator

b. Chief Reactor Supervisor

c. Reactor Administration and Reactor Safety Advisor Committee

d. Nuclear Regulatory Commission

QUESTION B.02 [1.0 point]
Which ONE of the following would violate the Limiting Safety System Setting for the UNMR?

a. The shutdown margin is less than one dollar.

b. Nuclear Safety Channel #2 exceeds 115 % of licensed power.

c. The average reactivity addition rate for each control rod exceeds 0.065% Δk/k per second.

d. The polystyrene core thermal fuse melts when heated to a temperature of about 120ºC resulting in core separation and a reactivity loss greater than 5% Δk/k.

QUESTION B.03 [1.0 point]
During an emergency, who is responsible for supervising decontamination actions including the decontamination and/or preparation of contaminated injured personnel?

a. Director of Emergency Operations (DEO)

b. Emergency Preparedness Coordinator (EPC)

c. Reactor Safety and Recovery Operations Coordinator (ROC)

d. Radiation Safety and Dose Assessment Coordinator (DAC)

Category B: Normal/Emergency Operating Procedures and Radiological Controls

QUESTION B.04 [1.0 point]
Which of the following statements best states the MINIMUM staffing requirements when the reactor is not secured?

a. 1 RO and SRO in the control room.

b. 1 RO in the control room and 1 SRO license at the facility.

c. 1 RO and a designated person capable of performing a reactor shutdown in the control room; 1 SRO on call; 1 HP on call.

d. 1 SRO and a designated person capable of performing a reactor shutdown in the control room; 1 SRO on call; 1 HP on call.

QUESTION B.05 [1.0 point]
The Technical Specification basis for the shield water temperature interlock is to prevent:

a. breakdown of the graphite reflector.

b. instrument inaccuracy.

c. release of Ar-41.

d. reactivity additions.

QUESTION B.06 [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 to any person occupying an unrestricted area in excess of 0.1 rem.

Category B: Normal/Emergency Operating Procedures and Radiological Controls

QUESTION B.07 [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).

a. During a normal operation, you compare the readings of the Nuclear Safety channel #2 and the Nuclear Safety channel #3.

b. During performance of the daily checklist, you depress a scram bar to verify a manual scram.

c. You adjustment the Power Safety channels in accordance with recent data collected during a gold foil calibration.

d. You expose a check source to the radiation area monitor detector to verify that its output is operable

QUESTION B.08 [1.0 point]
Per UNMR Technical Specifications, the reactor is considered “Secured” when:

a. the reactor is subcritical at $1.0.

b. the reactor console key switch is in the "OFF" position and all safety and control rods are withdrawn.

c. the core fuse melts resulting in separation of the core and the Cd rod is in the glory hole.

d. all safety and control rods are withdrawn and the key is in the OFF position; the key is removed from the console and under the control of a licensed operator; and the Cd rod is in the glory hole.

QUESTION B.09 [1.0 point]
The dose rate from a mixed beta-gamma point source is 100 mrem/hour at a distance of one (1) foot, and is 0.1 mrem/hour at a distance of ten (10) feet. What percentage of the source consists of beta radiation?

a. 30%

b. 50%

c. 70%

d. 90%

Category B: Normal/Emergency Operating Procedures and Radiological Controls

QUESTION B.10 [1.0 point]
Control rod scram times shall be measured:

a. quarterly

b. semi-annually

c. annually

d. every two years

QUESTION B.11 [1.0 point]
An area in which radiation levels could result in an individual receiving a dose equivalent of 120 mRem/hr at 30 cm is defined as:

a. Radiation area

b. Unrestricted Area

c. High Radiation Area

d. Very High Radiation Area

QUESTION B.12 [1.0 point]
“Deep Dose Equivalent” as defined in 10 CFR 20 is:

a. The concentration of a radio-nuclide in air which, if inhaled by an adult worker for a year, results in a total effective dose equivalent of 100 mrem.

b. The portion of the dose equivalent received from radiative material taken into the body.

c. The portion of the dose equivalent received from radiation sources outside the body.

d. The dose equivalent at a tissue depth of 1 cm.

Category B: Normal/Emergency Operating Procedures and Radiological Controls

QUESTION B.13 [1.0 point]
The safety rods and coarse control rod shall be interlocked such that at any operating power below _____, none of the rods can be moved to a more reactive position.

a. 5 watts

b. 1 watt

c. 50×10^{-5} watts

d. 50×10^{-6} watts

QUESTION B.14 [1.0 point]
Which ONE of the following is NOT considered a reportable event?

a. During the reactor operation, a student inserted an experiment to cause 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 will let the power drift up to the 6 Watt limit, whereupon a reactor scram occurs.

QUESTION B.15 [1.0 point]
A two-curie source, emitted 80% of 100 Kev gamma, is to be stored in the reactor building. How far from the source will it read 100 mrem/hr?

a. 3 feet

b. 10 feet

c. 13 feet

d. 100 feet

Category B: Normal/Emergency Operating Procedures and Radiological Controls

QUESTION B.16 [1.0 point]
Reactor Operator works in a high radiation area for eight (8) hours a day. The dose rate in the area is 100 mrem/hour. Which ONE of the following is the MAXIMUM number of days in which Reactor Operator may perform his duties WITHOUT exceeding 10 CFR 20 limits?

a. 5 days

b. 6 days

c. 7 days

d. 12 days

QUESTION B.17 [2.0 points, 0.5 each]
Match the annual dose limit values to the type of exposure. Answer in Column B can be used more than once, or not at all.

	Type of Exposure		Annual Dose Limit Value
a.	Extremities	1.	0.1 rem
b.	Lens of the Eye	2.	0.5 rem
c.	Occupational Total Effective Dose Equivalent (TEDE)	3.	5.0 rem
d.	TEDE to a member of the public	4.	15.0 rem
		5.	50.0 rem

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

Category C: Facility and Radiation Monitoring Systems

QUESTION C.01 [1.0 point]
In the event the reactor fails to scram, TWO design features that prevent the core temperature exceeding the safety limit are:

a. Large temperature coefficient and volume of water shield.

b. Glory Hole Cadmium plug and volume of water shield.

c. Thermal fuse and large negative temperature coefficient.

d. Large positive temperature coefficient and thermal fuse.

QUESTION C.02 [1.0 point]
Which ONE of the following channels uses a positively-biased high voltage of 250 VDC?

a. Channel 1

b. Channel 2

c. Channel 3

d. Auxiliary Channel

QUESTION C.03 [1.0 point]
During a reactor operation of 1 watt, you observe that the shield water temperature indicates 15 ° C. For this temperature, you should:

a. increase power to 5 watts so you can observe the temperature change.

b. continue to operate because the shield water temperature is within TS limit.

c. shutdown the reactor; immediately report the result to Reactor Supervisor because the reactor control and safety systems are not operable.

d. continue operation; but immediately report the result to the Senior Reactor Operator since the temperature is decreasing below the facility operation limit.

Category C: Facility and Radiation Monitoring Systems

QUESTION C.04 [1.0 point]
For power calibration, the measurement will be made by irradiating a _____ at _____ (nominal) at the center of the core.

a. gold foil / 5 watts

b. nickel foil / 5 watts

c. gold foil / 3 watts

d. nickel foil / 3 watts

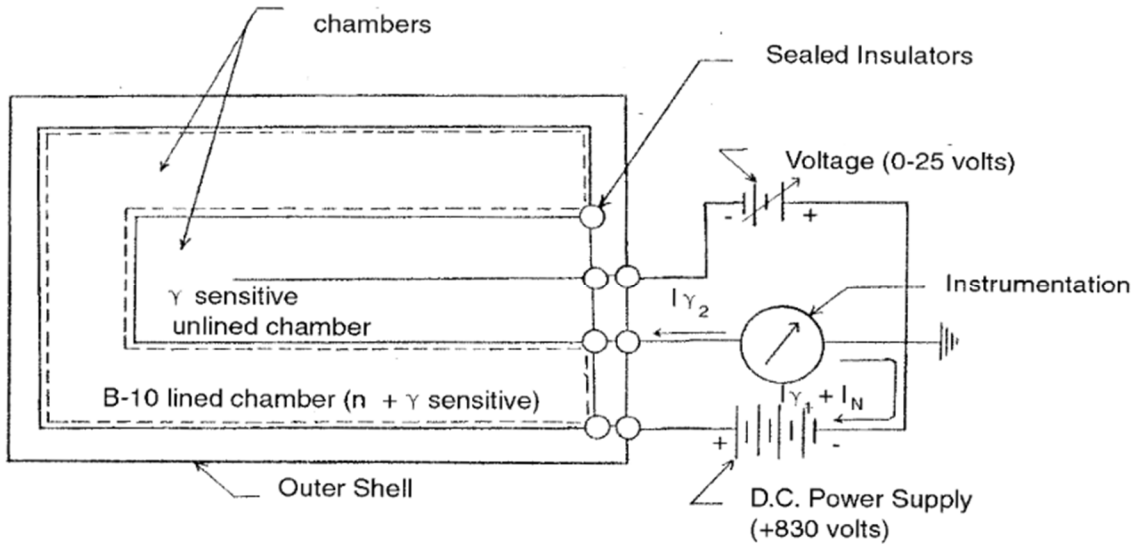
QUESTION C.05 [1.0 point]
The Figure below depicts:

a. The Compensated Ion Chamber.

b. The Uncompensated Ion Chamber.

c. The Scintillation Chamber.

d. The Fission Chamber.



Category C: Facility and Radiation Monitoring Systems

QUESTION C.06 [1.0 point]
Which ONE of the following is the design features for the UNMR AGN-201M Core?

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

b. The reactor consists of 9 fuel disc with less than 30% U-235 enrichment

c. The reactor consists of 12 fuel disc with less than 20% U-235 enrichment

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

QUESTION C.07 [1.0 point]
Which power channel detector high voltage is automatically removed when a pre-selected power level is reached?

a. Channel # 1.

b. Channel # 2.

c. Channel # 3.

d. Auxiliary Channel.

QUESTION C.08 [1.0 point]
Which ONE of the following is the MAXIMUM acceptable time between the initiation of a scram signal and the time that the SAFETY rods are fully withdrawn from the core?

a. 1100 msec

b. 900 msec

c. 800 msec

d. 500 msec

Category C: Facility and Radiation Monitoring Systems

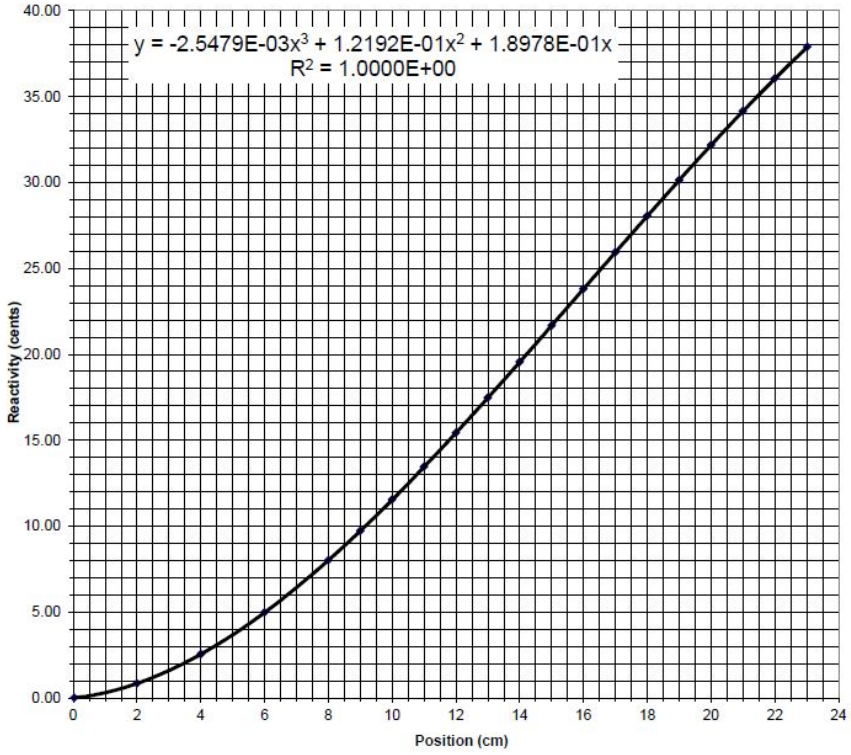
QUESTION C.09 [1.0 point]
The Figure below depicts:

a. Integral worth curve for the Fine Rod

b. Integral worth curve for the Coarse Rod

c. Differential worth curve for the Fine Rod

d. Differential worth curve for the Coarse Rod



QUESTION C.10 [1.0 point]
Which **ONE** of the following is the MAIN function of the high density graphite surrounding the reactor core?

a. To absorb thermal neutrons

b. To reduce neutron leakage

c. To absorb fission product gases

d. To reduce prompt gamma rays

Category C: Facility and Radiation Monitoring Systems

QUESTION C.11 [1.0 point]
Per UNMR Technical Specifications, which ONE of the following statement is considered the Design Feature?

a. The shutdown margin shall be at least one dollars.

b. Control rod drop scram times shall be measured annually.

c. The maximum core temperature shall not exceed 200 °C during operation.

d. The core, reflector and lead shielding are enclosed in and supported by a fluid-tight steel reactor tank.

QUESTION C.12 [1.0 point]
The MAIN purpose of the thermal fuse is to:

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.13 [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% of licensed power	3.	Interlock
d.	Try to move coarse control rod when both safety rods are fully down		

Category C: Facility and Radiation Monitoring Systems

QUESTION C.14 [1.0 point]
During an emergency evacuation due to fire, you should proceed to the Hold Station located in the:

a. North of the Nuclear Engineering Laboratory Building.

b. Office of the Reactor Supervisor.

c. Reactor Control room.

d. Counting Laboratory.

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

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

A.01
Answer: c
Reference: Reactor keeps increasing (positive period), then constant when reactor period reaches to infinitive.

A.02
Answer: d
Reference: Burn, R., Introduction of Nuclear Reactor Operations, © 1988, Sec 3.3.1

A.03
Answer: b
Reference: Reactivity added = 0.20 % $\Delta k/k$ = 0.0020 Δ k/k
$\tau = (\beta-\rho)/\lambda_{eff}\rho = \frac{0.0078 - 0.0020}{(0.1)\ (0.0020)}$ = 29 seconds

A.04
Answer: b
Reference: DOE Handbook, Volume 1, NP-02, pg. 31

A.05
Answer: b
Reference: Lamarsh 3rd ed., Section 3.6, pg. 68-71
Basic Nuclear Engineering 4th ed., Slowing Down of Neutrons, pg. 226-227

A.06
Answer: a(2) b(1) c(3) d(4) (0.25 each)
Reference: Burn, R., Introduction to Nuclear Reactor Operations, © 1988, Sec 2.6

A.07
Answer: c
Reference: Burn, R., Introduction of Nuclear Reactor Operations, © 1988, Sec 4.2

A.08
Answer: b
Reference: Burn, R., Introduction to Nuclear Reactor Operations, © 1982, Sec 3.3.3, page 3-21.
$\Delta\rho$ = keff1-keff2/(keff1 x keff2) = 0.95-0.8 /(0.8*0.95)=0.197 $\Delta k/k$

A.09
Answer: d
Reference: Burn, R., Introduction to Nuclear Reactor Operations, ©3.3, 1988

A.10
Answer: b
Reference: CR = S/(1-K) $\rightarrow$ CR = 2000/(1 - 0.6) = 5000 N/sec

A.11
Answer: a
Reference: $P = P_0\ e^{t/T}$ —> ln(2) = time ÷ 20 seconds –> time = ln (2) x 20 sec.
≈ 13.8 sec.

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

A.12
Answer: b
Reference: $P = Poe^{t/T}$ $40 = 20e^{10\ sec/T}$ $T = 14.4$ sec $1\ watt = 0.040e^{t/14.4}$
$t = 46$ sec

A.13
Answer d
Reference: DOE Fundamentals Handbook, Nuclear Physics and Reactor Theory Volume 1, Module 1, Enabling Objective 4.9, p. 61.

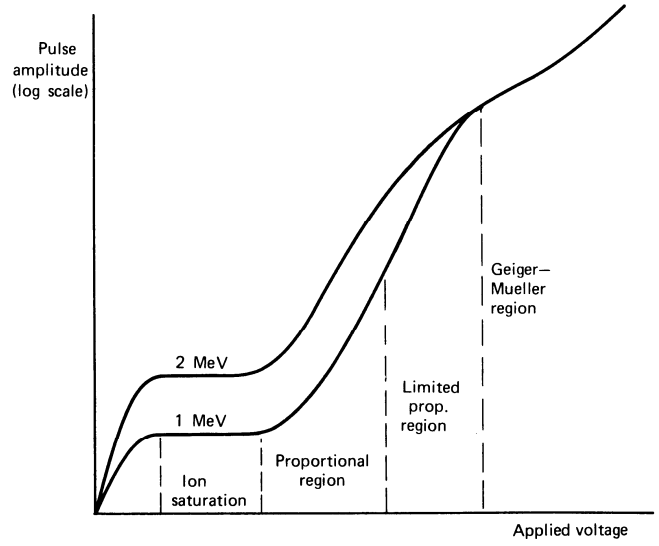
A.14
Answer: a. = fertile; b. = fissile; c. = fertile; d. = fissile (0.25 each)
Reference: Burn, R., Introduction of Nuclear Reactor Operations, © 1988, Sec 3.2

A.15 **Additional answer key was added during the administration of the examination. Either b or c was a correct answer.**
Answer: b or c
Reference: Burn, R., Introduction to Nuclear Reactor Operations, © 1988, § 3.13

A.16
Answer: a
Reference: $P = P_0\ e^{t/T}$ —> $T = t/Ln(P/P_0)$
$T = 10/Ln(100/10)$; $T = 4.34$ sec.

A.17
Answer: d
Reference: Burn, R., Introduction of Nuclear Reactor Operations, © 1988, Sec 4.6
For S/D reactor, $\tau = -80$ seconds. Time = 180 seconds.
$P = P0\ e^{t/\tau} = 3 \times 10^6\ e^{-180/80} = 3.162 \times 10^5$

A.18
Answer: d
Reference: NRC Standard Questions



Category B: Normal/Emergency Operating Procedures and Radiological Controls

B.01
Answer: b
Reference: TS 6.6

B.02
Answer: d
Reference: TS 2.2

B.03
Answer: d
Reference: EP 3.3

B.04
Answer: c
Reference: TS 6.1.3

B.05
Answer: d
Reference: TS 3.2

B.06
Answer: a
Reference: TS 3.3

B.07
Answer: a (check), b (test), c (cal) d (test) (0.25 each)
Reference: TS definitions

B.08
Answer: d
Reference: TS 1.1.24

B.09
Answer: d
Reference: 10CFR20 - At 10 feet, there is no beta radiation.
Calculate gamma at 1 ft.
DR1*(D1) 2= DR2*(D2) 2
0.1*(10) 2= DR2*(1) 2
gamma at 1 foot = 10 mrem/hour.
Therefore, beta at 1 foot = 90 mrem/hour or 90%.

Category B: Normal/Emergency Operating Procedures and Radiological Controls

B.10
Answer: c
Reference: TS 4.1

B.11
Answer: c
Reference: 10CFR20

B.12
Answer: d
Reference: 10CFR20.1003, Definitions

B.13
Answer: d
Reference: TS 3.2

B.14
Answer: d
Reference: Operations Manual, page 32

B.15
Answer: a
Reference: 6CEN = R/hr @ 1 ft. -> 6 x 2 x 0.8 x 0.1 = 0.96 R/hr at 1ft.
$I_0D_0^2 = I*D^2$
$0.96\ R/hr*(1\ ft)^2 = 0.1\ R/hr\ *D^2$
D= sqrt(0.96/0.1) = 3 ft.

B.16
Answer: b
Reference: 10CFR20.1201(a)(1) $\frac{[5000\ mr \times 1\ hr \times day}{100\ mr * 8\ hr} = 6.25$ days

B.17
Answer: a = 5; b = 4; c = 3; d = 1 (0.5 each)
Reference: 10 CFR 20 §§ 1201.a(2)(ii), 1201.a(1), 1201.a(2)(i), 1301

Category C: Facility and Radiation Monitoring Systems

C.01
Answer: c
Reference: TS 2.2, basis

C.02
Answer: a
Reference: Operations Manual, page 14

C.03
Answer: c
Reference: TS 3.2.h

C.04
Answer: c
Reference: Operations Manual, page 33

C.05
Answer: a
Reference: NRC Standard Questions

C.06
Answer: a
Reference: Operations Manual, page 5

C.07
Answer: a
Reference: Operations Manual, Start-up Procedure, page 27

C.08
Answer: b
Reference: TS 3.2

C.09
Answer: a
Reference: Operations Manual, page 13

C.10
Answer: b
Reference: NRC Standard Questions

Category C: Facility and Radiation Monitoring Systems

C.11
Answer: d
Reference: TS 5.1

C.12
Answer: c
Reference: Operations Manual, page 5

C.13
Answer: a, 1; b, 1; c, 2; d, 3 (0.25 each)
Reference: TS 3.2

C.14
Answer: a
Reference: Operations Manual, page 51