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

June 7, 2024

Dr. Mary Lou Dunzik-Gougar
Reactor Administrator
Idaho State University
College of Science and Engineering
921 South 8th Avenue, MS 8065
Pocatello, ID 83209-8065

SUBJECT: EXAMINATION REPORT NO. 50-284/OL-24-01, IDAHO STATE UNIVERSITY

Dear Dr. Dunzik-Gougar:

During the week of May 13, 2024, the U.S. Nuclear Regulatory Commission (NRC) administered operator licensing examinations at your Idaho State University 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 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 Tate, Travis
on 06/07/24

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. 50-284

Enclosures:
1. Examination Report No. 50-284/OL-24-01
2. Written examination

cc: w/enclosures to GovDelivery Subscribers

SUBJECT: EXAMINATION REPORT NO. 50-284/OL-24-01, IDAHO STATE UNIVERSITY
DATED: JUNE 7, 2024

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NAME	MDeSouza	NJones	TTate
DATE	6/7/2024	6/7/2024	6/7/2024

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

REPORT NO.: 50-284/24-01

FACILITY DOCKET NO.: 50-284

FACILITY LICENSE NO.: R-110

FACILITY: Idaho State University

EXAMINATION DATES: Week of May 13, 2017

SUBMITTED BY: Michele DeSouza 5/17/2024
Michele C. DeSouza, Chief Examiner
Date

SUMMARY:
During the week of May 13, the NRC administered operator licensing examinations to one Senior Reactor Operator-Instant (SRO-I) candidate and nine Reactor Operator (RO) candidates. One RO candidate failed the written examination but passed the operating test. The remaining candidates passed all applicable portions of the examination.

REPORT DETAILS

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

2. Results:

	RO PASS/FAIL	SRO PASS/FAIL	TOTAL PASS/FAIL
Written	8/1	1/0	9/1
Operating Tests	9/0	1/0	10/0
Overall	8/1	1/0	9/1

3. Exit Meeting:
Dr. Mary Lou Dunzik-Gougar, Reactor Administrator, ISU
Mackenzie Gorham, Training Coordinator, ISU
Michele C. DeSouza, Chief Examiner, 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.

U.S.NRC

UNITED STATES NUCLEAR REGULATORY COMMISSION

Protecting People and the Environment

Idaho State University

Operator Licensing

Examination Week of May

13, 2024

Enclosure 2

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

FACILITY: Idaho State University

REACTOR TYPE: AGN-201M

DATE ADMINISTERED: 05/17/2024

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 _____ (0.25 each)

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 _____ (0.25 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 ___

C19 a b c d ___

C20 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 is defined as the balance between production of neutrons and their absorption in the core for which core leakage can be neglected?

a. Utilization factor

b. Reproduction factor

c. Infinite multiplication factor

d. Effective multiplication factor

QUESTION A.02 [1.0 point, 0.25 each]
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]
What is the effect of delayed neutrons on the reactor power following a scram from full power?

a. Decrease the mean neutron lifetime.

b. Adds negative reactivity creating a greater shutdown margin.

c. Adds positive reactivity due to the fuel temperature decrease following the scram.

d. Limits the final rate at which power decreases to a negative 80 second period.

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]
If beta for U-235 is 0.0065 and beta effective is approximately 0.007, then the period is _____ when beta effective is used instead of beta in the reactor period equation $T = \frac{\beta - \rho}{\lambda \rho}$.

a. Stable period

b. Longer period

c. Shorter period

d. Decay constant (λ) increase

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

QUESTION A.07 [1.0 point]
Which ONE of the following most accurately describes the reason that fission products such as Xenon-135 and Samarium-149 have the most substantial impact in reactor design and operation?

a. Xenon-135 and Samarium-149 cause excess positive reactivity in the core.

b. Xenon-135 and Samarium-149 emit thermal neutrons.

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.

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

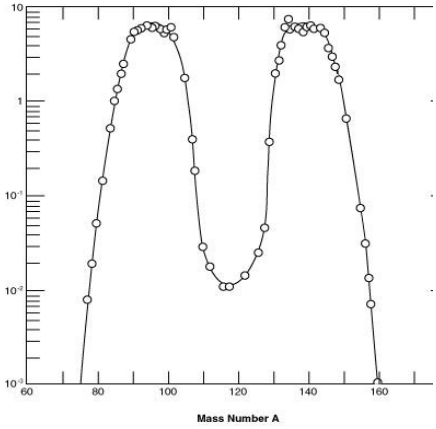
QUESTION A.09 [1.0 point]
The following graph for U-235 depicts……

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]
What is the meaning of any point on a differential rod worth curve?

a. The negative reactivity added as the rod is inserted.

b. The cumulative area under the differential curve starting from the bottom of the core.

c. The amount of reactivity that a given unit of rod motion would insert at that position in the core.

d. The zero reactivity when the rod is on the bottom and the positive reactivity being added as the rod is withdrawn.

QUESTION A.11 [1.0 point]
Which ONE of the following is the definition of REACTIVITY?

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

b. Fractional departure from criticality

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.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]
Which ONE of the following factors in the 'six factor formula' is the most affected by the negative temperature coefficient?

a. Fast fission factor

b. Thermal utilization factor

c. Fast non-leakage probability

d. Thermal non-leakage probability

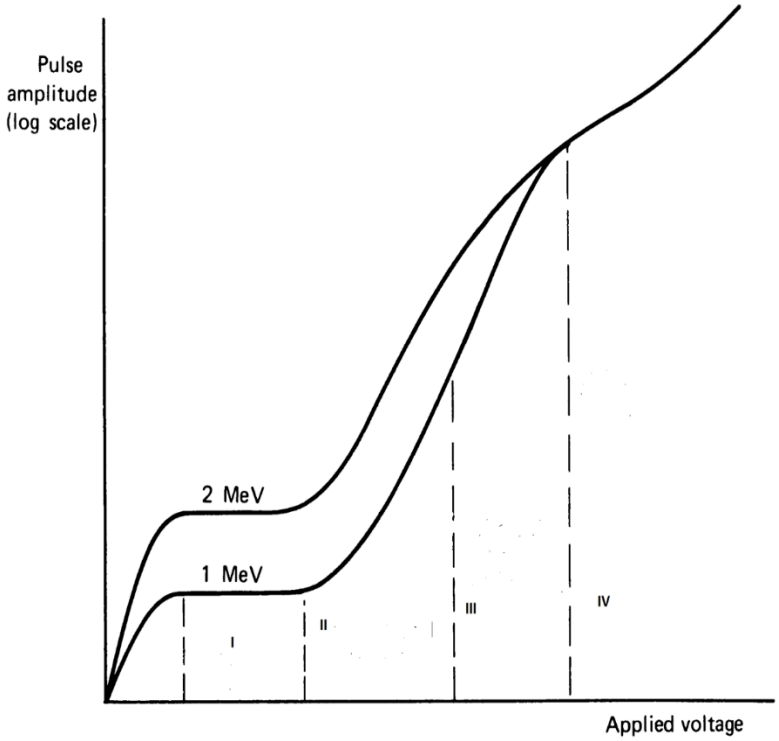
QUESTION A.14 [1.0 point]
The graph below depicts the different regions of operation for a gas-filled detector. Which ONE of the following labels is the Geiger-Mueller region?

a. I

b. II

c. III

d. IV



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

QUESTION A.15 [1.0 point]
Five minutes after shutdown of the reactor, reactor power is 3×10^6 counts per minute (cpm). Which ONE of the following is the count rate you would expect two minutes later?

a. 1×10^5 cpm

b. 3×10^5 cpm

c. 5×10^5 cpm

d. 7×10^5 cpm

QUESTION A.16 [1.0 point]
Which ONE of the following is the definition of the term SHUTDOWN MARGIN?

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]
During rod insertion of start-up, as the reactor approaches critical, which ONE of the following is the value of 1/M?

a. Increases toward one

b. Decreases toward one

c. Increases toward infinity

d. Decreases toward zero

QUESTION A.18 [1.0 point]
Which ONE of the following does the term PROMPT CRITICAL refer to?

a. Reactivity insertion which is less than β_{eff}

b. Reactor which is critical by using only prompt neutrons

c. Instantaneous jump in power due to a removal of the control rods

d. Reactor which is critical by using both prompt and delayed neutrons

QUESTION A.19 [1.0 point]
Which ONE of the following isotopes is fissile?

a. U-235

b. Th-238

c. Pu-238

d. Cm-242

QUESTION A.20 [1.0 point]
Which ONE of the following is the major source of energy released during fission?

a. Neutrino interactions

b. Fission fragments

c. Fission neutron scattering

d. Absorption of prompt gamma rays

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

Category B: Normal/Emergency Operating Procedures and Radiological Controls

QUESTION B.01 [1.0 point]
Which ONE of the following is NOT considered a reportable event?

a. Deployment of the thermal fuse.

b. During the reactor operation, the operator found fission products released from fuel.

c. During the reactor operation, the operator found a disagreement between expected and actual critical rod positions of 0.4%Δk/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.02 [1.0 point]
ISU Technical Specifications states: a loss of electrical power shall cause the reactor to scram. This is an example of _____.

a. Design Features

b. Surveillance Requirements

c. Limiting Conditions for Operation

d. Limiting Safety System Settings

QUESTION B.03 [1.0 point]
A reactor operator (RO) works in a high radiation area for eight hours a day. The dose rate in the area is 50 mrem/hour. Which ONE of the following is the MAXIMUM number of days in which the RO may perform his duties WITHOUT exceeding 10 CFR 20 limits?

a. 10 days

b. 11 days

c. 12 days

d. 13 days

Category B: Normal/Emergency Operating Procedures and Radiological Controls

QUESTION B.04 [1.0 point]
The Emergency Planning Zone (EPZ) consists of:

a. Room 20 (reactor lab) and room 23 (subcritical assembly) on the first level of the LEL building.

b. Room 20 (reactor lab) and room 22 (counting lab) on the first level of the LEL building.

c. Room 23 (subcritical assembly) and room 22 (counting lab) on the first level of the LEL.

d. Room 126 (machine shop and emergency support center) on the second level of the LEL building.

QUESTION B.05 [1.0 point]
Which ONE of the following is the required interval for 'control rod scram times and average reactivity insertion' measurements?

a. Quarterly

b. Semi-annually

c. Annually

d. Biennial

QUESTION B.06 [1.0 point]
As a licensed ISU reactor operator, which ONE of the following is allowed to manipulate the controls of the reactor under your direction?

a. A student participating in a reactor operator training program.

b. A health physicist who is trying to earn a certified health physicist (CHP) license.

c. A local college newspaper reporter who wants to write a story on the safety of nuclear reactors.

3.
d. An NRC examiner trying to make sure that all set points of the reactor are the same as listed in the technical specifications.

Category B: Normal/Emergency Operating Procedures and Radiological Controls

QUESTION B.07 [1.0 point]
A two curie radioactive point source results in an emission of a 100 kEv gamma, 80% of the time. What is the dose rate at one foot?

a. 160 mRem

b. 960 mRem

c. 1600 mRem

d. 9600 mRem

QUESTION B.08 [1.0 point]
In accordance with the ISU Technical Specifications, which ONE of the following is the basis for the shield water temperature interlock? Prevent:

a. reactivity additions.

b. instrument inaccuracy.

c. radiation from the reactor core.

d. breakdown of the graphite reflector.

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]
Which ONE of the following is the MINIMUM staffing requirement when the reactor is NOT SECURED?

a. 2 reactor operators (RO) in the control room

b. 1 senior reactor operator (SRO) and 1 certified observer (CO) in the control room

c. 1 RO in the control room and 1 SRO who can arrive at the facility within 15 minutes

d. 1 RO and 1 CO in the control room and 1 SRO who can arrive at the facility within 60 minutes

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]
Which ONE of the following would violate the Limiting Safety System Setting (LSSS) ISU Technical Specifications?

a. Shutdown less than $1.00

b. Nuclear safety channel #2 exceeds 5.5 watts

c. Average reactivity addition rate for each control rod exceeds 0.065% $\Delta k/k$

d. Core temperature fuse melts when heated to a temperature of about 120°C resulting in core separation and a reactivity loss greater than 5% $\Delta k/k$

Category B: Normal/Emergency Operating Procedures and Radiological Controls

QUESTION B.13 [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.

QUESTION B.14 [1.0 point]
Per ISU Technical Specifications, temporary procedure changes which do NOT change the intent of the original procedure or involve a 10 CFR 50.59 review may be approved as a MINIMUM by the:

a. senior reactor operator

b. reactor supervisor

c. reactor administrator and reactor safety committee

d. Nuclear Reactor Commission

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]
Which ONE of the following is an example of an Emergency Action Level described in the ISU Emergency Plan?

a. Bomb threat

b. Individual injury

c. Measured dose rate is below 10MPC at the site boundary

d. Fuel element failure

QUESTION B.18 [1.0 point]
In accordance with ISU AGN-201 MP-1, Rod Drive Maintenance and Rod Worth Measurements Procedure, the operator removes the dash pot by unscrewing and placing it in the lay-down area for all of the following EXCEPT:

a. Coarse Control Rod (CCR)

b. Fine Control Rod (FCR)

c. Safety Rod #1 (SR-1)

d. Safety Rod #2 (SR-2)

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 an ISU reactor emergency, where will the reactor personnel gather to insure everyone is accounted for and checked for radioactive contamination?

a. Hold station, room 101

b. Reactor laboratory, room 20

c. Subcritical assembly laboratory, room 23

d. Nuclear engineering laboratory entrance hallway, room 14

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

Category C: Facility and Radiation Monitoring Systems

QUESTION C.01 [1.0 point]
Which ONE of the following is the type of detector used for the Low Temperature switch?

a. Thermometer

b. Bi-metallic thermal switch

c. Chromel-alumel (type K) thermocouple

d. Precision platinum wound resistance temperature detector (RTD)

QUESTION C.02 [1.0 point]
Which ONE of the following would add the most positive reactivity to the reactor when placed in the GLORY HOLE?

a. Gold

b. Boron

c. Cadmium

d. Polyethylene

QUESTION C.03 [1.0 point]
Which ONE of the following is the MAIN purpose of the thermal fuse?

a. Measure the temperature of the 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 the Limiting Safety System Setting (LSSS) is exceeded.

Category C: Facility and Radiation Monitoring Systems

QUESTION C.04 [1.0 point]
Which ONE of the following is the MAIN function of the high-density graphite surrounding the reactor core?

a. Reduce neutron leakage

b. Increase neutron leakage

c. Absorb thermal neutrons

d. Absorb fission product gases

QUESTION C.05 [1.0 point]
Which ONE of the following is NOT connected to the scram bus?

a. Seismic sensor

b. Water level

c. Reset switch

d. Radiation alarm

QUESTION C.06 [1.0 point]
Which ONE of the following is a hydraulic (oil-filled) or pneumatic control rod drive component used to decelerate each scrammable rod during the last 10 cm of travel?

a. Dashpot

b. Electromagnet

c. Synchro generator

d. Double lead screw drivetrain

Category C: Facility and Radiation Monitoring Systems

QUESTION C.07 [1.0 point]
What is the detector voltage region that corresponds to the Channel#2 neutron detector?

a. Ionization region

b. Proportional region

c. Geiger-Mueller region

d. Recombination region

QUESTION C.08 [1.0 point]
Which ONE of the following provides for automatic protection of the reactor through a scram?

a. Water level at 8in below the manhole opening

b. Reactor period at 10 seconds

c. Loss of console power

d. Area Radiation Monitor reading of 2.5 mR/hr

QUESTION C.09 [1.0 point]
The ISU reactor Gamma Shield is 10 cm thick and completely surrounds the reflector. Which ONE of the following is the material for it?

a. Lead

b. Graphite

c. Aluminum

d. Polyethylene

Category C: Facility and Radiation Monitoring Systems

QUESTION C.10 [1.0 point]
Which ONE of the following is used as the AGN-201 start-up srouce?

a. Pu-Be

b. Californium

c. RaBe

d. Cs-137

QUESTION C.11 [1.0 point]
Which ONE of the following correctly describes the characteristics of the fuel disks used at the ISU reactor?

a. The uranium content is approximately 670 grams enriched to <19.0% Uranium-235 dispersed in approximately 25 kilograms of polyethylene.

b. The uranium content is approximately 670 grams enriched to <20% Uranium-235 dispersed in approximately 25 kilograms of polyethylene.

c. The uranium content is approximately 670 grams enriched to <19% Uranium-235 dispersed in approximately 11 kilograms of polyethylene.

d. The uranium content is approximately 670 grams enriched to <20% Uranium-235 dispersed in approximately 11 kilograms of polyethylene.

QUESTION C.12 [1.0 point]
How many fuel disks are in the core, how many are above, and how many below the Central Irradiation Facility/Glory Hole, respectively? (Note: total, above, and below)

a. 9, 5, 4

b. 9, 4, 5

c. 9, 2, 7

d. 9, 7, 2

Category C: Facility and Radiation Monitoring Systems

QUESTION C.13 [1.0 points, 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 once, more than once, or not at all).

	Column A	Column B
a.	Shield water temperature = 17 ^{o}C	1. scram
b.	Reactor period = 30 seconds	2. interlock
c.	Nuclear safety #2 = 120% of licensed power	3. indication only
d.	Try to move the coarse control rod when both safety rods are fully down	

QUESTION C.14 [1.0 point]
What type of detector is used in Channel#1?

a. Proportional Counter

b. Ionization Counter

c. Geiger-Mueller

4.

d. Plastic Scintillator

QUESTION C.15 [1.0 point]
Per ISU Technical Specifications, which ONE of the following is NOT an acceptable time between the initiation of a scram signal and the time the SAFETY rods are fully withdrawn from the core?

a. 720 msec

b. 845 msec

c. 990 msec

d. 1000 msec

Category C: Facility and Radiation Monitoring Systems

QUESTION C.16 [1.0 point]
What is the appropriate time for the reactor operator to remove the source from the reactor and store it in its approved container?

a. After SR1 and SR2 have been fully inserted

b. After CCR is at 15 cm

c. When the CCR is at full insertion

d. When the CCR is at full insertion and the FCR is at the estimated critical rod height

QUESTION C.17 [1.0 point]
Which ONE of the following control rod listed below will NOT instantaneously eject from the core in the event of a scram?

a. Fine

b. Coarse

c. Safety #1

d. Safety #2

QUESTION C.18 [1.0 point]
The movable shield doors above the thermal column shall be maintained in a _____ position whenever the reactor is operated at a power greater than _____ watts.

a. Open 0.1

b. Open 0.5

c. Closed 0.1

d. Closed 0.5

Category C: Facility and Radiation Monitoring Systems

QUESTION C.19 [1.0 point]
In the event the reactor fails to scram, what are the two design features that prevent the core temperature exceeding the safety limit?

a. Glory Hole cadmium plug and the volume of water shield.

b. large temperature coefficient and the volume of water shield.

c. Large positive temperature coefficient and melting of the thermal fuse.

d. Melting of the thermal fuse and the large negative temperature coefficient.
5.

QUESTION C.20 [1.0 point]
When the reactor is operating at 5 watts, which part of the Nuclear Operations Area has a radiation field of 6 mR/hour?

a. Counting laboratory, room 22

b. Subcritical laboratory, room 23

c. Reactor Supervisor's Office, room 15

d. Observation/conference room, room 19

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

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

A.01
Answer: c
Reference: DOE Fundamentals Handbook, Nuclear Physics and Reactor Theory, NP-03, page 9

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 4.10.12, pages 4-32 & 4-33

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: $P = P_0\, e^{\frac{t}{\tau}} = t/\ln(P/P_0) \rightarrow \tau = 60/\ln(195/100) = 60/\ln(1.95) = 89.84$ or 90 sec.

A.06
Answer: b
Reference: Burn, R., *Introduction to Nuclear Reactor Operations*, example 3.4.3, pages 3-32 & 3-33

A.07
Answer c
Reference: DOE Fundamentals Handbook, Nuclear Physics and Reactor Theory, NP-03, page 34

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.

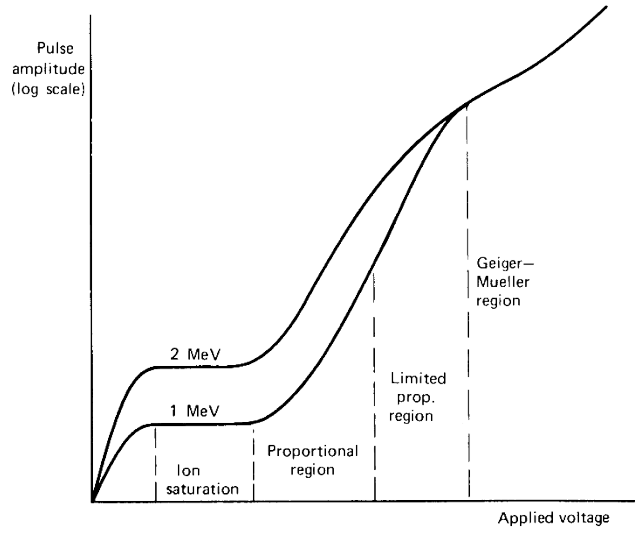
A.10
Answer: c
Reference: Burn, *Introduction to Nuclear Reactor Operations*, Table 3.5, page 3-22

A.11
Answer: b
Reference: Burn, *Introduction to Nuclear Reactor Operations*, Section 1.3.1, page 1-5

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: b
Reference: Glasstone, S. and Sesonske, A., *Nuclear Reactor Engineering,* 1991, page 264

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



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

A.15
Answer: d
Reference: Burn, R., *Introduction to Nuclear Reactor Operations*, Volume 3, Section 4.6
Shutdown reactor, T = -80 seconds; Time = 120 seconds
$P = P_o e^{t/T}$ -> $3 \times 10^6 e^{-120/80} = 6.69 \times 10^5$

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

A.17
Answer: d
Reference: Burn, R., *Introduction to Nuclear Reactor Operations*

A.18
Answer: b
Reference: DOE Fundamentals Handbook, Nuclear Physics and Reactor Theory, Volume 2, Module 4, page 15

A.19
Answer: a
Reference: Burn, R., *Introduction to Nuclear Reactor Operations,* Volume 1, Section 3.2

A.20
Answer b
Reference: DOE Fundamentals Handbook, Nuclear Physics and Reactor Theory

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

Category B: Normal/Emergency Operating Procedures and Radiological Controls

B.01
Answer: d
Reference: ISU Technical Specifications 6.9.2

B.02
Answer: c
Reference: ISU Technical Specifications 3.2

B.03
Answer: c
Reference: 10 CFR 20.1201(a)(1); (5000 mr x 1 hour x 1 day) / 50 mr x 8 hours = 12.5 days; If you round up it is exceeding the limit

B.04
Answer: a
Reference: UNM Emergency Plan 6.0

B.05
Answer: c
Reference: ISU Technical Specifications 4.2

B.06
Answer: a
Reference: 10 CFR 55.13

B.07
Answer: b
Reference: 6CEN = R/hr @ 1ft. -> 6 x 2 x 0.8 x 0.1 = 0.96 R/hr at 1 ft.

B.08
Answer: a
Reference: ISU Technical Specifications 3.2

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

B.10
Answer: b
Reference: ISU Technical Specifications 6.1.11

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: d
Reference: ISU Technical Specifications 2.2.b

B.13
Answer: a
Reference: ISU Technical Specifications 3.3.a

B.14
Answer: b
Reference: ISU Technical Specifications 6.6

B.15
Answer: a: check, b: test, c: cal, d: test

Reference: ISU 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: a
Reference: ISU Emergency Plan, Appendix C2, page 23

B.18
Answer: b
Reference: ISU MP-1, Rev.6, II.1.a, page 3

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: a

Reference: ISU EP 2.10, page 4

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

Category C: Facility and Radiation Monitoring Systems

C.01
Answer: b
Reference: ISU SAR 4.3.4

C.02
Answer: d
Reference: NRC standard question

C.03
Answer: c
Reference: NRC standard question

C.04
Answer: a
Reference: NRC standard question

C.05
Answer: d
Reference: ISU RO lecture 6, page 4

C.06
Answer: a
Reference: ISU SAR 4.3.1, page 54

C.07
Answer: a
Reference: ISU RO lecture 5 NI, page 19, 30 and SAR 4.3.2, page 62

C.08
Answer: c
Reference: ISU SAR 5.10

C.09
Answer: a
Reference: UNM Technical Specifications 5.1.b and UNM SAR Table 4.2-1, page 46, SAR Figure 4.3-2, page 55

C.10
Answer: b
Reference: ISU SAR Table 4.2-1, page 47

Category B: Normal/Emergency Operating Procedures and Radiological Controls

C.11
Answer: d
Reference: ISU Technical Specifications 5.1.a

C.12
Answer: a
Reference: ISU SAR table 4.2-1, page 46

C.13
Answer: a. 3; b. 3; c. 1; d. 2
Reference: ISU Technical Specifications 3.2

C.14
Answer: a
Reference: ISU SAR 4.3.2

C.15
Answer: d
Reference: ISU Technical Specifications 3.2.a

C.16
Answer: d
Reference: ISU operating procedure #1, section VII

C.17
Answer: a
Reference: NRC standard question

C.18
Answer: d
Reference: ISU Technical Specifications 3.4.c

C.19
Answer: d
Reference: ISU Technical Specifications 2.2

C.20
Answer: d
Reference: ISU SAR 3.2.4

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