June 27, 2017

Dr. Marylou Dunzik-Gougar, Reactor Administrator
And Professor and Chair of Nuclear Engineering
College of Science and Engineering
Idaho State University
921 S. 8th Avenue, MS 8060
Pocatello, ID 83209-8060

SUBJECT: EXAMINATION REPORT NO. 50-284/OL-17-01, IDAHO STATE UNIVERSITY

Dear Dr. Dunzik-Gougar:

During the week of April 17, 2017, the U.S. Nuclear Regulatory Commission (NRC) administered an operator licensing examination at your Idaho State University 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 Ms. Michele DeSouza at (301) 415-0747 or via e-mail at Michele.DeSouza@nrc.gov.

Sincerely,

/RA/

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

Docket No. 50-284

Enclosures:
1. Examination Report No. 50-284/OL-17-01
2. Facility Comments with NRC Resolution
3. Written Examination

cc w/o enclosures: See next page

SUBJECT: EXAMINATION REPORT NO. 50-284/OL-17-01, IDAHO STATE UNIVERSITY DATED JUNE 27, 2017.

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DATE	05/30/2017	06/26/2017	06/27/2017

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

REPORT NO.: 50-284/OL-17-01

FACILITY DOCKET NO.: 50-284

FACILITY LICENSE NO.: R-110

FACILITY: AGN-201

EXAMINATION DATES: April 18-20, 2017

SUBMITTED BY: /RA/ 5/30/17
Michele DeSouza, Chief Examiner Date

SUMMARY:
During the week of April 17, 2017, the NRC administered an operator licensing examination to one Senior Reactor Operator Upgrade (SRO-U) candidate, five Reactor Operator (RO) candidates, and one RO retake Category A written examination. The SRO Upgrade and RO retake candidate passed all applicable portions of the examination(s). One RO candidate failed the written examination and operating test. One RO candidate failed Category A of the written examination. One RO candidate failed the operating test.

REPORT DETAILS

1. Examiner: Michele DeSouza, Chief Examiner, NRC

2. Results:

	RO PASS/FAIL	SRO PASS/FAIL	TOTAL PASS/FAIL
Written	6/2	0/0	6/2
Operating Tests	6/2	1/0	7/2
Overall	6/3	1/0	7/3

3. Exit Meeting:
Michele C. DeSouza, Chief Examiner, NRC
Osvaldo Font, Inspector, NRC
George Imel, Assistant Reactor Administrator, Idaho State University
Mary Lou Dunzik-Gouger, Reactor Administrator, Idaho State University
Maxwell J. Daniels, Reactor Supervisor, Idaho State University
Matthew Beatty, Training Instructor/SRO, Idaho State University

Per discussion with the facility, prior to administration of the examination, adjustments were accepted. Upon completion of the examination, the NRC Examiner and Inspector met with facility staff representatives to discuss the results. NRC received additional facility comments on May 1, 2017. At the conclusion of the meeting, the NRC examiner thanked the facility for their support in the administration of the examination.

Facility Comments with NRC Resolution

Facility Comments

May 1, 2017
Comments on written examination, 50-284/OL-17-01

Question A.02
The reference to half-life in this problem is ambiguous. The longest-lived neutron precursor has a half-life of 80 seconds. When arranging delayed neutron precursors into six groups according to half-life, the average half-life of group 6 is 55.72 seconds (close to C). However, this problem doesn't specify that we are looking average group half-lives, so it's difficult to decide which answer is correct.

We have been teaching to the fact that the longest-lived delayed neutron precursor has an 80-second half-life. If you would prefer, we can begin teaching with the 6-group assumption and more specifically to the average half-life of the longest-lived group. However, based on the wording of the question asked, either C or D should be considered correct.

Facility recommendation: Drop this question from the examination.

Question A.05
If $\rho=\beta$ then the reactor is critical on prompt neutrons alone. Therefore, both answers C and D would be correct choices in this problem. I agree with the reference, but this doesn't specify what the correct answer is to this problem? (LaMarsh, Page 340-341). Both answers C and D are correct.

Facility recommendation: Count both options C and D as correct.

Question A.19
This reference specifically dictates that the flux shape has the largest impact on determining rod worth (not the temperature). The reference (Burn, Introduction to Nuclear Reactor Operations) isn't available to this facility and I see no option of obtaining it.

Facility recommendation: Change correct answer to B. Flux Shape

Question B.14
Each of these exams (2016 & 2011) have the same answer to this problem. After speaking with the previous reactor supervisor, several efforts have been made to remove this problem from future examinations due to the ambiguity of the problem.

Facility recommendation: I agree that it should be removed on both this exam and future examinations. If we choose to continue to use this question on future examinations, then I feel the correct answer will be smaller than the previous start-up.

Question C.11
After looking at the reference for both the 2017 examination and the 2006 examination it is clear that a functional problem exists in the Safety Analysis Report. This question has brought my attention to this inadequacy. Depending on which portion of the SAR is referenced two separate answers can exist. Due to this, I would like to have this question dropped until I can ensure that there is no ambiguity between the answers of 9, 6, 3 and 9, 4, 5. I will work with Dr. Kunze to find out why this error exists and will take the appropriate steps to resolve this issue.

Facility recommendation: Drop this question from the examination.

NRC Resolution

Question A.02: Comment rejected. This question has only one correct answer and remains as written.

Question A.05: Comment rejected. This question has only one correct answer and remains as written.

Question A.19: Comment accepted. The answer key is adjusted to reflect b. as the correct answer to this question.

Question B.14: Comment partially accepted, question deleted. The NRC agrees to delete this question from this examination. The NRC also agrees the correct answer is 'smaller than the previous.'

Question C.11: Comment rejected. This question has only one correct answer available and remains as written.

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

FACILITY: ISU

REACTOR TYPE: AGN-201

DATE ADMINISTERED: 04/19/2017

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 CONTROLS
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 ___ (0.25 each)

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 ____ (0.25 each)

B10 a b c d ___

B11 a b c d ___

B12 a b c d ___

B13 a b c d ___

B14 a b c d ___

B15 a b c d ___

B16 a b c d ___

B17 a b c d ___

B18 a ___ b ___ c ___ (0.33 each)

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 ___ (0.33 each)

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 ___ (0.25 each)

C11 a b c d ___

C12 a b c d ___

C13 a b c d ___

C14 a b c d ___

C15 a b c d ___

C16 a b c d ___

C17 a b c d ___

C18 a b c d ___

C19 a b c d ___

C20 a b c d ___

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

$$T_{\frac{1}{2}} = \frac{0.693}{\lambda} \quad \Delta\rho = \frac{K_{eff_2} - K_{eff_1}}{K_{eff_1} K_{eff_2}}$$

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

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

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

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

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

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

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

1 kg = 2.21 lb

1 Horsepower = 2.54 x 10^3 BTU/hr

1 Mw = 3.41 x 10^6 BTU/hr

1 BTU = 778 ft-lb

°F = 9/5 °C + 32

1 gal (H_2O) ≈ 8 lb

°C = 5/9 (°F - 32)

c_P = 1.0 BTU/hr/lb/°F

c_p = 1 cal/sec/gm/°C

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

QUESTION A.01 [1.0 point]
Which ONE of the following is the **MAJOR** source of energy released during fission?

a. Capture gamma rays

b. Fission product decay

c. Prompt gamma rays

d. Fission neutrons (kinetic energy)

QUESTION A.02 [1.0 point]
During the time following a reactor scram, reactor power decreases on an 80 second period, which corresponds to the half-life of the longest-lived delayed neutron precursors, which is approximately _____.

a. 20 seconds

b. 40 seconds

c. 55 seconds

d. 80 seconds

QUESTION A.03 [1.0 point, 0.25 each]
Match the following Neutron Interactions (each used only once)

a. Fission	1. Neutron enters nucleus, forms a compound nucleus, then decays by gamma emission
b. Radiative capture	2. Particle enters nucleus, forms a compound nucleus and is excited enough to eject a new particle with incident neutron remaining in nucleus
c. Scattering	3. Nucleus absorbs neutron and splits into two similarly sized parts
d. Particle ejection	4. Nucleus is struck by a neutron and emits a single neutron

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

QUESTION A.04 [1.0 point]
Two common FISSION PRODUCTS that have especially large neutron cross sections and play a significant role in reactor physics are Xe-135 and _____.

a. Nitrogen-16

b. Argon-41

c. Iodine-131

d. Samarium-149

QUESTION A.05 [1.0 point]
What is the condition of the reactor when $k = \frac{1}{1-\beta}$?

a. Subcritical

b. Critical

c. Super critical

d. Prompt critical

QUESTION A.06 [1.0 point]
Which ONE of the following conditions describes a critical reactor?

a. $k = 1; \Delta k/k = 1$

b. $k = 1; \Delta k/k = 0$

c. $k = 0; \Delta k/k = 1$

d. $k = 0; \Delta k/k = 0$

QUESTION A.07 [1.0 point]
What is β_{eff}?

a. The fractional change in neutron population per generation

b. The fraction of all fission neutrons that are born as delayed neutrons

c. The time required for the reactor to change by power by a factor of e

d. The fraction of all delayed neutrons that reach thermal energy

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

QUESTION A.08 [1.0 point]
Which one of the following statements describes the difference between differential rod worth (DRW) and integral rod worth (IRW) curves?

a. DRW relates the time rate of reactivity change to rod position. IRW relates the total reactivity in the core to the time rate of reactivity change

b. IRW relates the worth of the rod per increment of movement to rod position. DRW relates the total reactivity added by the rod to the rod position

c. IRW is the slope of the DRW at a given rod position

d. DRW relates the worth of the rod per increment of movement to rod position. IRW relates the total reactivity added by the rod to the rod position

QUESTION A.09 [1.0 point]
Which ONE of the following is the reason for an installed neutron source within the reactor core?

a. Without it, a reactor startup is impossible as no neutrons would be available

b. Power can be compensated for by adjusting the compensating voltage on the source range detector

c. Could result in a very short period due to the reactor going critical before the neutron population is built up high enough to be read on nuclear instrumentation

d. Period would be very slow due to the long time to build up the neutron population from such a low level

QUESTION A.10 [1.0 point]
The following shows part of a decay chain for the radioactive element Pa-234:
$_{91}Pa^{234} \rightarrow {}_{92}U^{234}$
This decay chain is an example of _____ decay.

a. Alpha

b. Beta

c. Gamma

d. Neutron

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

QUESTION A.11 [1.0 point]
A reactor is on a CONSTANT positive period. Which ONE of the following power changes will take the SHORTEST time to complete?

a. From 100 kW to 150 kW

b. From 10 kW to 20 kW

c. From 10 W to 30 W

d. From 1 W to 5 W

QUESTION A.12 [1.0 point]
Given a source strength of 200 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. 150 N/sec

b. 250 N/sec

c. 400 N/sec

d. 500 N/sec

QUESTION A.13 [1.0 point]
Which ONE of the following isotopes will absorb neutrons quickly when it interacts with neutrons?

a. Hydrogen-1

b. Carbon-14

c. Boron-10

d. Uranium-235

QUESTION A.14 [1.0 point]
Reactor is critical. What would be the corresponding k_{eff} when removing 0.07 $\Delta k/k$ from its criticality?

a. 0.9151

b. 0.9346

c. 0.9750

d. 1.0522

QUESTION A.15 [1.0 point]
A subcritical reactor, k_{eff} is increased from 0.914 to 0.965. Which ONE of the following is the amount of reactivity that was added to the core?

a. 3.64%Δk/k

b. 4.38%Δk/k

c. 5.83%Δk/k

d. 6.57%Δk/k

QUESTION A.16 [1.0 point]
Which ONE of the following best describes the difference between reflectors and moderators?

a. Reflectors decrease thermal leakage while moderators decrease fast leakage

b. Reflectors thermalize neutrons while moderators decrease core leakage

c. Reflectors decrease core leakage while moderators thermalize neutrons

d. Reflectors shield against neutrons while moderators decrease core leakage

QUESTION A.17 [1.0 point]
How high will the reactor power get given the lowest of the reactor high power scrams set point is 110%, the scram delay time is 0.5 seconds, the reactor is operating at 100% power prior to the scram, and the reactor period is positive 20 second?

a. 113%

b. 115%

c. 120%

d. 220%

QUESTION A.18 [1.0 point]
Which factors of the six factor formula are affected by an INCREASE in core temperature and how are they affected?

a. $\downarrow Lf$, $\downarrow$p, $\uparrow f$

b. $\uparrow \varepsilon$, $\uparrow L_f$, $\downarrow L_t$, $\uparrow$p

c. $\uparrow \varepsilon$, $\downarrow Lf$, $\downarrow L_t$, $\downarrow$p, $\uparrow \eta$, $\uparrow f$

d. $\uparrow \varepsilon$, $\uparrow L_f$, $\downarrow L_t$, $\downarrow$p, $\uparrow \eta$, $\uparrow f$

QUESTION A.19 [1.0 point]
Which ONE of the following parameters is MOST significant in determining the differential rod worth of a control rod?

a. Fuel temperature

b. Flux shape

c. Reactor power

d. Rod speed

QUESTION A.20 [1.0 point]
Which ONE of the following is a correct statement of how delayed neutrons enhance the ability to control reactor power?

a. Prompt neutrons can cause fissions in both U-235 and U-238 and delayed neutrons can only cause fissions in U-235

b. Delayed neutrons are born at higher energy levels than prompt neutrons

c. The average number of delayed neutrons produced per fission is higher than the average number of prompt neutrons

d. Delayed neutrons increase the average neutron lifetime that allows a reactor to be controlled

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

Category B: Normal/Emergency Operating Procedures and Radiological Controls

QUESTION B.01 [1.0 point]
What is the MAXIMUM core temperature safety limit during either steady-state operation?

a. 5 °C

b. 44 °C

c. 100 °C

d. 200°C

QUESTION B.02 [1.0 point]
What type of radiation detector is preferred for dose rate assessment?

a. Ionization Chamber

b. Proportional Counter

c. Geiger-Mueller

d. Scintillation detector

QUESTION B.03 [1.0 point]
Idaho State University (ISU) Emergency Plan requires, in the event of any emergency, if the radiation level outside of the Operations Area exceeds _____mR/hr, the operator shall order an evacuation.

a. 10

b. 50

c. 75

d. 100

QUESTION B.04 [1.0 point]
As a minimum, how long must the reactor be secured prior to opening the ISU core tank?

a. 12 hours

b. 24 hours

c. 2 days

d. 7 days

Category B: Normal/Emergency Operating Procedures and Radiological Controls

QUESTION B.05 [1.0 point]
Per ISU Technical Specifications, what is the basis for the MAXIMUM core temperature limit used to prevent?

a. Breakdown of the graphite reflector

b. Instrument inaccuracies

c. Release of the fission products

d. Boiling of the shield water

QUESTION B.06 [1.0 point]
Which ONE of the following federal regulations establish procedures and criteria for the issuance of licenses to Reactor Operators and Senior Reactor Operators?

a. 10 CFR 20

b. 10 CFR 50

c. 10 CFR55

d. 10 CFR 73

QUESTION B.07 [1.0 point]
Per the ISU Emergency Plan, where is the designated Emergency Support Center?

a. Rooms 19 and 20

b. Rooms 20 and 23

c. Foyer, room 101

d. Entire Lillibridge Engineering Laboratory basement

QUESTION B.08 [1.0 point]
Which ONE of the below listed procedures shall be approved as a MINIMUM by the Reactor Administrator EXCEPT?

a. Preventative or corrective maintenance which could affect the safety of the reactor

b. Radiation Safety Protection for all reactor related personnel

c. Temporary Procedures which do not change the intent of the original procedrue or involve an unreviewed safety question

d. Implementation of the Security Plan and Emergency Plan

Category B: Normal/Emergency Operating Procedures and Radiological Controls

QUESTION B.09 [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 prestart readings of the radiation area monitors to the previous day readings

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 linear channel in accordance with recent data collected during a reactor power calibration

d. You expose a 2 mCi check source to the stack particulate monitor detector to verify that it alarms at 10,000 cpm

QUESTION B.10 [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 meter. Which ONE of the following is the posting requirement for the area, in accordance with 10CFR20?

a. CAUTION RADIATION AREA

b. CAUTION – HIGH RADIATION AREA

c. CAUTION – RADIOACTIVE MATERIAL

d. CAUTION – AIRBORNE RADIOACTIVITY AREA

QUESTION B.11 [1.0 point]
Which ONE of the following items will ALLOW a reactor operator to continue to operate the reactor? Assume today is the three year anniversary of receiving your RO license.

a. Last physical examination was 3 years ago

b. Written exam administered by Reactor Supervisor was 10 months ago

c. 2 hours on the console last quarter performing the functions of a licensed operator

d. Performing one startup over the past year

Category B: Normal/Emergency Operating Procedures and Radiological Controls

QUESTION B.12 [1.0 point]
In accordance with ISU Emergency Procedures, in the event of an extensive uncontrollable fire, which ONE of the following actions should the reactor operator perform immediately after securing the reactor?

a. Initiate a building evacuation

b. Notify the Reactor Supervisor

c. Attempt to extinguish the fire using available fire-fighting equipment

d. Notify the Pocatello Police Department

QUESTION B.13 [1.0 point]
What is your dose rate at 9 feet away from the source, if you are receiving 250 mR/hr at 3 feet away from the source?

a. 24 mR/hr

b. 28 mR/hr

c. 32 mR/hr

d. 36 mR/hr

Question B.14 deleted following the administration of the examination per facility comments

~~**QUESTION B.14 [1.0 point]**~~
~~You performed a startup this morning with the pneumatic tube terminus in the core and no other experiments in the reactor. After shutting down, one hour later, you removed the tube. No other changes were made to the reactor. During the new reactor startup, what will be the new core excess?~~

~~a. Larger than the previous startup~~

~~b. Smaller than the previous startup~~

~~c. Same as the previous startup~~

~~d. Dependent on the time of shutdown~~

QUESTION B. 15 [1.0 point]
During a survey you read 100 mRem/hr with the window open and 40 mRem/hr with the window closed. Which ONE of the following is the dose rate due to BETA radiation?

a. 40 mRem/hr

b. 60 mRem/hr

c. 100 mRem/hr

d. 140 mRem/hr

Category B: Normal/Emergency Operating Procedures and Radiological Controls

QUESTION B.16 [1.0 point]
Per ISU Technical Specification, which ONE of the following is an operating staff requirement?

a. With prior approval from the reactor supervisor, a licensed Reactor Operator performs a maintenance activity which could affect the reactivity of the reactor

b. A listing of reactor facility personnel by name and phone number shall be conspicuously posted in the reactor control room

c. A licensed Reactor Operator and Certified Observer in the reactor control room when the reactor is not secured

d. A licensed Senior Reactor Operator performs the duties of the licensed Reactor Operator and Certified Observer when the reactor is not secured

QUESTION B.17 [1.0 point]
During ISU emergency recovery operations to restore the facility to a safe status, who must assess the existing radiation and contamination levels?

a. Reactor Supervisor

b. Director of Emergency Operations

c. Recovery Operations Coordinator (ROC)

d. Any individual on the team

QUESTION B.18 [1.0 point, 0.25 each]
Match the area radiation levels in Column A with the corresponding area type (as defined by 10CFR20) from in Column B. (Some of the items in Column B may be used more than once or not at all.)

Column A	Column B
a. 5 mR/hr	1. Unrestricted
b. 50 mR/hr	2. Radiation Area
c. 100 mR/hr	3. High Radiation Area
d. 500 mR/hr	4. Very High Radiation Area

Category B: Normal/Emergency Operating Procedures and Radiological Controls

QUESTION B.19 [1.0 point]
As a licensed reactor operator, who is allowed to operate the controls of the reactor under your direction?

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

b. Student participating in nuclear engineering training

c. Health Physicist who is trying to gain a Certified Health Physicist (CHP) certification

d. NRC inspector trying to make sure that all set points of the reactor are the same as those in the technical specifications

QUESTION B.20 [1.0 point]
For abnormal radiation levels within the Operations Boundary, which ONE of the following describes how the reactor operator initiates an emergency building evacuation?

a. Call the Radiation Safety Office

b. Notify the Pocatello Police and Fire Departments

c. Trip the fire alarm on the east wall near the entrance to the Reactor Lab

d. Using a bull horn making a public address announcement throughout the building

(***** End of Category B *****)

Category C: Facility and Radiation Monitoring Systems

QUESTION C.01 [1.0 point, 0.33 each]
Match the facility safety channels in Column A with the setpoints in Column B.

Column A	Column B
a. Channel 1	1. 1/16”
b. Channel 2	2. 0.5 cps
c. Channel 3	3. 5% of full
	4. 3×10^{-3} amps

QUESTION C.02 [1.0 point]
Which ONE of the following procedures is used for the channel check, channel calibration, and verification of the low level trip of channel 1?

a. Operation Procedure #1

b. Surveillance Procedure #1

c. Maintenance Procedure #1

d. Routine Procedure #1

QUESTION C.03 [1.0 point]
Which ONE of the following safety interlocks provides for reactor shutdown?

a. An earthquake occurs

b. Shield water rises

c. Reactor temperature is 20°C

d. Radiation monitor stops working

QUESTION C.04 [1.0 point]
Which ONE of the following is controlled by an indication from the Low Level Source Interlock?

a. Auxiliary Channel

b. Channel #1

c. Channel #2

d. Channel #3

Category C: Facility and Radiation Monitoring Systems

QUESTION C.05 [1.0 point]
GEH NTR Technical Specifications requires fuel elements be stored in a safe array where the k_{eff} is less than _____.

a. 0.6

b. 0.7

c. 0.8

d. 0.9

QUESTION C.06 [1.0 point]
Which ONE of the following materials makes up the cladding on the control rods?

a. Aluminum

b. Stainless steel

c. Cadmium

d. Graphite

QUESTION C.07 [1.0 point]
Which material is used to fill the movable tank on top of the reactor when using as a Thermal Neutron column?

a. Water

b. Graphite

c. Cadmium

d. Beryllium

QUESTION C.08 [1.0 point]
Which ONE of the following identifies the location of the area radiation monitor?

a. Control console area

b. Above the reactor

c. Observation classroom

d. Radiation counting laboratory

Category C: Facility and Radiation Monitoring Systems

QUESTION C.09 [1.0 point]
Which ONE of the following methods is used to generate control rod position indication?

a. Direct output from the rod drive DC motor

b. Output of a synchro-generator linked to the rod drive DC motor

c. Change in voltage due to movement of a lead screw linked to the rod

d. Changing current due to closing of multiple magnetic switches located the length of the rod

QUESTION C.10 [1.0 point]
Which ONE of the following is the water interlock trip point?

a. 5” above the reactor shield

b. 8” above the shield tank level

c. 10” below the reactor shield tank opening

d. 15” below the control and safety rods

QUESTION C.11 [1.0 point]
What is the total number of fuel disks and how many are in the lower and upper section for the aluminum baffle?

a. 9, 5, 4

b. 8, 5, 3

c. 9, 4, 5

d. 8, 4, 4

QUESTION C.12 [1.0 point]
What type of switch is used for the shield tank water level?

a. Bi-metallic thermal

b. Resistance

c. Differential pressure

d. Float

Category C: Facility and Radiation Monitoring Systems

QUESTION C.13 [1.0 point]
Which ONE of the following materials is used as ISU fast neutron shield?

a. Lead

b. Graphite

c. Aluminum

d. Water

QUESTION C.14 [1.0 point]
Which ONE of the following nuclear instrumentation channels uses a BF_3 filled Proportional counter?

a. 1

b. 2

c. 3

d. 4

QUESTION C.15 [1.0 point]
What type of material is used as the moderator in the fuse and core?

a. Beryllium and Aluminum

b. Graphite and Lead

c. Water and Cadmium

d. Polystyrene and Polyethylene

QUESTION C.16 [1.0 point]
Which other material can the fine control rod be loaded with besides fuel?

a. Aluminum clad graphite

b. Polystyrene

c. Cadmium

d. Polyethylene

Category C: Facility and Radiation Monitoring Systems

QUESTION C.17 [1.0 point]
Which ONE of the following is NOT an approved location for placement of the startup source?

a. Access ports

b. Center column

c. Skirt door

d. Glory hole

QUESTION C.18 [1.0 point]
Which ONE of the following conditions will NOT automatically result in a reactor scram?

a. Power failure

b. Water level

c. Radiation level

d. Reactor period

QUESTION C.19 [1.0 point]
Which ONE of the following is the gas used in the ISU rabbit tube assembly?

a. Air

b. Helium

c. Nitrogen

d. Carbon Dioxide

QUESTION C.20 [1.0 point]
Where is the majority of the facility's Ar-41 produced?

a. Glory hole

b. Reactor bay

c. Core water

d. Rods and fuel

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

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

A.01
Answer: b
Reference: Burn, *Introduction to Nuclear Reactor Operations*, Table 3.2, Page 3-5

A.02
Answer: c
Reference: LaMarsh, *Introduction to Nuclear Engineering*, Page 88
Group 1 is longest lived neutron precursor for thermal fission in U-235 with a half-life of 55.72 seconds

A.03
Answer: a 3 b 1 c 4 d 2
Reference: DOE Fundamentals Handbook *Nuclear Physics and Reactor Theory*, Volume 1, Module 1, Page 43-46

A.04
Answer: d
Reference: Burn, *Introduction to Nuclear Reactor Operations*, Section 8.1, Page 8-1

A.05
Answer: c
Reference: LaMarsh, *Introduction to Nuclear Engineering*, Page 340-341
(1-B)k=1 manipulated reads k=1/(1-B)

A.06
Answer: b
Reference: LaMarsh, *Introduction to Nuclear Engineering*

A.07
Answer: b
Reference: DOE Fundamentals Handbook *Nuclear Physics and Reactor Theory*, Volume 2, Module 2

A.08
Answer: d
Reference: PSBR CCP 15

A.09
Answer: c
Reference: Burn, *Introduction to Nuclear Reactor Operations*, Section 5.2.2, Pages 5-2 - 5-4

A.10
Answer: b
Reference: Chart of the Nuclides

A.11
Answer: a
Reference: $P=P_o e^{t/T} \rightarrow t=T*\ln(P/P_o)$ assume constant period=1
The smallest ratio of P/P_o is the shortest time to complete

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

A.12
Answer: d
Reference: CR=S/(1-k)→200/(1-0.6) = 500 N/sec

A.13
Answer: c
Reference: Burn, *Introduction to Nuclear Reactor Operations*, Section 2.5.1, Pages 2-38-43

A.14
Answer: b
Reference: ρ=(k-1)/k-0.07→1=k-(-0.07k)=k(1+0.07)→k=1/1.07 =0.9346

A.15
Answer: c
Reference: Burn, *Introduction to Nuclear Reactor Operations*, Section 3.3.4, Page 3-20&21
$\Delta\rho=(k_{eff2}-k_{eff1})/(k_{eff1}*k_{eff2})$ = (0.971-0.919)/(0.971*0.919) = 0.0583Δk/k=5.83%Δk/k

A.16
Answer: c
Reference: Burn, *Introduction to Nuclear Reactor Operations,* Section 5.4

A.17
Answer: a
Reference: P/P_o = 110%, T = 20 seconds, t = 0.5, P/P_o = 110 e^0.5/20 = 112.78%

A.18
Answer: a
Reference: DOE Fundamentals Handbook *Nuclear Physics and Reactor Theory*, Volume 2, Module 3

A.19
Answer: ~~a~~ b Adjusted per facility comment
Reference: Burn, *Introduction to Nuclear Reactor Operations*, Section 7.2

A.20
Answer: d
Reference: Burn, *Introduction to Nuclear Reactor Operations,* Section 3.3.2, Page 3-7

Category B: Normal/Emergency Operating Procedures and Radiological Controls

B.1
Answer: d
Reference: ISU TS 6.1.11

B.2
Answer: a
Reference: NRC standard question

B.3
Answer: a
Reference: ISU Emergency Plan, Appendix C.6

B.4
Answer: b
Reference: ISU Maintenance Procedure #2, Prerequisites and Safety

B.5
Answer: c
Reference: ISU TS, 2.1.b Basis, Page 6

B.6
Answer: c
Reference: 10CFR55.1(a)

B.7
Answer: c
Reference: ISU Emergency Plan, 2.0 Definitions, 2.9

B.8
Answer: c
Reference: ISU TS, 6.6, Page 26

B.9
Answer: a (check), b (test), c (cal), d (test)
Reference: ISU TS definitions

B.10
Answer: b
Reference: 10 CFR 20.1003; $S=S_o(r_o/r)^2$, therefore for a point source, 10 mrem/hr at 100 cm = 111.1mrem/hr at 30 cm

B.11
Answer: b
Reference: ISU Reactor Operator Requalification Program and 10 CFR 55.53

B.12
Answer: a
Reference: ISU Emergency Plan, Appendix C2, Extensive Fire or Explosion

B.13
Answer: b
Reference: $I_1D_1^2=I_2D_2^2 \rightarrow$ 250mR/hr@$(3ft)^2=I_2$@$(9ft)^2 \rightarrow$28mR/hr

Category B: Normal/Emergency Operating Procedures and Radiological Controls

Question B.14 deleted following the administration of the examination per facility comments

~~**B.14**~~

~~Answer: b~~ Question deleted per facility comment

~~Reference: ISU Experimental Plan No. 19, *Sample Transfer by Pneumatic Tube*, Safety Analysis, Page 3~~

B.15

Answer: b

Reference: $Dose_{Beta} = Dose_{(open\ window)} - Dose_{(closed\ window)}$

B.16

Answer: b

Reference: ISU TS 6.1.11

B.17

Answer: c

Reference: ISU Emergency Plan, *Nuclear Emergency*, Page 14

B.18

Answer: a (1), b (2), c (2), d (3)

Reference: 10CFR20.1003, *Definitions*

B.19

Answer: b

Reference: 10CFR55.13

B.20

Answer: c

Reference: ISU Emergency Plan, 7.3 Protective Actions, 7.3.2, Page 11

Category C: Facility and Radiation Monitoring Systems

C.01
Answer: a (2), b (4), c (3)
Reference: ISU SAR Section 11.1.4, and Radiation Protection Procedures 10, Radiation Safety Procedure 7.0, Remote Area Monitor 7.2, Section 3.0, and Continuous Air Monitor 7.12, Section 3.0

C.02
Answer: b
Reference: ISU Surveillance Procedure #1

C.03
Answer: a
Reference: ISU SAR 4.2

C.04
Answer: b
Reference: ISU SAR 4.3.2, Page 57

C.05
Answer: d
Reference: ISU TS 5.2

C.06
Answer: a
Reference: ISU SAR 4

C.07
Answer: b
Reference: ISU SAR 4.1

C.08
Answer: a
Reference: ISU TS 3.4

C.09
Answer: b
Reference: ISU SAR 4.3-1

C.10
Answer: c
Reference: ISU TS 3.2.e

C.11
Answer: c
Reference: ISU SAR 4.1

C.12
Answer: d
Reference: ISU SAR 4.3.4

C.13
Answer: d
Reference: ISU SAR 4.2, Table 4.2-1

Category C: Facility and Radiation Monitoring Systems

C.14
Answer: a
Reference: ISU SAR Figure 4.3-6

C.15
Answer: d
Reference: ISU SAR 4.2, Table 4.2-1

C.16
Answer: d
Reference: ISU SAR 4.2, Page 42

C.17
Answer: c
Reference: ISU SAR 4.3.1, Figure 4.3-1, Page 54

C.18
Answer: c
Reference: ISU SAR 4.3.2

C.19
Answer: c
Reference: ISU SAR 3.2.2

C.20
Answer: a
Reference: ISU SAR 5.4