May 14, 2015

Dr. Jeffrey Geuther, Manager
Nuclear Reactor Facility
Kansas State University
112 Ward Hall
Manhattan, KS 66506-2500

SUBJECT: EXAMINATION REPORT NO. 50-188/OL-15-02, KANSAS STATE UNIVERSITY

Dear Dr. Geuther:

During the week of March 23, 2015, the U.S. Nuclear Regulatory Commission (NRC) administered operator licensing examinations at your Kansas 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 you as identified in the enclosed report at the conclusion of the examinations.

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/

Kevin Hsueh, Chief
Research and Test Reactors Oversight Branch
Division of Policy and Rulemaking
Office of Nuclear Reactor Regulation

Docket No. 50-188

Enclosures:
1. Examination Report No. 50-188/OL-15-02
2. Written Examination

cc: w/o enclosures: See next page

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OFFICE	NRR/DPR/PROB	NRR/DPR/PROB	NRR/DPR/PROB
NAME	JNguyen	CRevelle	KHsueh
DATE	04/07/2015	05/13/2015	05/14/2015

OFFICIAL RECORD COPY

cc:

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Test, Research, and Training
Reactor Newsletter
University of Florida
202 Nuclear Sciences Center
Gainesville, FL 32611

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

REPORT NO.: 50-188/OL-15-02

FACILITY DOCKET NO.: 50-188

FACILITY LICENSE NO.: R-37

FACILITY: KSU

EXAMINATION DATES: March 23-24, 2015

SUBMITTED BY: **P.Young for** **05/14/15**
John T. Nguyen, Chief Examiner Date

SUMMARY:
During the week of March 23, 2015, the NRC administered operator licensing examinations to one Reactor Operator and one Reactor Operator-Retake candidates. The Reactor Operator candidate passed all applicable portions of the examinations. The Reactor Operator-Retake candidate passed the Section B, Normal/Emergency Procedures and Radiological Controls, of the written examination.

REPORT DETAILS

1. Examiners: John T. Nguyen, Chief Examiner, NRC
Michele C. DeSouza, Examiner Trainee, NRC

2. Results:

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

3. Exit Meeting:
Kevin Hsueh, Chief, Research and Test Reactors Oversight Branch, NRC
John T. Nguyen, Chief Examiner, NRC
Michele C. DeSouza, Examiner Trainee, NRC
Jeffrey Geuther, Manager, Nuclear Reactor Facility

Upon completion of the examinations, the NRC Examiners met with the facility manager to discuss the results. At the conclusion of the meeting, the NRC examiners thanked the facility for their support in the administration of the examinations.

ENCLOSURE 1

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

FACILITY: Kansas State University

REACTOR TYPE: KSU TRIGA

DATE ADMINISTERED: 3/24/2015

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

Section A – Reactor Theory, Thermo. & Facility Operating Characteristics
KSU 15-02

A N S W E R   S H E E T

Multiple Choice (Circle or X your choice)
If you change your Answer, write your selection in the blank.

A01 a b c d ___

A02 a b c d ___

A03 a b c d ___

A04 a b c d ___

A05 a b c d ___

A06 a b c d ___

A07 a ___ b ___ c ___ d ___ (0.25 each)

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 _________ (0.33 each)

A20 a b c d ___

(***** END OF SECTION A *****)

Section B – Normal/Emergency Procedures and Radiological Controls
KSU 15-02

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 ___ (0.25 each)

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 ___

B12 a ___ b ___ c ___ d ___ (0.25 each)

B13 a b c d ___

B14 a b c d ___

B15 a b c d ___

B16 a b c d ___

B17 a b c d ___

B18 a b c d ___

B19 a b c d ___

B20 a b c d ___

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

Section C – Plant and Radiological Monitoring Systems
KSU 15-02
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 ___ (0.25 each)

C04 a b c d ___

C05 a b c d ___

C06 a b c d ___

C07 a b c d ___

C08 a b c d ___

C09 a b c d ___

C10 a b c d ___

C11 a b c d ___

C12 a b c d ___

C13 a b c d ___

C14 a b c d ___

C15 a b c d ___

C16 a b c d ___

C17 a b c d ___

C18 a b c d ___

C19 a b c d ___

C20 a b c d ___

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

NRC RULES AND GUIDELINES FOR LICENSE EXAMINATIONS

During the administration of this examination the following rules apply:

1. Cheating on the examination means an automatic denial of your application and could result in more severe penalties.

2. After the examination has been completed, you must sign the statement on the cover sheet indicating that the work is your own and you have neither received nor given assistance in completing the examination. This must be done after you complete the examination.

3. Restroom trips are to be limited and only one candidate at a time may leave. You must avoid all contacts with anyone outside the examination room to avoid even the appearance or possibility of cheating.

4. Use black ink or dark pencil <u>only</u> to facilitate legible reproductions.

5. Print your name in the blank provided in the upper right-hand corner of the examination cover sheet and each Answer sheet.

6. Mark your Answers on the Answer sheet provided. 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.

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

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

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

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

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

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

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

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

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

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

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

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

$$M = \frac{1 - K_{eff_1}}{1 - K_{eff_2}}$$

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

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

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

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

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

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

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

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

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

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

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

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

1 kg = 2.21 lb

1 Horsepower = 2.54 x 10^3 BTU/hr

1 Mw = 3.41 x 10^6 BTU/hr

1 BTU = 778 ft-lb

°F = 9/5 °C + 32

1 gal (H_2O) ≈ 8 lb

°C = 5/9 (°F - 32)

c_P = 1.0 BTU/hr/lb/°F

c_p = 1 cal/sec/gm/°C

QUESTION A.01 [1.0 point]
What happens to the mass number and the atomic number of an element when it undergoes β-decay?

a. The mass number decreases by 4 and the atomic number decreases by 2.

b. The mass number does not change and the atomic number decreases by 2.

c. The mass number increases by 2 and the atomic number increases by 1.

d. The mass number does not change and the atomic number increases by 1.

QUESTION A.02 [1.0 point]
Which ONE of the following is the **MAJOR** source of energy released during fission?

a. Fission fragments

b. Fission product decay

c. Prompt gamma rays

d. Fission neutrons (kinetic energy)

QUESTION A.03 [1.0 point]
If Beta for U-235 is 0.0065 and Beta effective is approximately 0.007, how does this difference affect reactor period in the reactor period equation, $T=(\beta-\rho)/\lambda\rho$? This difference produces a ____________ for a given addition of reactivity with Beta effective.

a. shorter period

b. longer period

c. stable period

d. decay constant (λ) increase

QUESTION A.04 [1.0 point]
Which ONE is true about “subcritical multiplication”? As the reactor approaches criticality, the parameter

a. k_{eff} approaches zero

b. ρ approaches infinity

c. M approaches one

d. 1/M approaches zero

QUESTION A.05 [1.0 point]
The term “macroscopic cross section” is defined as:

a. The average distance travelled by a neutron between interactions in a material.

b. An indication of energy loss per collision.

c. The probability of neutron interaction per centimeter of travel in a material.

d. The effective cross sectional area of a single nucleus presented to an oncoming neutron.

QUESTION A.06 [1.0 point]
Which ONE is true about prompt neutrons?

a. They are released directly from fission within 10^{-13} seconds of the fission event.

b. They are the total fraction of all neutrons born.

c. They are emitted immediately following the first beta decay of a fission fragment.

d. They are responsible for the ability to control the rate at which power can rise in a reactor.

QUESTION A.07 [0.25 points each]
Match with the correct answer:

a. Critical reactor	1. The neutron flux decreases each generation
b. Supercritical reactor	2. Takes leakage into consideration
c. Subcritical reactor	3. The power level will rise exponentially
d. Effective multiplication factor	4. Constant number of neutrons

QUESTION A.08 [1.0 point]
Which ONE is true about the excess reactivity?

a. Ensures that the reactor can be shut down from any condition of operation

b. Ensures that the fuel temperature safety limit will not be exceeded

c. Is the change in reactivity caused by control rod motion

d. Is the amount of reactivity beyond what is needed for the reactor to be critical

QUESTION A.09 [1.0 point]
Which ONE defines an integral rod worth curve?

a. Conforms to an axial flux shape.

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

c. Any point on the curve represents the amount of reactivity that one inch of rod motion would insert at that position in the core.

d. Reactivity is highest at the top of the core and lowest at bottom of the core.

QUESTION A.10 [1.0 point]
The fuel temperature coefficient of reactivity is -2.5×10^{-4} k/k/°C. When a control rod with an average rod worth of 0.2 % k/k/inch is withdrawn 12 inches, reactor power increases and becomes stable at a higher level. At this point, the fuel temperature has:

a. decreased by 96°C

b. increased by 96°C

c. decreased by 0.67°C

d. increased by 0.67°C

QUESTION A.11 [1.0 point]
A reactor is operating at criticality. Instantaneously, all of the delayed neutrons are suddenly removed from the reactor. The K_{eff} of the reactor in this state would be approximately:

a. 1.007

b. 1.000

c. 0.993

d. 0.000

QUESTION A.12 [1.0 point]
About two minutes following a reactor scram, period has stabilized, and is decreasing at a CONSTANT rate. If reactor power is 10^{-3} % full power what will the power be in four minutes?

a. 5×10^{-5} % full power

b. 2×10^{-5} % full power

c. 4×10^{-6} % full power

d. 1×10^{-6} % full power

QUESTION A.13 [1.0 point]
For different changes to the core configuration, which one increases the thermal utilization factor in the six factor formula?

a. Increasing moderator/fuel ratio

b. Raising control rods

c. Decreasing enrichment

d. Fuel Burn up

QUESTION A.14 [1.0 point]
Reactor period is defined as ____________.

a. The time required for a reactor to change by a factor of *e*.

b. The time required for the reactor power to double.

c. The number of factors of ten that reactor power changes in one minute.

d. The fraction of all neutrons that are born as delayed neutrons.

QUESTION A.15 [1.0 point]
An Integral Rod Worth (IRW) curve is ___________, while a Differential Rod Worth (DRW) curve is __________.

a. the total reactivity worth added by the rod at any point of withdrawal;
the reactivity change per unit movement of the rod at the point of withdrawal.

b. at its maximum value when the rod is approximately half-way out of the core;
at its maximum value when the rod is fully withdrawn from the core.

c. the slope of the DRW curve at any point of withdrawal;
the area under the IRW curve at any point of withdrawal.

d. the reactivity change per unit movement of the rod at any point of withdrawal;
the total reactivity worth of the rod at any point of withdrawal.

QUESTION A.16 [1.0 point]
During a reactor startup, criticality occurred at a LOWER ROD HEIGHT than the last startup. Which ONE of the following reasons could be the cause?

a. Xe^{135} increased.

b. Fuel temperature increased.

c. Pool temperature decreased.

d. Removing an experiment with negative reactivity from the core.

QUESTION A.17 [1.0 point]
Which one of the following has the highest thermal neutron cross section?

a. Cd-113

b. Gd-157

c. Xe-135

d. Sm-149

QUESTION A.18 [1.0 point]
You've just increased power at a research reactor. As a result fuel temperature increased from 100°C to 120°C. For this reactor the fuel temperature coefficient (α_{tf}) is -0.01% Δk/k/°C, and the average rod worth for the regulating rod is 0.05% Δk/k/inch. How far and in what direction must you move the regulating rod to compensate? (Assume all other factors which could affect reactivity remain unchanged.)

a. 2 inches inward

b. 2 inches outward

c. 4 inches inward

d. 4 inches outward

QUESTION A.19 [1.0 point, 0.33 each]
Fill in the blanks with: increase, decrease or same (answers can be used more than once).
When the average moderator temperature in a reactor core increases,

a. Numbers of neutrons absorbed in the control rods (assuming the rods do not move) ____________.

b. Number of neutrons leaking from the core ____________.

c. Number of neutrons absorbed in the moderator ____________ compared to the number of neutrons absorbed in the fuel.

QUESTION A.20 [1.0 point]
The term ____________ defines the condition where no delay neutrons are needed to remain critical.

a. Prompt jump

b. Prompt drop

c. Asymptotic period

d. Prompt critical

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

Question B.01 [1.0 point]
A "high radiation area" is:

a. an area where airborne radioactive materials, composed wholly or partly of licensed material, exist in concentrations are In excess of the derived air concentrations (DACs) specified in appendix B, or an individual present in the area without respiratory protective equipment could exceed, during the hours an individual is present in a week, an intake of 0.6 percent of the annual limit on intake (ALI) or 12 DAC-hours.

b. an area accessible to individuals, in which radiation levels could result in an individual receiving a dose equivalent in excess of 0.005 rem (0.05 mSv) in 1 hour at 30 centimeters from the radiation source or from any surface that the radiation penetrates.

c. an area, accessible to individuals, in which radiation levels from radiation sources external to the body could result in an individual receiving a dose equivalent in excess of 0.1 rem (1 mSv) in 1 hour at 30 centimeters from the radiation source or 30 centimeters from any surface that the radiation penetrates.

d. an area, access to which is limited by the licensee for the purpose of protecting individuals against undue risks from exposure to radiation and radioactive materials.

Question B.02 [1.0 point]
Which ONE of the following statements is a condition for pulsing the KSU reactor?

a. In the Pulse mode, the reactor must be operated with a standard fuel TRIGA fuel element in the central thimble.

b. The fuel elements must be gauged after every pulse of magnitude greater than $1.00.

c. Pulsing operations must not be done from a subcritical configuration.

d. The peak fuel temperature of each pulse must be measured.

Question B.03 [1.0 point]
If an evacuation is required, it must be verified complete within:

a. 3 minutes

b. 10 minutes

c. 15 minutes

d. 30 minutes

Question B.04 [1.0 point, 0.25 each]
Match the annual dose limit values to the type of exposure.

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

Question B.05 [1.0 point]
A foreign object is accidentally dropped into the reactor tank while the reactor is operating. The Reactor Supervisor is not immediately available. The reactor operator must:

a. direct another individual to try to remove the object by grappling hooks, vacuum line or other “fishing” tools.

b. immediately notify the Radiation Safety Officer.

c. declare an Unusual Event.

d. shut down the reactor.

Question B.06 [1.0 point]
The "evacuation alarm" sounds when radiation levels [A] exceed [B].

a. [A] control room [B] 1 R/h

b. [A] 12-foot level [B] 10 mR/h

c. [A] 0-foot level [B] 1,000 mR/h

d. [A] 22-foot level [B] 5 R/h

Question B.07 [1.0 point]
A survey instrument with a window probe is used to measure the beta-gamma dose rate from an irradiated experiment. The dose rate is 100 mrem/hour with the window open and 60 mrem/hour with the window closed. The gamma dose rate is:

a. 100 mRem/hr

b. 60 mRem/hr

c. 40 mRem/hr

d. 160 mRem/hr

Question B.08 [1.0 point]
In accordance with Procedure No. 2, "Annual Power Level Calibration," after power level has been determined:

a. the linear power channel meter and recorder are adjusted to give the correct power indication.

b. the high voltage to the linear power channel detector is adjusted to give the correct power indication.

c. the compensating voltage of the compensated ion chamber is adjusted to give the proper power indication.

d. the position of the compensated ion chamber is adjusted to give the proper power indication.

Question B.09 [1.0 point]
10CFR50.54(x) states: "A licensee may take reasonable action that departs from a license condition or a technical specification (contained in a license issued under this part) in an emergency when this action is immediately needed to protect the public health and safety and no action consistent with license conditions and technical specifications that can provide adequate or equivalent protection is immediately apparent." 10CFR50.54(y) states that the minimum level of management which may authorize this action is …

a. any Reactor Operator licensed at facility

b. any Senior Reactor Operator licensed at facility

c. Facility Manager (or equivalent at facility).

d. NRC Project Manager

Question B.10 [1.0 point]
A radioactive source generates a reading of 100 mr/hr at a distance of 10 feet. With two inches of lead shielding the reading drops to 50 mr/hr at a distance of 10 feet. If you were to add another four inches of the same type of shielding, the reading at 10 feet would drop to …

a. 25 mr/hr

b. 12½ mr/hr

c. 6¼ mr/hr

d. 3⅛ mr/hr

Question B.11 [1.0 point]
In accordance with the KSU Fitness for Duty policy, which ONE of the following statements is NOT true?

a. An arrest for possession or distribution of a controlled substance will result in the permanent loss of access to the Nuclear Reactor Facility.

b. Extended use of prescription or over-the-counter drugs is to be reported to the examining physician during employment physicals.

c. Consumption of alcohol during an abstinence period need not necessarily preclude responding to an emergency.

d. Consumption of alcohol is prohibited for 5 hours preceding any scheduled activity within the facility.

Question B.12 [1.0 point, 0.25 each]
Identify each of the four surveillances listed as a channel CHeck, a channel TEST, or a channel CALibration.

a. During performance of the Daily Checkout you verify the Bay differential pressure is negative.

b. Following maintenance on Nuclear Instrument channel 1 you compare its readings to Nuclear Instrument channel 2 readings.

c. You verify a temperature channel's operation by replacing the RTD with a precision variable resistance and checking proper output.

d. You perform a heat balance (calorimetric) on the primary system and based on Nuclear Instrumentation readings you make adjustments.

Question B.13 [1.0 point]
To ensure the occupational radiation limits for workers are kept within ALARA goals, KSU administratively limits the total effective dose equivalent (TEDE) for workers to:

a. 50 mRem/month.

b. 1.25 Rem/qtr.

c. 500 mRem/yr.

d. 3 Rem/yr.

Question B.14 [1.0 point]
In accordance with the Technical Specifications, which ONE condition below is NOT permissible when the reactor is operating?

a. Maximum available reactivity above cold, clean condition = $4.00.

b. Primary water temperature = 110 deg. F.

c. Pool water conductivity = 2 micromho/cm.

d. Fuel temperature = 400 deg. C.

Question B.15 [1.0 point]
You initially remove a sample from the pool reading 1 R/hr at 30 cm from the source. You then replace the sample in the pool. An hour later you remove the sample and the reading is now 390 mR/hr at 30 cm. You again replace the sample back in the pool. How much longer should you wait to be able to bring out the sample without generating a high radiation area?

a. ½ hour

b. 1 hour

c. 1½ hours

d. 3 hours

Question B.16 [1.0 point]
According to the Emergency Plan, the Emergency Planning Zone (EPZ) is

a. Room 110 (Reactor Bay).

b. Room 109 (Control Room) and Room 110 (Reactor Bay).

c. Ward Hall.

d. Ward Hall and the adjacent Fenced Area.

Question B.17 [1.0 point]
The Continuous Air Monitor (CAM) is set to alarm at the Maximum allowed Effluent Concentration of:

a. Te^{131}

b. I^{131}

c. Xe^{131}

d. Cs^{131}

Question B.18 [1.0 point]
The OPERATIONS BOUNDARY is defined as:

a. Room 110 of Ward Hall.

b. Ward Hall and adjacent fenced areas.

c. Facility Control Center.

d. Nuclear Engineering Departmental Office.

Question B.19 [1.0 point]
You plan to perform a pulse. Per KSU Technical Specifications, The MAXIMUM rod drive positioned for reactivity insertion (upon withdrawal) is _____.

a. $1.5

b. $2.0

c. $3.0

d. $4.0

Question B.20 [1.0 point]
Which ONE of the following statements correctly describes the relationship between the Safety Limit (SL) and the Limiting Safety System Setting (LSSS)?

a. The SL is a maximum operationally limiting value that prevents exceeding the LSSS during normal operations.

b. The SL is a parameter that assures the integrity of the fuel cladding. The LSSS initiates protective actions to preclude reaching the SL.

c. The SL is a maximum setpoint for instrumentation response. The LSSS is the minimum number of channels required to be operable.

d. The LSSS is a parameter that assures the integrity of the fuel cladding. The SL initiates protective action to preclude reaching the LSSS.

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

QUESTION C.01 [1.0 point]
Which ONE of the following experimental facilities allows for access to the point of maximum flux in the core?

a. Beam Tube Facilities

b. Central Thimble

c. Pneumatic Specimen Tube

d. Rotary Specimen Rack

QUESTION C.02 [1.0 point]
The __________ provides rod position indication.

a. Armature

b. Electromagnet

c. Micro-switches

d. Potentiometer

QUESTION C.03 [0.25 each point]
Match the following KSU TRIGA items with their corresponding core position. Answers can be used more than once.

Column A	Column B
a. Startup Source	1. B Ring
b. Shim & Safety Rod	2. C ring
c. Transient Rod	3. D ring
d. Regulating Rod	4. E ring
	5. F ring
	6. May be positioned in any one of the fuel positions defined by the upper and lower grid plates

QUESTION C.04 [1.0 point]
Which ONE of the followings interlocks prevents the withdrawal of standard rods in pulse mode?

a. Control Rod Position interlock

b. Pulse Rod interlock

c. Multiple Rod Withdrawal interlock

d. Pulse Power interlock

QUESTION C.05 [1.0 point]
Which ONE of the following scrams can be bypassed during operations?

a. High reactor power scram

b. High voltage power supply failure

c. Period scram

d. Manual scram

QUESTION C.06 [1.0 point]
Which ONE of the following measuring channels has a limiting trip set point in both Steady State and Pulse mode of operations?

a. Detector High Voltage

b. Linear Channel High Power

c. Period Trip

d. Power Channel High Power

QUESTION C.07 [1.0 point]
Which ONE of the following systems is used at KSU in the event of a rupture in the primary piping?

a. A diffuser system

b. A deionizer

c. A siphon break

d. A skimmer

QUESTION C.08 [1.0 point]
A small breach in the heat exchanger would be evidenced by __________ contamination of the secondary water.

a. Argon-41

b. Cesium-135

c. Hydrogen-3

d. Nitrogen-16

QUESTION C.09 [1.0 point]
Technical Specifications require water level above the core to be at least 13 ft. from the top of the core to __________.

a. Prevent possible corrosion of reactor components

b. Provide shielding and support cooling

c. Minimize production of radioactive materials

d. Maintain optical clarity of the coolant

QUESTION C.10 [1.0 point]
The portable NEUTRON survey reader is a radiation monitoring and surveillance equipment that __________.

a. Measure radioiodine, noble gases, and particulates

b. Measure high level gamma-ray exposure rate

c. Measure gamma-ray exposure rate, sense beta particles

d. Measure ambient dose rate

QUESTION C.11 [1.0 point]
The following monitors indicate the presence of dispersible radioactive materials, an indication of possible fuel cladding failures, EXCEPT:

a. Continuous Air monitor

b. Pool Surface monitor

c. Water Box monitor

d. 22 foot Area Radiation monitor

QUESTION C.12 [1.0 point]
What is the alarm set point for the radiation monitor stationed on the top of the reactor that will alarm to initiate evacuation of the reactor bay?

a. 2.5 R/hr

b. 5.0 R/hr

c. 10 mR/hr

d. 100 mR/hr

QUESTION C.13 [1.0 point]
An experiment with design reactivity worth of greater than $1.00:

a. Shall have the actual reactivity measured and recorded at the time of initial insertion.

b. Shall be securely fastened to prevent movement during reactor operations.

c. Shall be performed under the direct supervision of the Reactor Supervisor.

d. Is the minimum value of the reactor shutdown margin.

QUESTION C.14 [1.0 point]
What is the basic safety limit for the TRIGA reactor related to the limit on the fuel temperature for both steady state and pulsed-mode operations? Temperature is limited to prevent:

a. Fuel expansion through phase changes and prevent gas pressure build up.

b. Fission product built up.

c. Excessive pressure from expansion of Argon-41.

d. Excessive pressure caused by air, fission product gases, and zirconium hydride hydrogen dissociation.

QUESTION C.15 [1.0 point]
The Control Rod (Standard) drop times shall be measured __________.

a. Quarterly

b. Semi annually

c. Annually

d. Biannually

QUESTION C.16 [1.0 point]
What kind of detector feeds the NMP-1000?

a. Fission chamber

b. Compensated ion chamber

c. Geiger-Mueller

d. Scintillation

QUESTION C.17 [1.0 point]
Which ONE of the following transient rod drive components determines the amount of reactivity inserted for a pulse?

a. The piston

b. The worm gear and ball-screw assembly

c. The air supply hose

d. The solenoid valve

QUESTION C.18 [1.0 point]
Which ONE of the following design features prevents the accidental siphoning of reactor pool water?

a. The actions of the flow orifice within the cleanup loop.

b. The capacity of the makeup water system.

c. A positive pressure difference between the plates inside the heat exchanger.

d. A small hole in the pipe located about one foot below the water surface of the tank.

QUESTION C.19 [1.0 point]
When the Reactor Bay Ventilation Exhaust system is not OPERABLE, the following required actions are true EXCEPT:

a. Secure experiment operations for experiment with failure modes that could result in the release of radioactive gases or aerosols

b. Do not operate in Steady State mode

c. Secure experiment operation

d. Ensure no irradiated fuel handling

QUESTION C.20 [1.0 point]
What is the water conductivity limit?

a. 1.25 μmhos/cm

b. 2.0 μmhos/cm

c. 5.0 μmhos/cm

d. 7.0 μmhos/cm

***** END OF SECTION C *****
***** END OF EXAM *****

A.01
Answer: d
REF: DOE Handbook volume 1, module 1, NP-01, pg. 24
β decay = $ZX^A \rightarrow Z+1Y^A + e + \nu$
A = mass number
Z = atomic number

A.02
Answer: a
REF: Burns, Table 3.2, pg. 3-5

A.03
Answer: b
REF: Burns, Example 3.4.3, pg. 3-32, 3-33
In the reactor period equation, $T=(\beta-\rho)/\lambda\rho$, if Beta effective is used instead of Beta for U-235, the term $(\beta_{eff}-\rho)$ is larger giving a longer period.

A.04
Answer: d
REF: Burns, Table 5.5, pg. 5-15

A.05
Answer: c
REF: Burns, Section 2.5, pg. 2-43

A.06
Answer: a
REF: DOE Handbook volume 1, module 2, pg. 29, 32
(Answer for b is the delayed neutron fraction, answer for c and d are delayed neutrons)

A.07
Answer: a = 4 b = 3 c = 1 d = 2
REF: DOE Handbook part 2, module 3, pg. 8-9

A.08
Answer: d
REF: DOE Handbook volume 2, module 3, p. 50 (Answer for c is control rod worth)

A.09
Answer: b
REF: Burn, Section 7.3, pg. 7-5 to 7-7

A.10
Answer: b
REF: Lamarsh, pg. 365

A.11
Answer: c
Reference: DOE Fundamentals Handbook, Module 2, page 30.

A.12
Answer: a
Reference: $P = P_0\, e^{-(t/T)}$; $P_0 = 10^{-3}$ %, T= 80 sec (negative reactivity due to reactor scram), t = 4 min = 240 sec
$P = 10^{-3} \times e^{(-240/80)} = 10^{-3} \times e^{-3} = 0.0498 \times 10^{-3} = 4.98 \times 10^{-5}$ % full power

A.13
Answer: b (Answers a, c and d decreases the thermal utilization factor)
REF: Reed Training Manual, pg. 131

A.14
Answer: a
REF: DOE Handbook part 2, module 4, pg. 21

A.15
Answer: a
Reference: DOE Fundamentals Handbook, Module 3, Control Rods

A.16
Answer: d
REF: Burn, Sec 8.4, page 8-9

A.17
Answer: c
REF: Lamarsh 3rd ed., pg. 377, 387

A.18
Answer: d
Reference: DOE Fundamentals Handbook, Nuclear Physics and Reactor Theory
$-0.0001\Delta k/k/°C \times +20°C = -0.002\Delta k/k$. To compensate must add $+0.002\Delta k/k$.
$(0.002\Delta k/k) \div (0.0005\%\Delta k/k/\text{inch})$ = 4 inches in the positive (outward) direction.

A.19
Answer: a = increase b = increase c = decrease
REF: Burns, problem 6.5.2, pg. 6-14

A.20
Answer: d
REF: Nuclear Engineering, 2nd ed., Ronald Allen Knief, pg. 142

B.01
Answer: c
Reference: Facility supplied question

B.02
Answer: d
Reference: Experiment 23

B.03
Answer: d
Reference: KSU Exam Bank

B.04
Answer: a = 4; b = 3; c = 2; d = 1
Reference: 10 CFR 20 §§ 1201.a(2)(ii), 1201.a(1), 1201.a(2)(i), 1301

B.05
Answer: d
Reference: Experiment No. 1

B.06
Answer: d
Reference: KSU Exam Bank

B.07
Answer: b
Reference: Standard NRC Radiation Health Physics Question

B.08
Answer: d
Reference: Procedure No. 2

B.09
Answer: b.
Reference: 10CFR50.54(y)

B.10
Answer: b
Reference: 2" = one-half thichness ($T_{½}$). Using 3 half-thickness will drop the dose by a factor of $(½)^3$ = ⅛. 100/8 = 12.5

B.11
Answer: a
Reference: Training Manual, page A6-1

B.12
Answer: a = CH; b = CH; c = TEST; d = CAL
Reference: KSU Technical specification § 1, Definitions

B.13
Answer: c
Reference: KSU Exam Bank

B.14
Answer: a
Reference: KSU Technical Specifications, KSU Procedure 15, Attachment 1: Daily Checkout

B.15
Answer: c
Reference: $I_t = I_0\ e^{-\lambda t}$ 390 mR/hr ÷ 1000 mR/hr = $e^{-\lambda 1hr}$ ln(0.39) = -λ * 1 hr.
λ = 0.9416 $hour^{-1}$ SOLVING for additional time: $If = I_t\ e^{-\lambda t}$
100mR/hr = 390 mR/hr $e^{-0.9416\ (time)}$ ln (0.25) = -0.9163 * time
time = 1.4454 hours

B.16
Answer: b
Reference: Emergency Plan § 1.5.2

B.17
Answer: b
Reference: Rewrite of facility supplied question

B.18
Answer: a
Reference: Emergency Plan, section 1.1

B.19
Answer: c
Reference: TS 3.2

B.20
Answer: b
Reference: Standard NRC question on Safety Limits

Section C: Facility and Radiation Monitoring Systems

KSU 15-02

C.01 b
REF: SAR 1.3.8.a, pg. 1-13

C.02 d
REF: SAR 7.3.4.a, pg. 7-11

C.03 a, 5 b, 3 c, 2 d, 4
REF: SAR 4.2.1.c Figure 4.4, pg. 4-7 and SAR 4.5.2 Table 4.5, pg. 4-15

C.04 a
REF: TS 3.4 Table 2, pg. TS-16, SAR 4.2.2.a Table 4.2, pg. 4-11

C.05 c
REF: SAR 7.4, pg. 7-17

C.06 a
REF: SAR 4.2.2.b table 4.3, pg. 4-12

C.07 c
REF: SAR 5.2, pg. 5-4

C.08 c
REF: SAR 5.3.3, pg. 5-8

C.09 b
REF: TS 3.8.3(3) and 3.8.5, pg. TS-21

C.10 d
REF: SAR 11.1.4 Table 11.2, pg. 11-9

C.11 d
REF: SAR 7.2.2, pg. 7-4

C.12 b
REF: SAR 1.3.5.d, pg. 1-10

C.13 b
REF: TS 5.4.3(1), pg. TS-28

C.14 a
REF: SAR 3.5.1 pg. 3-12 to 3-17

C.15 c
REF: TS 4.4, pg. TS-24

C.16 b
REF: SAR 7.3.1, pg. 7-9

C.17 b
REF: SAR 7.3.4.b, pg. 7-14 and Figure 7.8, pg. 7-16

C.18 d
REF: SAR 5.2, pg. 5-4

C.19 d
REF: TS 3.5.4, pg. TS-17

C.20 c
REF: TS 3.8.3, pg. TS-21