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

April 13, 2018

Dr. Alan T. Cebula, Nuclear Reactor Facility Manager
Kansas State University
112 Ward Hall
Manhattan, KS 66506-2500

SUBJECT: EXAMINATION REPORT NO. 50-188/OL-18-01, KANSAS STATE UNIVERSITY

Dear Dr. Cebula:

During the week of December 4, 2017, the U.S. Nuclear Regulatory Commission (NRC) administered an operator licensing examination at your Kansas State University Nuclear 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 internet e-mail Michele.DeSouza@nrc.gov.

Sincerely,

/RA/

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

Docket No. 50-188

Enclosures:
1. Examination Report No. 50-188/OL-18-01
2. Written Examination

cc: w/o enclosures: See next page

SUBJECT: EXAMINATION REPORT NO. 50-188/OL-18-01, KANSAS STATE UNIVERSITY DATED APRIL 13, 2018

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ADAMS ACCESSION No. ML18102A608 **NRR-079**

OFFICE	NRR/DLP/PROB/CE	NRR/DLP/PROB	NRR/DLP/PROB/BC
NAME	MDeSouza	AFerguson	AMendiola
DATE	12/08/2017	04/12/2018	04/13/2018

OFFICIAL RECORD COPY

cc:

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Reactor Newsletter
P.O. Box 118300
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U. S. NUCLEAR REGULATORY COMMISSION
OPERATOR LICENSING INITIAL EXAMINATION REPORT

REPORT NO.: 50-188/OL-18-01

FACILITY DOCKET NO.: 50-188

FACILITY LICENSE NO.: R-88

FACILITY: KSU

EXAMINATION DATES: December 5-6, 2017

SUBMITTED BY: ***/RA/*** ***12/21/2017***
Michele DeSouza, Chief Examiner Date

SUMMARY:
During the week of December 4, 2017, the NRC administered an operator licensing examination to one Senior Reactor Operator Upgrade (SRO-U) candidate and one Reactor Operator (RO) candidate. The candidates passed all applicable portions of the examinations.

REPORT DETAILS

1. Examiner: Michele DeSouza, Chief Examiner, NRC

2. Results:

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

3. Exit Meeting:
Michele C. DeSouza, Chief Examiner, NRC
Amir Bahadori, Reactor Manager, KSU
Max Nager, Interim Reactor Supervisor, KSU

Per discussion with the facility, prior to administration of the examination, adjustments were accepted. Upon completion of the examination, 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.

ENCLOSURE 1

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

FACILITY: KSU

REACTOR TYPE: TRIGA

DATE ADMINISTERED: 12/06/2017

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

ENCLOSURE 2

Category A – Reactor Theory, Thermodynamics, & Facility Operating Characteristics

A N S W E R S H E E T

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

A01 a b c d ___

A02 a b c d ___

A03 a b c d ___

A04 a ___ b ___ c ___ d ___ (0.25 each)

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 ___

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 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 ___ (0.25 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 ___

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

$Q = m\ c_p\ \Delta T$

$Q = m\ \Delta h$

$Q = UA\ \Delta T$

$$SUR = \frac{26.06\ (\lambda_{eff}\rho)}{(\beta - \rho)}$$

$SUR = 26.06/\tau$

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

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

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

$\tau = (P^*/\rho) + [(\bar{\beta}-\rho)/\lambda_{eff}\rho]$

$\rho = (Keff-1)/Keff$

$\rho = \Delta Keff/Keff$

$\bar{\beta} = 0.007$

$DR_1D_1^2 = DR_2D_2^2$

$Cp\ (H20) = 0.146\ \frac{kw}{gpm}\ \cong EF$

$\lambda_{eff} = 0.1/sec$

$SCR = S/(1-Keff)$

$CR_1\ (1-Keff)_1 = CR_2\ (1-Keff)_2$

$$M = \frac{(1-Keff)_0}{(1-Keff)_1}$$

$M = 1/(1-Keff) = CR_1/CR_0$

$SDM = (1-Keff)/Keff$

$I = I_o\ e^{-ux}$

$P^* = 1 \times 10^{-4}$ seconds

$\tau = P^*/(\rho-\bar{\beta})$

$R = 6\ C\ E\ n/r^2$

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

$DR = DR_o e^{-\lambda t}$

$P = S / (1 - Keff)$

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

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1 Curie = 3.7×10^{10} dps

1 kg = 2.21 lbm

1 hp = 2.54×10^3 BTU/hr

1 Mw = 3.41×10^6 BTU/hr

1 BTU = 778 ft-lbf

$F = 9/5\ C + 32$

931 Mev = 1 amu

$C = 5/9\ (F - 32)$

Category A: Theory, Thermodynamics & Facility Operating Characteristics

Question A.01 [1.0 point]
Reactor period is defined as:

a. The time required for the reactor power to double

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

c. The time required for the reactor power to be reduced to one-half the initial level

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

Question A.02 [1.0 point]
A reactor is slightly supercritical with the following values for each of the factors in the six-factor formula:

Fast Fission Factor = 1.03	Fast non-leakage probability = 0.84
Resonance Escape Probability = 0.96	Thermal non-leakage probability = 0.88
Thermal Utilization Factor = 0.70	Reproduction Factor = 1.96

A control rod is inserted to bring the reactor back to critical. Assuming all other factors remain unchanged, the new value for the Thermal Utilization Factor is:

a. 0.698

b. 0.702

c. 0.704

d. 0.708

Question A.03 [1.0 point]
What is the effect of U-238 on the reactor neutron life cycle when a neutron energy is below 1 MeV?

a. The number of fissions due to U-238 decrease.

b. The number of fissions due to U-238 remains the same.

c. The number of fissions due to U-238 increase.

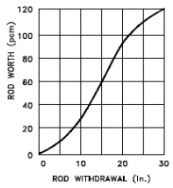
d. The number of fissions due to U-235 increase.

Category A: Theory, Thermodynamics & Facility Operating Characteristics

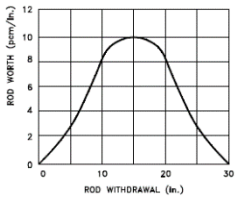
Question A.04 [1.0 point, 0.25 points each]
Identify if the descriptions or graphs in Column A describe or depict integral control rod worth or differential rod worth?

Column A	Column B
a. total reactivity worth of the control rod at that height	1. Differential Rod Worth
b. reactivity change per unit movement of a control rod	2. Integral Rod Worth

c.



d.



Question A.05 [1.0 point]
What is the difference between prompt and delayed neutrons?

a. Prompt neutrons are released virtually instantaneously, and delayed neutrons are a very small fraction of the total number of neutrons and do not have an important role in the control of the reactor.

b. Prompt neutrons are released during fast fission while delayed neutrons are released during thermal fissions.

c. Prompt neutrons are released within 10^{-13} seconds, whereas delayed neutrons are emitted following the beta decay of a fission fragment.

d. Prompt neutrons are 99% of the neutron produced in fission and are therefore the dominating factor in determining the reactor period, whereas delayed neutrons account for less than 1% of the neutron population and have little effect on the reactor period

Question A.06 [1.0 point]
What is the reason the stable negative period following a scram is always the same value (- 80 second) regardless of initial power level?

a. The nuclear instrument reads the constant count rate from a neutron source.

b. The rate of power change is dependent on a mean lifetime of the short lived delayed neutron precursors.

c. The delayed neutrons are born at same rate as prompt neutrons after shutdown resulting in a constant neutron count rate.

d. The rate of power change is dependent on a mean lifetime of the longest lived delayed neutron precursors.

Question A.07 [1.0 point]
Which ONE of the reactions below describes a method of production and removal of Xenon?

a. $_{52}Te^{134} \rightarrow \gamma + {}_{53}I^{134} \rightarrow p + {}_{54}Xe^{135} \rightarrow \beta^- + {}_{55}Cs^{135} \rightarrow \beta^- + {}_{56}Ba^{135}$

b. $_{52}Te^{135} \rightarrow \gamma + {}_{53}I^{135} \rightarrow \beta^- + {}_{54}Xe^{135} \rightarrow {}_{0}n^{1} + {}_{54}Xe^{136} \rightarrow \beta^- + {}_{56}Ba^{135}$

c. $_{52}Te^{135} \rightarrow \beta^- + {}_{53}I^{135} \rightarrow \beta^- + {}_{54}Xe^{135} \rightarrow \beta^- + {}_{55}Cs^{135} \rightarrow \beta^- + {}_{56}Ba^{135}$

d. $_{52}Te^{134} \rightarrow \beta^- + {}_{53}I^{135} \rightarrow \beta^- + {}_{54}Xe^{135} \rightarrow \gamma + {}_{55}Cs^{135} \rightarrow \beta^+ + {}_{56}Ba^{135}$

Question A.08 [1.0 point]
What is the result between a neutron and a target nucleus in elastic scattering?

a. Energy is transferred into nuclear excitation, and then emitted via a gamma emissions.

b. The target nucleus gains the amount of kinetic energy that the neutron loses.

c. The neutron is absorbed by the target nucleus and then emitted with lower kinetic energy.

d. The neutron conserves its initial kinetic energy if the target nucleus is large.

Question A.09 [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

Category A: Theory, Thermodynamics & Facility Operating Characteristics

Question A.10 [1.0 point]
Which ONE of the following conditions will INCREASE the shutdown margin of a reactor?

a. Lowering moderator temperature (assume negative temperature coefficient)

b. Insertion of a positive reactivity worth experiment

c. Burnout of a burnable poison

d. Fuel depletion

Question A.11 [1.0 point]
The first pulse has a reactivity worth of **$1.10** which results in a peak power of **500 MW**. If the second pulse has a peak power of **5000 MW**, the corresponding reactivity worth is:
Given: β_{eff}=0.0075

a. $1.32

b. $1.40

c. $1.62

d. $2.02

Question A.12 [1.0 point]
Which of the following is an example of a **FERTILE** material?

a. Th-232

b. U-233

c. U-235

d. Pu-239

Question A.13 [1.0 point]
A reactor contains a neutron source that produces 15,000 neutrons/second. The reactor has a k_{eff} = 0.88. What is the stable total neutron production rate in the reactor?

a. 100,000 neutrons/sec

b. 115,074 neutrons/sec

c. 125,000 neutrons/sec

d. 135,135 neutrons/sec

Question A.14 [1.0 point]
Xenon-135 (Xe^{135}) is produced in the reactor by two methods. One is directly from fission; the other is indirectly from the decay of:

a. Xe^{136}

b. Sm^{136}

c. Cs^{135}

d. I^{135}

Question A.15 [1.0 point]
What is the result of the Doppler Effect in the fuel temperature coefficient?

a. Stationary nuclei absorb more neutrons

b. Vibrating nuclei absorb less neutrons

c. Raising the temperature causes the nuclei to vibrate more rapidly effectively broadening the energy range of neutrons that may be resonantly absorbed.

d. An apparent broadening of the nuclei's resonances due to a temperature increase.

Question A.16 [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.17 [1.0 point]
Which ONE of the following best describes the alpha decay (α) of a nuclide?

a. The number of protons decreases by 2, and the number of neutrons decreases by 2.

b. The number of protons decreases by 2, and the number of neutrons decrease by 4.

c. The number of protons decreases by 4, and the number of neutrons decrease by 2.

d. The number of protons decreases by 4, and the number of neutrons decreases by 4.

Question A.18 [1.0 point]
In a subcritical reactor, K_{eff} is increased from 0.885 to 0.943. Which one of the following is the amount of reactivity that was added to the core?

a. 4.68 %Δk/k

b. 5.58 %Δk/k

c. 6.94 %Δk/k

d. 7.45 %Δk/k

Question A.19 [1.0 point]
Which ONE of the following is the stable reactor period which will result in a power rise from 50% to 100% power in 50 seconds?

a. 14 seconds

b. 36 seconds

c. 72 seconds

d. 144 seconds

Question A.20 [1.0 point]
The reactor is subcritical with the count rate of 100 counts per second (cps) and K_{eff} of 0.950. The control rods are withdrawn until the count rate is doubled. What is the new value of K_{eff}?

a. 1.020

b. 0.998

c. 0.975

d. 0.952

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

Category B: Normal/Emergency Procedures and Radiological Controls

Question B.01 [1.0 point]
Which ONE of the following changes requires NRC Approval?

a. Revision of the operator licensing requalification examination

b. Revision of Standard Operating Procedure #1 for Use of the Reactor

c. Major changes in the Administrative Procedure #7

d. Delete an administrative control requirement listed in the KSU Technical Specification 6.0

Question B.02 [1.0 point]
Who may authorize reentry into the Reactor Facility after an emergency evacuation of the facility?

a. Reactor Operator

b. Radiation Safety Officer

c. Emergency Coordinator

d. Emergency Director

Question B.03 [1.0 point]
A radioactive source reads 80 mRem/hr on contact. Thirty minutes later, the same source reads 40 mrem/hr. How long is the time for the source to decay from a reading of 80 mrem/hr to 5 mrem/hr?

a. 1.5 hours

b. 2 hours

c. 3 hours

d. 5 hours

Question B.04 [1.0 point]
Which ONE of the following regulations requires submitting NRC Form 396, Certification of Medical Examination by Facility Licensee, as part of an application for an operator license?

a. 10 CFR 19

b. 10 CFR 20

c. 10 CFR 50

d. 10 CFR 55

Category B: Normal/Emergency Procedures and Radiological Controls

Question B.05 [1.0 point]
Which ONE of the following is the renewal requirement for an existing license?

a. Every six months

b. Every year

c. Biennually

d. Every six years

Question B.06 [1.0 point]
Which ONE of the following is the surveillance reporting requirement of Ar^{41} discharge?

a. Every 3 months

b. Twice a year

c. Once a year

d. Every other year

Question B.07 [1.0 point]
The Regulating Rod shall be visually inspected _____ while the Transient Rod Drive shall be inspected _____.

a. Monthly, annually

b. Every six months, every year

c. Every year, semiannually

d. Every two years, every six months

Question B.08 [1.0 point]
Which ONE of the following radioactive GASES might be an indication of a fuel element leak?

a. N^{16}

b. Ar^{41}

c. Xe^{135}

d. Cs^{137}

Category B: Normal/Emergency Procedures and Radiological Controls

Question B.09 [1.0 point]
A radioactive source is to be stored in the reactor bay with no shielding. The source reads 2 R/hr at 1 foot. How far from the source does a barrier need to be placed for it to be considered a “Radiation Area”?

a. 372 m

b. 610 cm

c. 110 cm

d. 30 cm

Question B.10 [1.0 point]
The reactor is operating at 10 mrem/hr at the pool radiation area monitor. You are conducting the facility walk-thru portion of your NRC licensing exam with the NRC examiner. How long can the NRC examiner stay before their 10 CFR 20 total ANNUAL effective dose limit is exceeded?

a. 10 hours

b. 5 hours

c. 2 hours

d. 1 hour

Question B.11 [1.0 point]
Which ONE of the following is the correct definition of a CHANNEL CHECK?

a. The combination of sensor, line, amplifier, and output device which are connected for the purpose of measuring the value of a parameter.

b. The introduction of a signal into the channel for verification that it is operable.

c. A qualitative verification of acceptable performance by observation of channel behavior.

d. An adjustment of the channel such that its output corresponds with acceptable accuracy to known values of the parameter which the channel measures.

Category B: Normal/Emergency Procedures and Radiological Controls

Question B.12 [1.0 point]
Which ONE of the following is the definition for "Annual Limit on Intake (ALI)"?

a. Projected dose commitment values to individuals that warrant protective action following a release of radioactive material.

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

c. The effluent concentration of a radio-nuclide in air which, if inhaled continuously over a year, would result in a total effective dose equivalent of 50 millirem for noble gases.

d. 10CFR20 derived limit, based on a Committed Effective Dose Equivalent of 5 Rems whole body or 50 Rems to any individual organ, for the amount of radioactive material inhaled or ingested in a year by an adult worker.

Question B.13 [1.0 point]
You are performing a periodic radiation survey of an area where general radiation readings are approximately 1 mrem/hr. However, you find an old experimental facility in an accessible area not posted for radiological safety reading reading 25 mrem/hr at 30 cm. How would this area be posted in accordance with the requirements of 10 CFR 20?

a. Radiation Area on contact with the experimental facility

b. Radiation Area @ 30 cm from the experimental facility

c. High Radiation Area on contact with the experimental facility

d. High Radiation Area @ 30 cm from the experimental facility

Question B.14 [1.0 point]
KSU Emergency Preparedness Plan allows a one-time MAXIMUM exposure limit of _____ to save a life or protect large populations.

a. 5 rem

b. 10 rem

c. 25 rem

d. 50 rem

Category B: Normal/Emergency Procedures and Radiological Controls

Question B.15 [1.0 point]
Per KSU Emergency Classification, which ONE of the following is a “medical incident requiring transportation of a contaminated victim to an off-site hospital”?

a. Alert

b. Unusual Event

c. Safety Event

d. Normal Operation

Question B.16 [1.0 point]
The CURIE content of a radioactive source is a measure of

a. number of radioactive atoms in the source.

b. number of nuclear disintegrations per unit time.

c. amount of energy emitted per unit time by the source

d. amount of damage to soft body tissue per unit time.

Question B.17 [1.0 point]
What is the MINIMUM level of management who shall be present at the facility during a recovery from an unplanned or unscheduled shutdown?

a. Reactor Operator

b. Senior Reactor Operator

c. Reactor Supervisor

d. Reactor Operations Committee

Question B.18 [1.0 point]
10 CFR 50.59 would require KSU submit to the NRC for which ONE of the following modifications?

a. Utilize a new Xenon poisoning method of measurement

b. Change of primary coolant pressure gauge with an identical model

c. Use new Resistance Temperature Detectors (RTD) to perform reactor power calibration

d. Replace the Wide Range Log with an uncompensated ion chamber

Category B: Normal/Emergency Procedures and Radiological Controls

Question B.19 [1.0 point]
You use a survey instrument with a window probe to measure the beta-gamma dose rate from an irradiated experiment. The dose rate with the window closed is 160 mrem/hour and 200 mrem/hour with the window open. Which ONE of the following is the gamma dose rate?

a. 40 mrem/hour

b. 140 mrem/hour

c. 160 mrem/hour

d. 360 mrem/hour

Question B.20 [1.0 point]
Which ONE of the following are the KSU Technical Specification limits for reactor fuel in storage?

a. k-eff <0.95

b. k-eff <0.90

c. k-eff <0.85

d. k-eff <0.80

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

Category C: Facility and Radiation Monitoring Systems

Question C.01 [1.0 point, 0.25 each]
Match the following KSU TRIGA items in Column A with their corresponding core position in Column B. Answers can be used more than once or not at all.

Column A	Column B
a. Startup Source	1. C ring
b. Transient Rod	2. D ring
c. Regulating Rod	3. E ring
d. Shim & Safety Rod	4. F ring

Question C.02 [1.0 point]
Which ONE of the following best describes on how the Uncompensated Ion Chamber (UIC) and Compensated Ion Chamber (CIC) operate?

a. The CIC has Two chambers, one is coated with U-235 for fission reaction and the other is coated with Boron-10 for (n,a) reaction; whereas the UIC has only one chamber coated with U-235 for fission reaction.

b. The CIC has only one chamber coated with U-235 for fission reaction, whereas the UIC has two chambers, both can sense gamma rays but only one is coated with Boron-10 for (n,a) reaction.

c. The CIC has two chamber, both can sense gamma rays but only one is coated with Boron-10 for (n,a) reaction; whereas the UIC has only one chamber coated with Boron-10 for (n,a) reaction.

d. The CIC has only one chamber coated with Boron-10 for (n,a) reaction; whereas the UIC has two chambers, one is coated with U-235 for fission reaction and the other is coated with Boron-10 for (n,a) reaction.

Question C.03 [1.0 point]
Which ONE of the following provides a reactor SCRAM in PULSE mode of operation?

a. Low Pool Level

b. High Voltage

c. High Fuel Temperature

d. Low Reactor Period

Category C: Facility and Radiation Monitoring Systems

Question C.04 [1.0 point]
What is the nominal Hydrogen-Zirconium atom ratio in the KSU TRIGA fuel elements?

a. Max 8.5 weight percent uranium which has a max enrichment of 20%. Shall be 1.55 to 1.6 Hydrogen atoms to 20 Zirconium atoms

b. Max of 9.0 weight percent uranium which has a max enrichment of 19%. Shall be 1.65 to 1.8 Hydrogen atoms to 15 Zirconium atoms

c. Max 8.0 weight percent uranium which has a max enrichment of 19%. Shall be 1 Hydrogen atom to 1.55 to 1.8 Zirconium atoms

d. Max 9.0 weight percent uranium which has a max enrichment of 20%. Shall be 1.55 to 1.8 Hydrogen atoms to 1 Zirconium atoms

Question C.05 [1.0 point]
Which ONE of the following interlocks prevents the withdrawal of standard rods in PULSE mode?

a. Pulse Rod

b. Pulse Power

c. Control Rod Position

d. Multiple Rod Withdrawal

Question C.06 [1.0 point]
Which ONE of the following is NOT measured in the Primary Cooling/Purification System Loops?

a. pH

b. Flow Rate

c. Conductivity

d. Temperature

Category C: Facility and Radiation Monitoring Systems

Question C.07 [1.0 point]
Which ONE of the following Nuclear Instrumentation Channels supplies Period Indication?

a. NPR-1000

b. NPP-1000

c. NLWR-1000

d. NMP-1000

Question C.08 [1.0 point]
Which ONE of the following ensures the pulse rod is held in position during operations?

a. Solenoid

b. Air pressure

c. Electro-magnets

d. Micro-switches

Question C.09 [1.0 point]
Which ONE of the following is an In Reflector Experimental Facility?

a. Beam Ports

b. Central Thimble

c. IRIS

d. Thermal Column

Question C.10 [1.0 point]
In the primary purification system, which ONE of the following is the main function of the demineralizer?

a. Absorb H-3 to maintain purity of the pool water

b. Absorb thermal neutrons to increase life of the reactor pool

c. Reduce N-16 formation to reduce the dose rate at the reactor pool

d. Remove soluble impurity to maintain low conductivity in the pool water

Category C: Facility and Radiation Monitoring Systems

Question C.11 [1.0 point]
Which ONE of the following channels is the PA-1000 preamplifier part of?

a. NPP-1000

b. NLW-1000

c. NMP-1000

d. NPR-1000

Question C.12 [1.0 point]
Which ONE of the following experimental facilities provide the highest fast flux?

a. Central Thimble

b. Pneumatic Transfer System

c. Core Beam Port

d. Rotary Specimen Rack

Question C.13 [1.0 point]
Which ONE of the following detectors will prevent rod withdrawal unless source level is above a preset level?

a. Fission Chamber

b. Compensated Ion Chamber

c. Uncompensated Ion Chamber

d. Fuel Element Thermocouple

Question C.14 [1.0 point]
What is the result when you de-energize the three way solenoid valve to the transient rod?

a. Closes, admitting air to the cylinder

b. Closes, removing air from the cylinder

c. Opens, admitting air to the cylinder

d. Opens, removing air from the cylinder

Category C: Facility and Radiation Monitoring Systems

Question C.15 [1.0 point]
Which ONE of the following is a function of the Secondary Coolant Automatic Control System?

a. Minimize reactor component corrosion

b. Reduce production of radioactive materials

c. Maintain primary water optical clarity

d. Prevent cooling water freeze-up

Question C.16 [1.0 point]
Which ONE of the following is the limiting design parameter for TRIGA fuel?

a. Expansion of the 304 stainless steel

b. Excessive pressure from expansion of Argon-41

c. Fission product build-up from interaction of Nitrogen-16

d. Pressure buildup from Hydrogen dissociation

Question C.17 [1.0 point]
Which ONE of the following is the purpose of the pool surface skimmer?

a. Maintain pool water purity

b. Filtering mechanism for makeup water

c. Collect foreign particles that float on the pool surface

d. Provide a path for makeup pool fill during emergency situations

Question C.18 [1.0 point]
Which ONE of the following is the KSU neutron reactor startup source?

a. Am-Be

b. Sb-Be

c. Pu-Be

d. Ra-Be

Category C: Facility and Radiation Monitoring Systems

Question C.19 [1.0 point]
Which ONE of the following is the reason for the reactor pool exit water temperature to not exceed 130°C?

a. Prevent corrosion of reactor components

b. Avoid damage to the heat exchanger plates

c. Prevent slow leakage of fission products from degraded cladding

d. Maintain mechanical and chemical integrity of the deionizer resin mixed bed

Question C.20 [1.0 point]
Which ONE of the following is the purpose of the dashpot at the bottom of the barrel?

a. Prevent structure damage to the barrel

b. Reduce bottoming impact during a scram

c. Increase the rod scram time for the rod drop test

d. Decrease rod speed during initial withdrawal

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

Category A: Theory, Thermodynamics & Facility Operating Characteristics

A.01
Answer: b
Reference: DOE Fundamentals Handbook, NPRT, Vol. 2, Module 4, EO 2.1, p.17

A.02
Answer: a
Reference: 1.03 x 0.96 x 0.84 x 0.88 x 1.96 x 0.70 = 1.00
1 / (1.03 x 0.96 x 0.84 x 0.88 x 1.96) = 0.698

A.03
Answer: a
Reference: DOE Fundamentals Handbook, NPRT, Vol. 1, Module 1, EO 4.3, p.52

A.04
Answer: a. 2; b. 1; c. 2; d. 1
Reference: DOE Fundamentals Handbook, NPRT, Vol. 2, Module 3, EO 5.4, EO 5.5, EO 5.6, pp 51-53

A.05
Answer: c
Reference: DOE Fundamentals Handbook, NPRT, Vol., Module 2, EO 3.1, p. 29

A.06
Answer: d
Reference: Burn, R., Introduction of Nuclear Reactor Operations, © 1988, Sec 4.

A.07
Answer: c
Reference: DOE Fundamentals Handbook, NPRT, Vol. 2, Module 3, EO 4.1, p.35
KAPL, "Chart of the Nuclides", 17th Ed.

A.08
Answer: b
Reference: DOE Fundamentals Handbook, NPRT, Vol., Module 1, EO 3.1, p.43

A.09
Answer: c
Reference: Burn, *Introduction to Nuclear Reactor Operations,* Section 5.4

A.10
Answer: d
Reference: Decreasing the reactivity worth in the core will increase the shutdown margin

A.11
Answer: a
$\rho 1=(\rho \$1)(\beta_{eff})=(\$1.10)(.0075)=(.00825)$
$[(\rho 2-\beta_{eff})^2]/Peak2 = [(\rho 1-\beta_{eff})^2]/Peak1$
$Peak2/Peak1*[(\rho 1- \beta_{eff})^2]=[(\rho 2-\beta_{eff})^2]$
$(5000/500)*[(.00825-.0075)^2]= [(\rho 2-\beta_{eff})^2]$
$[(.000005625)^{1/2}]+\beta_{eff} =\rho 2=.009872$
$\rho \$2=(\rho 2/\beta_{eff})=(.009872/.0075)= \$1.316 \approx \$1.32$

Category A: Theory, Thermodynamics & Facility Operating Characteristics

Reference: Burn, R., Introduction to Nuclear Reactor Operations, 1988. § 4.6, p. 4-16

A.12
Answer a
Reference: DOE Fundamentals Handbook, NPRT, Vol., Module 1, EO 4.7,p. 51

A.13
Answer: c
N = (S) (M)
M = 1 / (1-k_{eff}) = 1 / (1-0.88) = 8.3333
N = (15,000)(8.3333) = 125,000 neutrons/second
Reference: DOE Fundamentals Handbook, NPRT, Vol. 2, Module 4, EO 1.2, p 4

A.14
Answer: d
Reference: Burn, R., Introduction to Nuclear Reactor Operations, Section 8.1 - 8.4

A.15
Answer: c
Reference: DOE Fundamentals Handbook, NPRT, Vol. 2, Module 3, EO 2.7,p. 26

A.16
Answer: d
Reference: CR=S/(1-k)→200/(1-0.6) = 500 N/sec

A.17
Answer: a
Reference: Chart of the Nuclides, KAPL. Seventeenth Edition

A.18
Answer: c
Reference: Burn, R., Introduction to Nuclear Reactor Operations, Section 3.3.4
Δρ = (Keff1-Keff2)/(Keff1*Keff2) = (0.943-0.885)/((0.943*0.885)
0.0694Δk/k = 6.94%Δk/k

A.19
Answer: c
Reference: $P = P_0 e^{t/T}$, T = t / (ln(P/P_0) = 50 / (ln(2)) = 72.15 seconds

A.20
Answer: c
Reference: Count1*(1-Keff1) = Count2*(1-Keff2) 100*(1-0.950) = 200*(1-Keff2)
100*(1-0.95) = 200(1- Keff2); Keff2 = 0.975

Category B: Normal/Emergency Procedures and Radiological Controls

B.01
Answer: d
Reference: KSU Technical Specification 6, 10 CFR 50.59

B.02
Answer: d
Reference: KSU Emergency Plan Procedure 13

B.03
Answer: b
Reference: $DR = DR_{\circ} * e^{-\lambda t} = 40\ mrem/hr = 80\ mrem/hr * e^{-\lambda(0.5hr)}$
$\ln(40/80) = -\lambda * 0.5hr = \lambda = 1.3863$
Solve for t: $\ln(5/80) = -1.3863\ (t) = t = 2$ hours
Short cut:
80 mrem to 40 mrem : 30 mins; 40 mrem to 20 mrem : 60 mins
20 mrem to 10 mrem : 90 mins; 10 mrem to 5 mrem : 120 mins
Total: 120 mins or 2 hrs

B.04
Answer: d
Reference: 10 CFR 55.21

B.05
Answer: d
Reference: 10 CFR 55.55

B.06
Answer: c
Reference: KSU Technical Specification 6.11e

B.07
Answer: d
Reference: KSU Technical Specification 4.4.2

B.08
Answer: c
Reference: Standard NRC question

B.09
Answer: b
Reference: $\frac{DR_1}{x_1^2} = \frac{DR_2}{x_2^2}$; $x_2^2 = \frac{2000\ mrem}{8\ mrem} 1\ ft^2 \left(\frac{(30.48\ cm)^2}{1\ ft^2}\right) = x = 609.6\ cm$

B.10
Answer: a
Reference: 10 CFR 20 100 mrem limit; TD = DR x T; 100 mrem = 10 mrem/hr x T = 10 hours

B.11
Answer: c
Reference: KSU Technical Specifications, Definitions

Category B: Normal/Emergency Procedures and Radiological Controls

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

B.13
Answer: b
Reference: 10 CFR 20

B.14
Answer: c
Reference: KSU Emergency Plan 7.4

B.15
Answer: b
Reference: KSU Emergency Plan 7.2

B.16
Answer: b
Reference: Standard Health Physics Definition

B.17
Answer: b
Reference: KSU Technical Specification 6.3

B.18
Answer: d
Reference: 10CFR50.59

B.19
Answer: c
Reference: NRC Standard Instrumentation Question

B.20
Answer: d
Reference: KSU Technical Specifications 5.2.3(e)

Category C: Facility and Radiation Monitoring Systems

C.01
Answer: a. 4. b. 1. c. 3. d. 2.
Reference: KSU SAR 4.2.1, Figure 4.4; SAR 4.5.2, Table 4.5

C.02
Answer: c
Reference: NRC Standard Question

C.03
Answer: c
Reference: KSU TS Table 1 & 2

C.04
Answer: d
Reference: KSU Technical Specification 5.1.3(1)

C.05
Answer: c
Reference: KSU SAR 4.2.2.a, Table 4.2

C.06
Answer: a
Reference: KSU SAR 5.1, Figure 5.1

C.07
Answer: c
Reference: KSU SAR 7.3.1, Figure 7.5

C.08
Answer: b
Reference: KSU SAR 3.5.3 & 4.2.2

C.09
Answer: c
Reference: KSU SAR 10.2.3

C.10
Answer: d
Reference: NRC Standard Question

C.11
Answer: b
Reference: KSU SAR 7.3

C.12
Answer: a
Reference: KSU Training Manual 5.7

C.13
Answer: a
Reference: KSU Training Manual 8

Category C: Facility and Radiation Monitoring Systems

C.14
Answer: b
Reference: KSU SAR 7.3.1.1

C.15
Answer: d
Reference: KSU SAR 5.3.2

C.16
Answer: d
Reference: KSU SAR 3.5.1, Table 2

C.17
Answer: c
Reference: KSU SAR 5.2

C.18
Answer: a
Reference: KSU SAR 4.2.4

C.19
Answer: d
Reference: KSU TS 3.8.5

C.20
Answer: b
Reference: NRC Standard Question