April 20, 2010

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

SUBJECT: INITIAL EXAMINATION REPORT NO. 50-188/OL-10-02, KANSAS STATE UNIVERSITY

Dear Dr. Geuther:

During the week of March 22, 2010, the NRC administered operator licensing examinations at your Kansas State University TRIGA reactor. The examinations were conducted according to NUREG-1478, "Operator Licensing Examiner Standards for Research and Test Reactors," Revision 2. Examination questions and preliminary findings were discussed with those members of your staff identified in the enclosed report at the conclusion of the examination.

In accordance with Title 10 of the Code of Federal Regulations Section 2.390, a copy of this letter and the enclosures will be available electronically for public inspection in the NRC Public Document Room or from the Publicly Available Records (PARS) component of NRC's Agencywide Documents Access and Management System (ADAMS). ADAMS is accessible from the NRC Web site at http://www.nrc.gov/reading-rm/adams.html. The NRC is forwarding the individual grades to you in a separate letter which will not be released publicly. Should you have any questions concerning this examination, please contact Mr. Phillip T. Young at (301) 415-4094 or via internet e-mail phillip.young@nrc.gov.

Sincerely,

/RA/

Johnny H. Eads Jr., Chief
Research and Test Reactors Oversight Branch
Division of Policy and Rulemaking
Office of Nuclear Reactor Regulation

Docket No. 50-188

Enclosures:
1. Initial Examination Report No. 50-188/OL-10-02
2. Facility comments on written examination
3. Written examination with facility comments incorporated

cc: without enclosures: Please see next page

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DISTRIBUTION w/ encls.:

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RidsNRRDPRPRTB	Facility File (CRevelle) O-7 F-08	

ADAMS ACCESSION #: ML100990148 **TEMPLATE #:NRR-074**

OFFICE	PROB:CE		IOLB:LA	E	PROB:SC	
NAME	PYoung		CRevelle		JEads	
DATE	04/13/2010		04/16/2010		04/20/2010	

OFFICIAL RECORD COPY

cc:

Office of the Governor
State of Kansas
Topeka, KS 66612

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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-10-02

FACILITY DOCKET NO.: 50-188

FACILITY LICENSE NO.: R-88

FACILITY: Kansas State University TRIGA Reactor

EXAMINATION DATES: March 22 – 25, 2010

SUBMITTED BY: ____________________________ __________
Phillip T. Young, Chief Examiner Date

SUMMARY:

During the week of March 22, 2010 the NRC administered licensing examinations to one SRO-I, two SRO-U and five RO applicants. Three SROs, and one RO passed these examinations. All others failed.

REPORT DETAILS

1. Examiners: Phillip T. Young, Chief Examiner, NRC

2. Results:

	RO PASS/FAIL	SRO PASS/FAIL	TOTAL PASS/FAIL
Written	1/4	1/0	2/4
Operating Tests	5/0	3/0	8/0
Overall	1/4	3/0	4/4

3. Exit Meeting:
Phillip T. Young, Chief Examiner, NRC
Dr. Jeffery Geuther, Nuclear Reactor Facility Manager, Kansas State University

At the conclusion of the site visit, the examiner met with representatives of the facility staff to discuss the results of the examinations. The facility presented some of their comments on the written examinations. The examiner thanked the facility and requested they forward all of their comments for resolution. These comments along with their resolutions are included as Attachment 2 to this report.

ENCLOSURE 1

Facility Comments With NRC Resolution.

Question A.020c

Comment: The correct technical specification shutdown margin (c) appears to be 1: B-A, not 6: E-D. The Facility recommends that the answer be changed accordingly.

Question A.020c

NRC Resolution: Comment accepted. Correct answer for A.020c changed from (6) to (1).

Question B.002

Comment: The correct answer could be (b) or (c), depending on the geometry of the source. The given answer of (c) assumes that the source is well-represented as a point source. However, virtually any other geometry would result in the correct answer of (b). The question did not specify that the source was a point source, and since the source was said to be a small pipe, one could not conclude that it was a point source (versus a linear source, for example) from the wording of the question. The Facility recommends that either (b) or (c) be accepted.

Question B.002

NRC Resolution: Comment accepted. Accepted either (b) or (c) as the correct answer.

Question B.003

Comment: Experiment No. 42 is still part of the experiment manual. However, the current core configuration no longer has room for the terminus of the Sample Rapid Transfer System, and a considerable amount of work, including core design, would be required to re-install the system. For these reasons, the staff is no longer trained in how to perform Experiment No. 42. The Facility recommends that this question be discarded.

Question B.003

NRC Resolution: Comment accepted. Question B.003 is deleted from the examination.

Question B.005

Comment: The Rotary Specimen Rack has been permanently removed from the KSU reactor, due to failure of the system. The Facility recommends that this question be discarded.

Question B.005

NRC Resolution: Comment accepted. Question B.005 is deleted from the examination.

Question B.006

Comment: Technical Specifications only require 2 of 3 power channels to be operable in order to operate in steady state mode, and 1 of 3 channels in pulse mode. Therefore, the Facility recommends that both (a) and (d) be accepted as correct answers.

Question B.006

NRC Resolution: Comment accepted. Accepted either answer (a) or (d).

Question B.019

Comment: An ongoing security compromise would be an Unusual Event per the Emergency Plan until an actual security breach occurs. Therefore the Facility recommends accepting both (b) and (d) as correct answers.

Question B.019

NRC Resolution: Comment accepted. Accepted either answer (b) or (d).

Question C.001

Comment: The 2008 revision of Procedure 15 does not specify that the pulse power channel be operable, as did the 1994 revision. From technical specifications, only two out of three power channels need to be operable to operate in steady state mode. Therefore the Facility recommends changing the correct answer from (c) to (b).

Question C.001

NRC Resolution: Comment accepted. Correct answer changed from (c) to (b).

Question C.006

Comment: The SAR (p. 7-17, #4) states that the basis for this interlock has been effectively removed as of the revision of the facility operating license to allow up to a $2.50 pulse, and that the interlock remains in effect as good operating practice. The Facility recommends that this question be removed.

Question C.006

NRC Resolution: Comment not accepted. The examiner acknowledges the facility comment, however, the interlock and basis are still in the SAR and the interlock is still in effect.

Question C.007

Comment: The given answer, (c), is correct for an old core design (II-19), as given in the quoted reference. The actual sum of the shim, regulating, and transient rod worth for the current core is about $5.50. The Facility recommends discarding this question.

Question C.007

NRC Resolution: Comment accepted. Question C.007 is deleted from the examination.

Question C.009

Comment: The given answer is correct. However, knowledge about thermocouple operation is not part of the Facility training program. The Facility recommends discarding this question.

Question C.009

NRC Resolution: Comment not accepted. Regulations require testing on key instrumentation. Thermocouples are used in fuel temperature measurement for the facility Limiting Safety System Settings (LSSS) and knowledge of this type of fundamental instrumentation is tested.

Question C.019

Comment: The SAR section supplied as reference does not state that the graphite slugs at the top and bottom of the fuel elements are meant to couple neutrons to the nuclear instrumentation, as stated in the given answer (c). General Atomics Fuel Description GA-3399 pg. 2-4-1 states that the graphite slugs are meant to reflect neutrons. The Facility recommends changing the correct answer to (a).

Question C.019

NRC Resolution: Comment accepted. Accepted answer (a).

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

FACILITY: Kansas State University

REACTOR TYPE: TRIGA

DATE ADMINISTERED: 03/22/2010

CANDIDATE: ______________________________

INSTRUCTIONS TO CANDIDATE:
Answers are to be written on the answer sheet provided. Attach the answer sheets to the examination. Points for each question are indicated in brackets for each question. A 70% in each section is required to pass the examination. Examinations will be picked up three (3) hours after the examination starts.

Category Value	% of Total	% of Candidates Score	Category Value	Category
21.00	33.3	______	____	A. Reactor Theory, Thermodynamics and Facility Operating Characteristics
~~20~~ 18.00	33.3	______	____	B. Normal and Emergency Operating Procedures and Radiological Controls
~~22~~ 21.00	33.3	______	____	C. Facility and Radiation Monitoring Systems
63.00		______	____% FINAL GRADE	TOTALS

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

____
Candidate's Signature

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.

13. When you have completed and turned in you examination, leave the examination area. If you are observed in this area while the examination is still in progress, your license may be denied or revoked.

EQUATION SHEET's

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

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

$$\ell^* = 1 \ x \ 10^{-4} \ seconds$$

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

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

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

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

$$M = \frac{1 - K_{eff_0}}{1 - K_{eff_1}}$$

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

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

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

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

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

Section A Reactor Theory, Thermo, and Facility Characteristic

EQUATION SHEET's

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

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

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

$$T_{½} = \frac{0.693}{\lambda}$$

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

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

$$DR = \frac{6CiE(n)}{R^2}$$

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

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

EQUATION SHEET's

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

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

1 kg = 2.21 lbm

1 Horsepower = 2.54 x 10^{3} BTU/hr

1 Mw = 3.41 x 10^{6} BTU/hr

1 BTU = 778 ft-lbf

°F = 9/5°C + 32

1 gal (H_2O) ≈ 8 lbm

°C = 5/9 (°F - 32)

c_P = 1.0 BTU/hr/lbm/°F

c_p = 1 cal/sec/gm/°C

Section A Reactor Theory, Thermo, and Facility Characteristic

Question: A.001 (1.00 point) {1.0}
Reactor power is increasing by a factor of 10 every minute. The reactor period is:

a. 65 seconds.

b. 52 seconds.

c. 26 seconds.

d. 13 seconds.

Answer: A.001 C.
Reference: DOE Fundamentals Handbook, Module 4, Reactor Kinetics, page 17.
Reactor Period = 26/Startup Rate

Question: A.002 (1.00 point) {2.0}
As a reactor continues to operate over a period of months, for a constant power level, the average neutron flux:

a. decreases, due to the increase in fission product poisons.

b. increases, in order to compensate for fuel depletion.

c. decreases, because fuel is being depleted.

d. remains the same.

Answer: A.002 B.
Reference: DOE Fundamentals Handbook, Module 2, Reaction Rates, pg 21.

Question: A.003 (1.00 point) {3.0}
A reactor is operating at a constant power level of 250 kW. The fission rate of this reactor is approximately:

a. 0.78×10^{12} fissions/sec.

b. 1.56×10^{14} fissions/sec.

c. 0.78×10^{16} fissions/sec.

d. 3.90×10^{18} fissions/sec.

Answer: A.003 C.
Reference: DOE Fundamentals Handbook, Module 2, Reaction Rates, pg 20.
250 kW = 1.562×10^{18} Mev/sec.
(1.562×10^{18} Mev/sec)/(200 Mev/fission) = 0.78×10^{16} fissions/sec.

Question: A.004 (1.00 point) {4.0}
Which ONE of the following statements correctly describes the influence of delayed neutrons during the neutron life cycle?

a. Delayed neutrons increase the average neutron generation time.

b. Delayed neutrons are more likely to cause fission because they thermalize more quickly than prompt neutrons.

c. Delayed neutrons take longer to thermalize because they are born at a higher average energy than prompt neutrons.

d. Delayed neutrons are produced some time after prompt neutrons and make up the majority of neutrons produced by fissions.

Answer: A.004 A.
Reference: DOE Fundamentals Handbook, Module 2, Prompt and Delayed Neutrons, page 29.

Question: A.005 (1.00 point) {5.0}
The moderator-to-fuel ratio describes the relationship between the number of moderator atoms in a volume of core to the number of fuel atoms. A reactor which is:

a. undermoderated will have a positive moderator temperature coefficient.

b. undermoderated will have a negative moderator temperature coefficient.

c. overmoderated will have a constant moderator temperature coefficient.

d. overmoderated will have a negative moderator temperature coefficient.

Answer: A.005 B.
Reference: DOE Fundamentals Handbook, Module 3, Reactivity Coefficients, page 25.

Question: A.006 (1.00 point) {6.0}

Inelastic scattering can be described as a process whereby a neutron collides with a nucleus and:

a. reappears with a higher kinetic energy, with the nucleus absorbing a gamma ray.

b. reappears with a lower kinetic energy, with the nucleus emitting a gamma ray.

c. is absorbed by the nucleus, with the nucleus emitting a gamma ray.

d. reappears with the same kinetic energy it had prior to the collision.

Answer: A.006 B.

Reference: DOE Fundamentals Handbook, Module 1, Neutron Interactions, page 45.

Question: A.007 (1.00 point) {7.0}

The Moderating Ratio measures the effectiveness of a moderator by combining the scattering cross section, the absorption cross section, and the average energy loss per collision. The Moderating Ratio is expressed as:

a. (absorption cross section)x(scattering cross section)/(average energy loss per collision).

b. (absorption cross section)x(average energy loss per collision)/(scattering cross section).

c. (scattering cross section)x(absorption cross section)x(average energy loss per collision).

d. (average energy loss per collision)x(scattering cross section)/(absorption cross section).

Answer: A.007 D.

Reference: DOE Fundamentals Handbook, Module 2, Neutron Moderation, page 28.

Question: A.008 (1.00 point) {8.0}
A reactor is subcritical by 5% delta k/k with a count rate of 100 cps on the startup channel. Rods are withdrawn until the count rate is 1000 cps. Which ONE of the following is the condition of the reactor following the rod withdrawal?

a. Critical with k_{eff} = 1.000.

b. Subcritical with k_{eff} = 0.995.

c. Subcritical with k_{eff} = 0.950.

d. Supercritical with k_{eff} = 1.005.

Answer: A.008 B.
Reference: DOE Fundamentals Handbook, Module 4, Subcritical Multiplication, page 6.
$CR_1 (1-K_1) = CR_2 (1-K_2)$; $\rho = (K-1)/K$; $-0.05 = (K - 1)/K$; $K = 0.952$.
$100(1 - 0.952) = 1000(1 - K_2)$; $K_2 = 0.995$.

Question: A.009 (1.00 point) {9.0}
The fuel temperature coefficient of reactivity is -1.25×10^{-4} delta K/K/deg.C. When a control rod with an average rod worth of 0.1% delta K/K/inch is withdrawn 10 inches, reactor power increases and becomes stable at a higher level. At this point, the fuel temperature has:

a. increased by 80 deg C.

b. decreased by 80 deg C.

c. increased by 8 deg C.

d. decreased by 8 deg C.

Answer: A.009 A.
Reference: DOE Fundamentals Handbook, Module 3, Reactivity, page 21.
Control rod inserts positive reactivity = 0.001delta k/k/inch x 10 inches = +0.01 delta k/k. Fuel temperature inserts negative reactivity = -1.25×10^{-4} delta k/k/deg.C x 80 deg.C = -0.01 delta k/k.

Question: A.010 (1.00 point) {10.0}
Which ONE of the following statements correctly describes a characteristic of subcritical multiplication?

a. The number of neutrons gained per generation doubles for each succeeding generation.

b. For equal reactivity additions, it requires less time for the equilibrium neutron population to be reached.

c. When the indicated count rate doubles, the margin to criticality has been reduced by approximately one-half.

d. A constant neutron population is achieved when the total number of neutrons produced in one generation is equal to the number of source neutrons added in the next generation.

Answer: A.010 C.
Reference: DOE Fundamentals Handbook, Module 4,
Subcritical Multiplication, pg 6.

Question: A.011 (1.00 point) {11.0}
A reactor is subcritical with a K_{eff} of 0.955. Seven dollars ($7.00) of positive reactivity is inserted into the core (β = 0.007). At this point, the reactor is:

a. subcritical.

b. exactly critical.

c. supercritical.

d. prompt critical.

Answer: A.011 C.
Reference: R. R. Burn, Introduction to Nuclear Reactor Operations,
page 3-21.
Shutdown reactivity = (K-1)/K = -0.047 delta K/K.
$7.00 added = 7(0.007) = +0.049 delta K/K.
-0.047 + 0.049 = + 0.002, i.e. supercritical.

Section A Reactor Theory, Thermo, and Facility Characteristics

Question: A.012 (1.00 point) {12.0}
Fuel is being loaded into the core. The operator is using a 1/M plot to monitor core loading. Which ONE of the following conditions would result in a non-conservative prediction of core critical mass (i.e., the reactor would become critical before the predicted number of fuel elements are loaded)?

a. The detector is too far from the source.

b. The detector is too close to the source.

c. Excessive time is allowed between fuel elements being loaded.

d. A fuel element is placed between the source and the detector.

Answer: A.012 B.
Reference: R. R. Burn, Introduction to Nuclear Reactor Operations, page 5-21.

Question: A.013 (1.00 point) {13.0}
A reactor fuel consisting of only U-235 and U-238 is 20% enriched. This means that:

a. 20% of the volume of the fuel consists of U-235.

b. 20% of the weight of the fuel consists of U-235.

c. 20% of the total number of atoms in the fuel consists of U-235.

d. the ratio of the number of U-235 atoms to the number of U-238 atoms is 0.20 (20%).

Answer: A.013 B.
Reference: R. R. Burn, Introduction to Nuclear Reactor Operations, page 2-51.

Question: A.014 (1.00 point) {14.0}
For the same constant reactor period, which ONE of the following transients requires the LONGEST time to occur? A power increase of:

a. 5% of rated power - increasing from 1% to 6% of rated power.

b. 10% of rated power - increasing from 10% to 20% of rated power.

c. 15% of rated power - increasing from 20% to 35% of rated power.

d. 20% of rated power - increasing from 40% to 60% of rated power.

Answer: A.014 A.
Reference: R. R. Burn, Introduction to Nuclear Reactor Operations, page 4-4.
P/P_o is largest for answer A, therefore requires the longest time.

Question: A.015 (1.00 point) {15.0}
Starting with a critical reactor at low power, a control rod is withdrawn from position X and reactor power starts to increase. Neglecting any temperature effects, in order to terminate the increase with the reactor again critical but at a higher power, the control rod must be:

a. inserted deeper than position X.
b. inserted, but not as far as position X.
c. inserted back to position X.
d. inserted, but exact position depends on power level.

Answer: A.015 C.
Reference: R. R. Burn, Introduction to Nuclear Reactor Operations.

Question: A.016 (1.00 point) {16.0}
The effective neutron multiplication factor, K_{eff}, is defined as:

a. absorption/(production + leakage)
b. (production + leakage)/absorption
c. (absorption + leakage)/production
d. production/(absorption + leakage)

Answer: A.016 D.
Reference: DOE Fundamentals Handbook, Module 3, page 8.

Question: A.017 (1.00 point) {17.0}
Which ONE of the following describes the term prompt jump?

a. The instantaneous change in power level due to withdrawing a control rod.
b. A reactor which has attained criticality on prompt neutrons alone.
c. A reactor which is critical using both prompt and delayed neutrons.
d. A negative reactivity insertion which is less than β_{eff}.

Answer: A.017 A.
Reference: DOE Fundamentals Handbook, Module 4, page 14.

Question: A.018 (1.00 point) {18.0}
Which ONE of the following is the major source of energy released due to thermal fission of a U-235 atom?

a. Prompt gamma rays.
b. Fission product decay.
c. Kinetic energy of the fission neutrons.
d. Kinetic energy of the fission fragments.

Answer: A.018 D.
Reference: DOE Fundamentals Handbook, Module 1, page 61.

Question: A.019 (1.00 point) {19.0}
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

Answer: A.019 C.
Reference: DOE Fundamentals Handbook, Module 2, page 30.

Question: A.020 (2.0 points, 0.5 each) {21.0}
Using the drawing of the Integral Rod Worth Curve provided, identify each of the following reactivity worth's.

a. Total Rod Worth	1. B - A
b. Actual Shutdown Margin	2. C - A
c. Technical Specification Shutdown Margin Limit	3. C - B
d. Excess Reactivity	4. D - C
	5. E - C
	6. E - D
	7. E - A

Answer: A.020 a. = 7; b. = 2; c. = ~~6~~ 1; d. = 5 c. changed per facility comment.
Reference: Standard NRC Question

Section B Normal/Emergency Procedures & Radiological Controls

Question: B.001 (1.00 point) {1.0}
In accordance with Procedure No. 1, "Biennial Control Rod Inspection," upon reinstallation of the assembly:

a. rod-drop measurements from full withdrawal to full insertion must be made.

b. a new differential rod worth curve must be measured.

c. a new integral rod worth curve must be measured.

d. the reactivity insertion rate must be measured.

Answer: B.001 A.
Reference: Procedure No. 1, page 3.

Question: B.002 (1.00 point) {2.0}
A radiation survey of an area reveals a general radiation reading of 1 mrem/hr. There is, however, a small pipe which reads 10 mrem/hr at one (1) meter. Which ONE of the following defines the posting requirements for the area in accordance with 10CFR20?

a. Restricted Area.

b. Caution Radiation Area.

c. Caution High Radiation Area.

d. Grave Danger, Very High Radiation Area.

Answer: B.002 B. or C. Accept either B. or C. per facility comment.
Reference: $DR_1D_1^2 = DR_2D_2^2$;
10 mrem/hr at one meter (100 cm.)
results in 111.1 mrem/hr at 30 cm.

~~Question: B.003 (1.00 point) {3.0}~~ Question deleted per facility comment.
~~In accordance with Experiment No. 42, "Operation of Sample Rapid Transfer System (Rabbit)," stuck rabbit limitations refer to:~~
~~a. the radiation dose received by the public as a result of a rabbit stuck in the tube.~~
~~b. limitations on helium purge gas pressure used to dislodge a stuck rabbit.~~
~~c. limitations on sample reactivity if the rabbit becomes stuck in the core.~~
~~d. Argon-41 concentrations in the reactor bay due to a stuck rabbit.~~
~~Answer: B.003 A.~~
~~Reference: Experiment No. 42, page 2~~

Question: B.004 (1.00 point) {4.0}
Two point sources have the same curie strength. Source A's gammas have an energy of 1 Mev, whereas Source B's gammas have an energy of 2 Mev. You obtain a reading from the same GM tube 10 feet from each source. Concerning the two readings, which ONE of the following statements is correct?

a. The reading from Source B is four times that of Source A.

b. The reading from Source B is twice that of Source A.

c. The reading from Source B is half that of Source A.

d. Both readings are the same.

Answer: B.004 D.
Reference: GM tube cannot distinguish between energies.

~~Question: B.005 (1.00 point) {5.0}~~ Question deleted per facility comment.
~~In order to find a leak which may have developed in the rotary specimen rack, a gas source is used to pressurize the rack. Which ONE of the following statements is true regarding the selection of gas to be used?~~
~~a. Oxygen is the most desirable gas to use since it has a very low neutron activation cross-section.~~
~~b. Argon is preferred since the continuous air monitor is already calibrated for the detection of activated argon.~~
~~c. Nitrogen or carbon dioxide is preferred, but oxygen could be used if neither of the other two are available.~~
~~d. Only nitrogen or carbon dioxide gas may be used.~~
~~Answer: B.005 D.~~
~~Reference: Experiment No. 31.~~

Question: B.006 (1.00 point) {6.0}
Which ONE of the following conditions is permissible when the reactor is operating, or about to be operated?

a. A pulse reactivity insertion of $2.20.

b. The sum of the absolute reactivity worth's of all experiments = $2.20.

c. A reactivity insertion rate of a standard control rod = $0.87 per second.

d. Operating in steady state mode with the linear power channel inoperable.

Answer: B.006 A. or D. Accept either A. or D. per facility comment.
Reference: Technical Specifications, LCO's 3.1.5; 3.2; 3.4 & .

<u>Section B</u>   <u>Normal/Emergency Procedures & Radiological Controls</u>

Question: B.007 (1.00 point) {7.0}
In accordance with the Technical Specifications, which ONE of the following conditions is <u>NOT</u> permissible when the reactor is operating, or about to be operated (not in restricted mode)?

a. Primary water temperature = 110□ F.

b. Minimum shutdown margin = $0.47.

c. Pool water conductivity = 1.6 micromho/cm.

d. Maximum available reactivity above cold, clean condition = $2.20.

Answer: B.007 B.
Reference: Technical Specifications

Question: B.008 (1.00 point) {8.0}
In accordance with Procedure No. 16, "Reactor Shutdown," an intentional safety system scram is accomplished by:

a. removing the console key.

b. actuating the manual scram bar.

c. manually adjusting a scram setpoint.

d. manually interrupting current flow to the control rod drive magnets.

Answer: B.008 C.
Reference: Procedure No. 16.

Question: B.009 (1.00 point) {9.0}
In accordance with 10CFR20.1301, individual members of the public are limited to a TEDE in one year of:

a. 10 mrem.

b. 100 mrem.

c. 500 mrem.

d. 1.25 rem.

Answer: B.009 B.
Reference: Radiation Protection Program

Question: B.010 (1.00 point) {10.0}
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.

Answer: B.010 D.
Reference: Experiment 23.

Question: B.011 (1.00 point) {11.0}
A maintenance technician has completed an authorized modification to the control rod drive electrical system. Which ONE of the following staffing requirements applies to the subsequent startup?

a. A senior reactor operator may conduct the startup if the senior health physicist is in the facility.

b. A senior reactor operator may conduct the startup alone to verify operability prior to normal operations.

c. A reactor operator and a trainee may conduct the startup if the senior reactor operator is available in the facility or on call.

d. The maintenance technician may conduct the startup to evaluate proper response under direction of a senior reactor operator.

Answer: B.011 C.
Reference: Procedure No. 15.

Question: B.012 (1.00 point) {12.0}
What is the minimum exposure monitoring requirement for an escorted visiting group in the reactor bay?

a. 1 TLD badge per person.

b. 2 TLD badges for every 10 members of the group.

c. 2 pocket dosimeters for every 15 members of the group.

d. 1 neutron-gamma sensitive pocket dosimeter for the tour guide.

Answer: B.012 C.
Reference: Procedure No. 9.

Question: B.013 (1.00 point) {13.0}
Which ONE of the following statements is FALSE? The Reactor Manager may authorize temporary changes to a procedure provided that:

a. the Reactor Safeguards Committee approves the changes.

b. the changes do not alter the original intent of the procedure.

c. all licensed individuals are informed of the changes.

d. the changes are noted in the operations logbook.

Answer: B.013 A.
Reference: Administrative Plan

Question: B.014 (1.00 point) {14.0}
An irradiated sample having a half-life of 3 minutes provides a dose rate of 200 mrem/hr at 3 ft. Approximately how far from the sample must a Radiation Area sign be posted?

a. 6 ft.

b. 12 ft.

c. 18 ft.

d. 36 ft.

Answer: B.014 C.
Reference: Radiation Protection Program, page A-9.
Radiation area > 5 mrem/hour. 200 mrem at 3 feet -> 5 mrem at 18.3 feet.

Question: B.015 (1.00 point) {15.0}
Which ONE of the following would be an initiating condition for an ALERT?

a. On-site life-threatening release of toxic or flammable gases.

b. Tornado damage to facility.

c. Threatened compromise of security.

d. Attempted sabotage.

Answer: B.015 B.
Reference: Emergency Plan

Question: B.016 (1.00 point) {16.0}
The dose rate from a mixed beta-gamma point source is 100 mrem/hour at a distance of one (1) foot, and is 0.1 mrem/hour at a distance of twenty (20) feet. What percentage of the source consists of beta radiation?

a. 20%

b. 40%

c. 60%

d. 80%

Answer: B.016 C.
Reference: 10CFR20 - At 20 feet, there is no beta radiation. Gamma at 20 feet = 0.1 mrem/hour, gamma at 1 foot = 40 mrem/hour. Therefore beta at 1 foot = 60 mrem/hour = 60%.

Question: B.017 (1.00 point) {17.0}
A small radioactive source is to be stored in the reactor facility. The source activity is estimated to be 25 curies and emits a 1.33 Mev gamma. Assuming no shielding is used, the dose rate from the source at a distance of 10 feet would be approximately:

a. 0.33 Rem/hour.

b. 2.0 Rem/hour.

c. 6.0 Rem/hour.

d. 20.0 Rem/hour.

Answer: B.017 B.
Reference: Dose Rate = $6CiE/R^2$ = 6x25x1.33/100 = 2 Rem/hour.

Question: B.018 (1.00 point) {18.0}
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.

Answer: B.018 D.
Reference: Experiment No. 1.

Question: B.019 (1.00 point) {19.0}
Which ONE of the following would be an initiating condition for an Unusual Event?

a. Fire potentially affecting safety systems.

b. Indication of damage to a fuel element

c. Tornado damage to facility.

d. Ongoing security compromise

Answer: B.019 B. or D. Accept either B. or D. per facility comment.
Reference: Emergency Plan Section 7.0

Question: B.020 (1.00 point) {20.0}
In accordance with Procedure No. 8, "Calibration of Continuous Air Monitors," Technicium-99 is used as a source because:

a. its decay particles and energies are similar to Ar-41.

b. its decay particles and energies are similar to I-131.

c. it produces count rates large enough to be measured.

d. its half-life is long enough so that it does not decay appreciably.

Answer: B.020 B.
Reference: Procedure No. 8, page 2.

Section C Facility and Radiation Monitoring Systems

Question: C.001 (1.00 point) {1.0}
It is desired to perform a reactor startup, but to raise power to only 10 kW. For this situation:

a. the primary system need not be operable.

b. the percent power channel need not be operable.

c. both the primary system and percent power channel must be operable.

d. neither the primary system nor the percent power channel is required to be operable.

Answer: C.001 ~~C.~~ B. Correct answer changed from (c) to (b) per facility comment.
Reference: Procedure No. 15, Triga MkII Reactor Startup.

Question: C.002 (1.00 point) {2.0}
In the reactor cooling system, there is a pressure gauge on each side of the filter. The purpose of these gauges is to:

a. provide a computer input for measuring system pressure.

b. provide a differential pressure to measure flow through the deionizer.

c. measure the pressure drop across the filter to determine filter clogging.

d. measure primary pressure to ensure that it is always lower than secondary pressure.

Answer: C.002 C.
Reference: Training Manual, page A1-11.

Section C Facility and Radiation Monitoring Systems

Question: C.003 (1.00 point) {3.0}
The outside air temperature is -15□F. The KSU TRIGA MKII reactor is operating at 100% power when the primary coolant temperature probe fails low. Which ONE of the following actions is performed by the secondary automatic control system if the temperature of the secondary cooling water is 62□F?

a. The cooling tower fan goes to slow speed and the secondary coolant flow bypasses the cooling tower.

b. The cooling tower fan goes to high speed and the secondary coolant flows to the cooling tower.

c. The cooling tower fan goes to slow speed and the secondary coolant flows to the cooling tower.

d. The cooling tower fan remains off and the secondary coolant flow bypasses the cooling tower.

Answer: C.003 D.
Reference: SAR - 5.3.2

Question: C.004 (1.00 point) {4.0}
When the shim control rod is withdrawn, the withdrawing force is provided by the:

a. pull rod.

b. push rod

c. draw tube.

d. worm gear.

Answer: C.004 C.
Reference: Training Manual, page A1-16.

Question: C.005 (1.00 point) {5.0}
When the reactor is operating at full power, the highest thermal neutron flux occurs at:

a. the E-ring.

b. the central thimble.

c. the rotary specimen rack.

d. the F-ring rabbit terminus.

Answer: C.005 B.
Reference: Training Manual, page A1-11.

Question: C.006 (1.00 point) {6.0}
When the reactor is in the steady state mode, two or more control rods may not be withdrawn simultaneously. The purpose of this interlock is to:

a. prevent the possibility of a sourceless startup.

b. minimize the possibility of pulsing a supercritical reactor.

c. prevent violation of the maximum reactivity insertion rate.

d. prevent the inadvertent pulsing of a reactor in the steady state mode.

Answer: C.006 C.
Reference: Training Manual, page A1-18.

~~Question: C.007 (1.00 point) {7.0}~~ Question deleted per facility comment.
~~Which ONE of the following is the approximate total worth of the shim, regulating and transient rods?~~

~~a. $5.00.~~

~~b. $5.75.~~

~~c. $6.42.~~

~~d. $7.25.~~

~~Answer: C.007 C.~~
~~Reference: SAR Table 4.5~~

Question: C.008 (1.00 point) {8.0}
The purpose of the diffuser above the core during operation is to:

a. better distribute heat throughout the pool.

b. ensure consistent water chemistry in the pool.

c. reduce dose rate at the pool surface from N-16.

d. enhance heat transfer across all fuel elements in the core.

Answer: C.008 C.
Reference: SAR Section 5.6 Nitrogen-16 Control System

Section C Facility and Radiation Monitoring Systems

Question: C.009 (1.00 point) {9.0}
Which one of the following correctly describes the operation of a Thermocouple?

a. A junction of two dissimilar metals, generating a potential (voltage) proportional to temperature changes.

b. A liquid filled container which expands and contracts proportional to temperature changes, one part of which is connected to a lever.

c. A precision wound resistor, placed in a Wheatstone bridge, the resistance of the resistor varies proportionally to temperature changes.

d. A bi-metallic strip which winds/unwinds due to different thermal expansion constants for the two metals, one end is fixed and the other moves a lever proportional to the temperature change.

Answer: C.009 A.
Reference: Standard NRC question

Question: C.010 (1.00 point) {10.0}
Which ONE of the following is the main function performed by the DISCRIMINATOR circuit in the Startup Channel?

a. To convert the linear output of the Startup Channel Detector to a logarithmic signal for metering purposes.

b. To convert the logarithmic output of the metering circuit to a δt (delta time) output for period metering purposes.

c. To filter out small pulses due to gamma interactions, passing only pulses due to neutron events within the Startup Channel Detector.

d. To generate a current signal equal and of opposite polarity as the signal due to gammas generated within the Startup Channel Detector.

Answer: C.010 C.
Reference: Standard NRC Question for proportional counters.
SAR chapter 7 shows a Fission Chamber.

Question: C.011 (1.00 point) {11.0}
For a standard control rod, the red light is OFF, the white light is OFF and the blue light is ON. This is an indication that the rod and drive are …

a. not in contact, and are somewhere between full up and full down.
b. in contact, and are somewhere between full up and full down.
c. in contact, and are both are full up.
d. in contact, and are both full down.

Answer: C.011 B.
Reference: Modification of facility supplied question per discussion with A. Meyer 01/11/2008.

Question: C.012 (1.00 point) {12.0}
The normal rods use electric drive motors for positioning. The transient rod operates by

a. pneumatics (air)
b. pneumatics (Nitrogen)
c. hydraulics (Water)
d. hydraulics (Oil)

Answer: C.012 A.
Reference: SAR Section 4.2.2

Question: C.013 (1.00 point) {13.0}
Upon receipt of a scram signal with the automatic flux control system engaged, the regulating rod …

a. and drive both automatically drive into the core.
b. magnet is de-energized, the rod falls into the core, and the drive is automatically driven in.
c. and drive remain where they are, and the operator must take action to drive both into the core.
d. magnet is de-energized, the rod falls into the core, but the operator must take action to return the drive to the fully inserted position.

Answer: C.013 D.
Reference: Procedure 23, Rewrite of January 2005 NRC examination question.

Question: C.014 (1.0 points, ¼ point each) {14.0}
Match the purification system conditions listed in column A with their respective causes listed in column B. Each choice is used only once.

Column A	Column B
a. High Radiation Level at demineralizer.	1. Channeling in demineralizer.
b. High Radiation Level downstream of demineralizer.	2. Fuel element failure.
c. High flow rate through demineralizer.	3. High temperature in demineralizer system
d. High pressure upstream of demineralizer.	4. Clogged demineralizer

Answer C.014 A. = 2; B. = 3; C = 1; D. = 4
Reference: Standard NRC cleanup loop question.

Question: C.015 (2.0 points, ½ point each) {16.0}
Match the control rod drive mechanism part from column "A" with the correct function in column "B".

COLUMN A	COLUMN B
a. Piston	1. Provide rod bottom indication.
b. Potentiometer	2. Provide rod full withdrawn indication.
c. Spring-loaded Pull Rod armature	3. Provide rod position indication when the electromagnet engages the armature.
d. Push Rod	4. Works with dash pot to slow rod near bottom of its travel.

Answer: C.015 A. = 4; B. = 3; C. = 1; D. = 2
Reference: Standard TRIGA Mk II question

Question: C.016 (2.0 point, 0.67 each) {18.0}
Match the Nuclear Instrumentation Channel provided in column A, with the correct Detector from column B. Each choice is used only once.

Column A	Column B
a. Wide Range Logarithmic Channel	1. Compensated Ion Chamber
b. Wide Range Linear Channel	2. Fission Chamber
c. Pulse and Power Channel	3. Uncompensated Ion Chamber

Answer C.016 A. = 2; B. =1; C. = 3
Reference: Modification of three facility supplied questions.

Question: C.017 (1.00 point) {19.0}
The shim rod and the regulating rod are constructed of:

a. graphite with aluminum cladding.
b. boron and carbon with aluminum cladding.
c. boron and carbon with stainless steel cladding.
d. graphite and boron with aluminum cladding.

Answer: C.017 B.
Reference: NRC Exam April, 2002. Training Manual, page A1-6.

Question: C.018 (1.00 point) {20.0}
Which ONE of the following parameters is NOT measured in the Primary Cooling/Purification System Loops?

a. Temperature
b. Conductivity
c. Flow Rate
d. pH

Answer: C.018 D.
Reference: SAR § 5.1 Summary Description, Figure 5.1

Question: C.019 (1.00 point) {21.0}
The purpose of the graphite slugs located at the top and bottom of each fuel rod is to …

a. reflect neutrons, thereby reducing neutron leakage from the core.

b. absorb neutrons, thereby reducing neutron leakage from the core.

c. couple neutrons from the core to the nuclear instrumentation, decreasing shadowing effects.

d. absorb neutrons, thereby reducing neutron embrittlement of the upper and lower guide plates.

Answer: C.019 A. ~~C.~~ Correct answer changed from (c) to (a) per facility comment.
Reference: SAR § 4.2.1 , Reactor Fuel, Figure 4.3.

Question: C.020 (1.00 point) {22.0}
The North-East Beam Port core-end terminates at:

a. The outer surface of the reflector container

b. The inner surface of the reflector container

c. The top of the Lazy Susan

d. The center of the core

Answer: C.020 B.
Reference: Facility Supplied Question modified to meet NRC requirements.

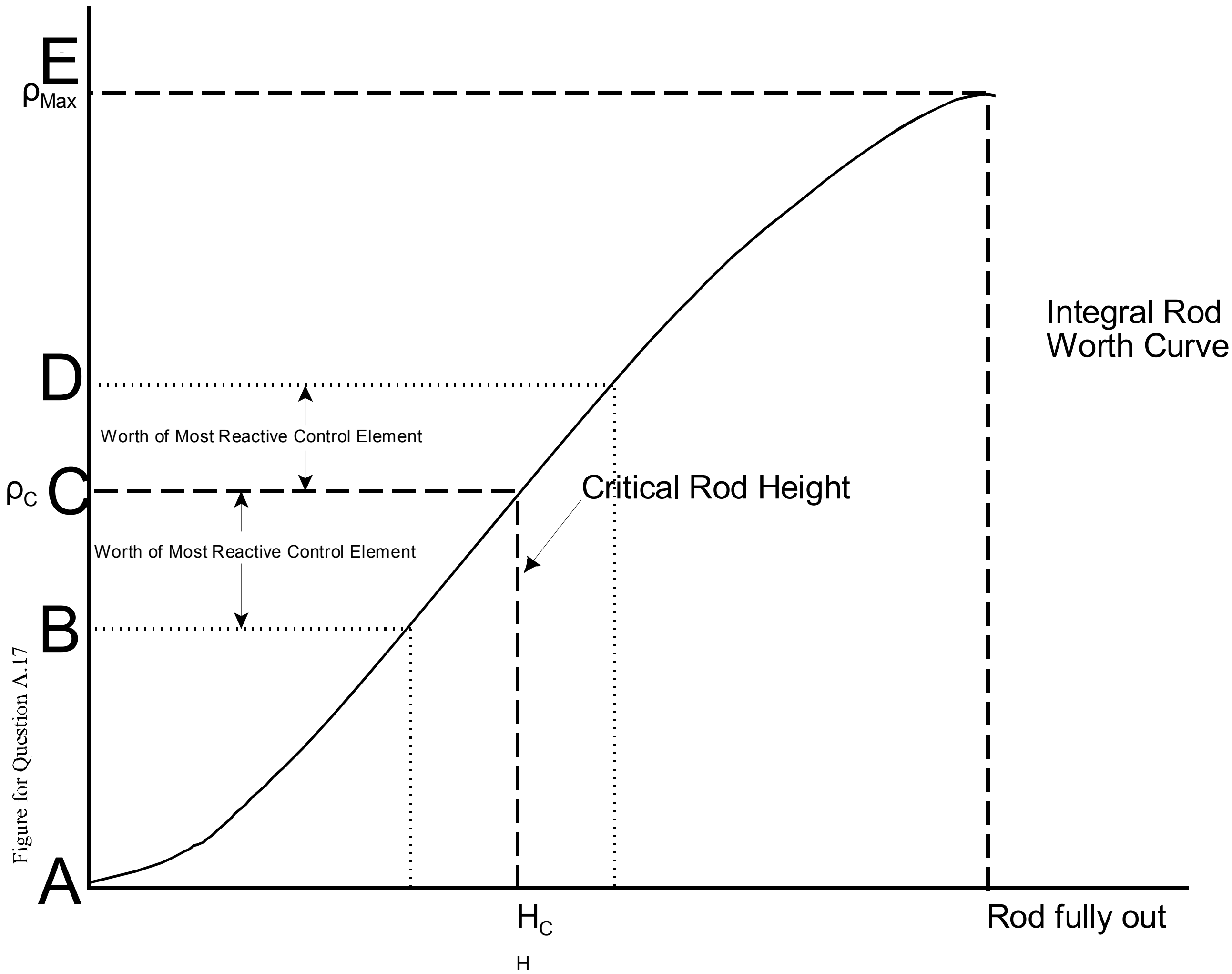

Figure for Question A.17