January 5, 2011

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

SUBJECT: INITIAL AND RETAKE EXAMINATION REPORT NO. 50-188/OL-11-01, KANSAS STATE UNIVERSITY

Dear Dr. Geuther:

During the week of November 29, 2010, the NRC administered initial and retake 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. Paul V. Doyle Jr. at (301) 415-1058 or via internet e-mail Paul.Doyle@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. Retake Examination Report No. 50-188/OL-11-01
2. Facility comments on written examination
3. Written examination with facility comments incorporated

cc w/o enclosures: Please see next page

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DISTRIBUTION w/ encls.:

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ADAMS ACCESSION #: ML103500590 **TEMPLATE #:NRR-074**

OFFICE	PRTB:CE	IOLB:LA	PR0B:SC
NAME	PDoyle	CRevelle	JEads
DATE	12/17/2010	1/03/2011	1/5/11

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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-11-01

FACILITY DOCKET NO.: 50-188

FACILITY LICENSE NO.: R-88

FACILITY: Kansas State University TRIGA Reactor

EXAMINATION DATES: November 30, 2010

SUBMITTED BY: /RA/ 12/3/2010
Paul V. Doyle Jr., Chief Examiner Date

SUMMARY:

During the week of November 29, 2010, an initial operator licensing examination was administered to one RO applicant and a retake operator licensing examination was administered to another RO applicant. Both applicants passed the examination.

REPORT DETAILS

1. Examiners: Paul V. Doyle Jr., Chief Examiner, NRC

2. Results:

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

3. Exit Meeting:
The Reactor Manager was not available for an exit meeting. The facility submitted comments on the examination via e-mail. These comments along with their resolutions are included as Attachment 2 to this report.

ENCLOSURE 1

Facility Comments with NRC Resolution.

Question B.02 –
According to Emergency Plan section 5.7, the site boundary shall be evacuated when the dose rate exceeds 100 mR / h at the boundary between the control room and the reactor bay. A dose rate of 150 mR / h at the boundary between the control room and the hallway implies that the dose between the control room and bay is well in excess of 100 mR / h. Therefore the facility recommends that the correct answer be changed to A.

NRC Resolution: Comment accepted, correct answer changed to a.

Question B.11 –
The 450 C fuel temperature scram / interlock does not exist in the current Tech Specs. The facility recommends deleting B.11.b.

NRC Resolution: Comment accepted. Part b of question B.11 has been deleted.

Question B.18 –
There are two experimental procedures for radiography. The 5 kW limit mentioned in the question pertains to Experiment 46, Pulsed Neutron Radiography, not Experiment 45, Neutron Radiography. The question referred to "neutron radiography," indicating Experiment 45, which does not have a similar power limit which precludes entry into the bay. Therefore the facility recommends deleting this question.

NRC Resolution: Comment accepted. This question is deleted from the examination.

Question C.10 –
The rabbit is no longer installed in the KSU reactor core. It was removed to allow the addition of more fuel to operate at higher power, and there are no plans to re-install it in the future. A similar question on the exam administered in the spring of 2010 was removed for this reason. (See Facility Comment B.003 in the Initial Examination Report issued on April 20, 2010). The facility recommends that question C.10 be deleted since the rabbit is no longer in use at the facility.

NRC Resolution: Comment accepted. Question C.10 deleted.

OPERATOR LICENSING INITIAL/RETAKE EXAMINATION

With Answer Key

UNITED STATES NUCLEAR REGULATORY COMMISSION

KANSAS STATE UNIVERSITY

Week of November 29, 2010

Enclosure 2

Question A.01 [1.0 point]
A reactor is subcritical with a K_{eff} of 0.955. Seven dollars ($7.00, assume $\beta = 0.007$) of positive reactivity is inserted into the core. At this point, the reactor is:

a. subcritical.

b. exactly critical.

c. supercritical.

d. prompt critical.

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]
The neutron microscopic cross-section for absorption, σ_a, generally:

a. increases as neutron energy increases.

b. decreases as neutron energy increases.

c. increases as the mass of the target nucleus increases.

d. decreases as the mass of the target nucleus increases.

Question A.04 [1.0 point]
Which ONE of the reactions below is an example of a <u>photoneutron</u> source?

a. ${}_{51}Sb^{123} + n \rightarrow {}_{51}Sb^{124} + \gamma$

b. ${}_{92}U^{238} \rightarrow {}_{35}Br^{87} + {}_{57}La^{148} + 3n + \gamma$

c. ${}_{1}H^{2} + \gamma \rightarrow {}_{1}H^{1} + n$

d. ${}_{4}Be^{9} + \alpha \rightarrow {}_{6}C^{12} + n$

Question A.05 [1.0 point]
You are performing a fuel load and predicting criticality using a 1/M curve. You stop for lunch. After lunch you recommence using the count rate at that time as a new initial count rate C_o. You load additional elements into the core and the inverse count rate ratio continues to decrease. As a result of changing the initial count rate:

a. criticality will occur with the same number of elements loaded as if there were no change in the initial count rate.

b. criticality will occur earlier (i.e., with fewer elements loaded.)

c. criticality will occur later (i.e., with more elements loaded.)

d. criticality will be completely unpredictable.

Question A.06 [1.0 point]
A reactor is critical at 18.1 inches on a controlling rod. You withdraw the controlling rod to 18.4 inches, adding 14.4 cents worth of reactivity. What is the differential rod worth?

a. 14.4 cents/inch at 18.25 inches.

b. 14.4 cents/inch only between 18.1 and 18.4 inches.

c. 48 cents/inch at 18.4 inches.

d. 48 cents/inch at 18.25 inches.

Question A.07 [1.0 point]
Which ONE of the following describes the response of the subcritical reactor to equal insertions of positive reactivity as the reactor approaches critical? Each reactivity insertion causes:

a. a SMALLER increase in the neutron flux, resulting in a LONGER time to reach equilibrium.

b. a SMALLER increase in the neutron flux, resulting in a SHORTER time to reach equilibrium.

c. a LARGER increase in the neutron flux, resulting in a LONGER time to reach equilibrium.

d. a LARGER increase in the neutron flux, resulting in a SHORTER time to reach equilibrium.

Question A.08 [1.0 point]
During a reactor startup, the count rate is increasing linearly with time, with no rod motion. This means that:

a. the reactor is subcritical and the count rate increase is due to the buildup of delayed neutron precursors.

b. the reactor is critical and the count rate increase is due to source neutrons.

c. the reactor is subcritical and the count rate increase is due to source neutrons.

d. the reactor is critical and the count rate increase is due to the buildup of delayed neutron precursors.

Question A.09 [1.0 point]
Which ONE of the following elements will slow down fast neutrons most quickly, i.e. produces the greatest energy loss per collision.

a. Oxygen-16

b. Uranium-238

c. Hydrogen-1

d. Boron-10

Question A.10 [1.0 point]
The major contribution to the production of Xenon-135 in a reactor operating at full power is:

a. directly from the fission of U-235.

b. from the radioactive decay of iodine.

c. from the radioactive decay of promethium.

d. directly from the fission of U-238.

Question A.11 [1.0 point]
The initial conditions for a reactor startup are count rate = 45 cps and K_{eff} = 0.980. When the count rate reaches 90 cps, the new K_{eff} will be:

a. 0.986.

b. 0.988

c. 0.990.

d. 0.992

Question A.12 [1.0 point]
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.

Question A.13 [1.0 point]
By definition, you may make an exactly critical reactor **PROMPT CRITICAL** by adding positive reactivity equal to …

a. the shutdown margin

b. the K_{excess} margin

c. the β_{eff} value

d. 1.0 %ΔK/K

Question A.14 [1.0 point]
Which one of the following statements correctly describes the property of a **GOOD MODERATOR**?

a. It slows down fast neutrons to thermal energy levels via a large number of collisions.

b. It reduces gamma radiation to thermal energy levels via a small number of collisions.

c. It slows down fast neutrons to thermal energy levels via a small number of collisions.

d. It reduces gamma radiation to thermal energy levels via a large number of collisions.

Question A.15 [1.0 point]
Which of the following factors has the LEAST effect on rod worth?

a. number and location of adjacent rods.

b. temperature of the moderator.

c. temperature of the fuel.

d. core age.

Question A.16 [1.0 point]
You enter the control room and note that all nuclear instrumentation channels show a steady neutron level, and no rods are in motion. Which ONE of the following conditions **CANNOT** be true?

a. The reactor is critical.

b. The reactor is subcritical.

c. The reactor is supercritical.

d. The neutron source has been removed from the core.

Question A.17 [1.0 point]
"Excess Reactivity" is …

a. a measure of the additional fuel loaded to overcome fission product poisoning.

b. a measure of remaining control rod worth with the reactor exactly critical.

c. the combined control rod negative reactivity worth required to keep the reactor shutdown.

d. the maximum reactivity by which the reactor can be shutdown with one control rod fully withdrawn.

Question A.18 [1.0 point]
The primary reason a neutron source is installed in the reactor is to …

a. allow for testing and irradiation of experiments when the core is shutdown.

b. supply the neutrons required to start the chain reaction for subsequent reactor startups.

c. provide a neutron level high enough to be monitored for a controlled reactor startup.

d. increase the excess reactivity of the reactor which reduces the frequency for refueling.

Question A.19 [1.0 point]
The delayed neutron precursor (β) for U^{235} is 0.0065. However, when calculating reactor parameters you use β_{eff} with a value of ~0.0070. Why is β_{eff} larger than β?

a. Delayed neutrons are born at higher energies than prompt neutrons resulting in a greater worth for the neutrons.

b. Delayed neutrons are born at lower energies than prompt neutrons resulting in less leakage during slowdown to thermal energies.

c. The fuel also contains U^{238} which has a relatively large β for fast fission.

d. U^{238} in the core becomes Pu^{239} (by neutron absorption), which has a higher β for fission.

Question A.20 [1.0 point]
Given the following data, which ONE of the following is the closest to the half-life of the material?

TIME	ACTIVITY
0	2400 cps
10 min.	1757 cps
20 min.	1286 cps
30 min.	941 cps
60 min.	369 cps

a. 11 minutes

b. 22 minutes

c. 44 minutes

d. 51 minutes

Question B.01 [1.0 point]
You are removing a sample from the pool. You expect the sample to emit both a beta and a gamma radiation. You stop removal at 1 meter below the surface to check for radiation levels from the sample. Given the HVL for 1 Mev gamma radiation in water is about 8 inches, is this a realistic level to stop to detect a radiation problem and why?

a. Yes, three feet of water is not a very good at shielding either beta or gamma radiation.

b. No, three feet of water is an excellent shield for betas, you will however get an accurate reading for gammas.

c. No, three feet of water is an excellent shield for gammas, you will however get an accurate reading for betas.

d. No, three feet of water is an excellent shield for betas and the reading for gammas will be off by a factor of about 30.

Question B.02 [1.0 point]
The 5 R/hr evacuation alarm has sounded. In addition, the gamma radiation level in the hallway outside the reactor control room is 150 mR/hr. Which ONE of the following actions should you take?

a. The Site Boundary area shall be evacuated.

b. All personnel in the Operations Boundary area shall assemble at Ward Hall Emergency Assembly Area 1 or 2.

c. Take no action until the University Radiation Safety Officer confirms the radiation levels.

d. All personnel in the Site Boundary area shall assemble in the Operations Boundary area.

Question B.03 [1.0 point, ¼ each]
Match the 10 CFR Part 55 requirements listed in Column A for an actively licensed operator with the correct time period from Column B. Column B answers may be used once, more than once, or not at all.

	Column A	Column B
a.	License Expiration	1 year
b.	Medical Examination	2 years
c.	Requalification Written Examination	3 years
d.	Requalification Operating Test	6 years

Question B.04 [1.0 point]
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 readings from the same GM tube and Ion Chamber at 10 feet from each source. Concerning the four readings, which ONE of the following statements is correct?

a. The reading from Source B is twice that of Source A for both meters.

b. The reading from Source B is twice that of Source A for the Ion chamber but the same for the GM tube.

c. The reading from Source B is half that of Source A for the GM tube, but the same for the Ion Chamber.

d. The reading from both sources is the same for both meters.

Question B.05 [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.06 [2.0 points, ⅓ each]
For the following terms (a through F) pick a definition (1 through 6) which most clearly describes the term.

a. Subcritical Multiplication	1. Substance used in a reactor to reduce the energy of neutrons to the energy at which there is a high probability of causing fission in the fuel.
b. Reactor Period	2. Different forms of the same chemical element that differ only by the number of neutrons in the nucleus.
c. Reactivity	3. The time required for neutron flux (power) to change by a factor of e (2.718).
d. Moderator	4. The multiplication of source neutrons resulting from reactivity addition.
e. Shutdown Margin	5. A measure of the deviation from critical.
f. Isotope	6. A measure of the reactivity that must be added to a shutdown reactor to make it just critical.

Question B.07 [1.0 point]
Which ONE of the following statements describes a reactivity limitation imposed on experiments?

a. The absolute reactivity worth of all experiments in the reactor shall not exceed $2.00.

b. An experiment which will not cause a 20-second period can be inserted in the core when the reactor is at power.

c. When determining the absolute reactivity worth of an experiment, the reactivity effects associated with the moderator temperature is to be considered.

d. No experiment shall be inserted or removed unless all control blades are fully inserted.

Question B.08 [1.0 point]
The Emergency Plan defines a Medical Incident as:

a. a laboratory accident involving radiation exposure.

b. bodily injury requiring medical treatment.

c. a laboratory accident involving radiation exposure accompanied by bodily injury.

d. a laboratory accident involving radioactive contamination.

Question B.09 [1.0 point]
Which ONE of the following interlocks, according to Technical Specifications, may be bypassed during fuel loading operations?

a. Movement of any rod except the transient rod.

b. Shim and regulating rod withdrawal with less than two counts per second on the start-up channel.

c. Simultaneous manual withdrawal of two rods.

d. Application of air to the transient rods unless regulating and shim rods are fully inserted.

Question B.10 [1.0 point]
According to 10 CFR 20, the "Annual Limit on Intake (ALI)" refers to …

a. the amount of radioactive material taken into the body by inhalation or ingestion in one (1) year which would result in a committed effective dose equivalent of five (5) rems.

b. the concentration of a given radionuclide in air which, if breathed for a working year of 2000 hours, would result in a committed effective dose equivalent of 5 rems.

c. the dose equivalent to organs that will be received from an intake of radioactive material by an individual during the 50-year period following the intake.

d. limits on the release of effluents to an unrestricted environment.

Question B.11 [~~2.0~~ 1.5 points, ½ each] Part b deleted per facility comment.
Select the MODE from Column II when the Scrams/Interlocks from Column I are required to be effective. Modes in Column II may be used once, more than once, or not at all.

Column I (Scrams/Interlocks)	Column II (Mode)
a. Safety Channel at 110% of full power	1. Steady State only
~~b. Fuel Temperature at 450°C.~~	2. Pulse Only
c. Ion Chamber Power Supply Failure	3. Both Pulse and Steady State
d. Simultaneous manual withdrawal of two rods.	4. Fuel loading only

Question B.12 [1.0 point]
Per 10CFR20.1201, the annual dose limit for the skin of your extremities per year is …

a. 1.0 rem.

b. 5.0 rem.

c. 15.0 rem.

d. 50.0 rem.

Question B.13 [1.0 point]
"Protective Action Guides" are:

a. specific instrument readings, observations, dose rates, etc., which provide thresholds for establishing emergency classes.

b. projected dose equivalents to individuals in the general population which warrants protective actions following a nuclear incident.

c. dose equivalents that are projected to be received by individuals in a population group from a contaminating event if no protective actions were taken.

d. instructions that detail the implementation actions and methods required to achieve the objectives of the emergency plan.

Question B.14 [1.0 point]
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.

Question B.15 [1.0 point]
Calculate the amount of reactivity by which the reactor is shutdown if the Pulse rod is stuck all the way out. Assume the following worths:

Shim= \$2.10; Regulating = \$1.05; Pulse = \$1.10; Excess reactivity = \$2.05.

a. \$0.95

b. \$1.10

c. \$2.20

d. \$4.25

Question B.16 [1.0 point]
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%

Question B.17 [1.0 point]
In accordance with Experiment No. 1, "Isotope Production," removal of any material from a region of significant neutron flux must be done in the presence of:

a. the Reactor Supervisor.

b. a Senior Reactor Operator.

c. a representative of the University Radiation Safety Office.

d. a person approved by the Reactor Supervisor who is trained in the safe handling of radioactive materials.

Question B.18 [1.0 point] **Question deleted per facility comment.**
~~Following neutron radiography, one must not reenter the reactor bay until:~~

~~a. The beam port radiation monitor reads less than 10 mR/hr~~

~~b. Reactor power is reduced to below 5 kW~~

~~c. The beam port radiation monitor reads less than 100 mR/hr~~

~~d. Reactor power is reduced to below 5 watts~~

Question C.01 [1.0 point]
WHICH ONE of the following detectors is used primarily to measure N^{16} released to the environment?

a. NONE, N^{16} has too short a half-life to require environmental monitoring.

b. Stack Gas Monitor

c. Air Particulate Monitor

d. Area Radiation Monitor above pool

Question C.02 [1.0 point]
Which one of the following correctly describes the operation of a Thermocouple?

a. 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.

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

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

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

Question C.03 [1.0 point]
Upon receipt of a scram signal with the automatic flux control system engaged, the regulating rod …

a. magnet is de-energized, the rod falls into the core, and the drive is automatically driven in.

b. and drive remain where they are, and both must be manually driven into the core.

c. and drive both automatically drive into the core.

d. magnet is de-energized, the rod falls into the core, but the drive must be manually driven into the core.

Question C.04 [1.0 point]
What is the normal rod motion speed?

a. 16 inches per minute

b. 14 inches per minute

c. 12 inches per minute

d. 10 inches per minute

Question C.05 [1.0 point]
The shim rod and the regulating rod are constructed of:

a. graphite with aluminum cladding.

b. boron and carbon with aluminum cladding.

c. cadmium with aluminum cladding.

d. graphite and boron with aluminum cladding.

Question C.06 [1.0 point]
The central thimble is an aluminum tube extending from the top of the reactor tank and terminating:

a. below the bottom grid plate.

b. at the bottom grid plate.

c. at the midpoint of the core.

d. at the top grid plate.

Question C.07 [1.0 point]
The purpose of the diffuser above the core during operation is to:

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

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

c. better distribute heat throughout the pool.

d. ensure consistent water chemistry in the pool.

Question C.08 [1.0 point]
The flow rate in the primary loop is maintained by which ONE of the following methods?

a. A flow orifice in the primary piping.

b. Adjustment of the filter pressure drop.

c. Adjustment of primary pump speed.

d. Throttling the discharge valve of the primary pump.

Question C.09 [2.0 points, ¼ each]
Identify the components labeled a through h on the figure of a Control Blade Drive Mechanism provided. (Note: Items are used only once. Only one answer per letter.)

a. ___	1. Foot
b. ___	2. Barrel
c. ___	3. Position Potentiometer
d. ___	4. Rod Down Limit Switch
e. ___	5. Drive Motor
f. ___	6. Pull Rod
g. ___	7. Armature
h. ___	8. Magnet

Question C.10 [1.0 point] **Question deleted per facility comment.**
~~Which **ONE** of the following is the gas used in the pneumatic tube system?~~

~~a. Air~~

~~b. CO_2~~

~~c. N_2~~

~~d. He~~

Question C.11 [2.0 points, ½ each]
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

Question C.12 [1.0 point] **Question deleted by examiner during administration (no figure provided).**

~~Using the drawing of a pneumatic tube system provided, identify the valve lineup which will result in sending a "rabbit" INTO the core.~~

	~~OPEN~~	~~SHUT~~
~~a.~~	~~A & B~~	~~C & D~~
~~b.~~	~~C & D~~	~~A & B~~
~~c.~~	~~A & C~~	~~B & D~~
~~d.~~	~~B & C~~	~~A & D~~

Question C.13 [2.0 points, ½ each]

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

Question C.14 [1.0 point]

Per technical specifications which **ONE** of the following safety system functions must be operable for both steady-state and pulsing operations?

a. Reactor Power Level Scram

b. Pulse Rod Interlock

c. Manual Scram Bar

d. Control Rod (standard) Position Interlock

Question C.15 [1.0 point]

The water monitor vessel contains:

a. a temperature probe, a pressure probe, and a GM tube.

b. a temperature probe, a conductivity probe, and a pressure probe.

c. a conductivity probe, a pressure probe, and a GM tube.

d. a conductivity probe, a temperature probe, and a GM tube.

Question C.16 [1.0 point]
Which ONE of the Nuclear Instrumentation channels/circuits listed below does NOT provide an input to the Regulating Rod Automatic Control circuit?

a. Nuclear Multi-Range Power Channel (NMP-1000)

b. Nuclear Power Pulse Channel (NPP-1000)

c. Nuclear Log Wide Range Channel (NLWR-1000)

d. Percent Demand Potentiometer

Question C.17 [1.0 point]
In the control rod drive system, the contact light will be extinguished if the **MAGNET DOWN** microswitch is …

a. actuated AND the **ROD DOWN** microswitch is actuated.

b. **NOT** actuated AND the **ROD DOWN** microswitch is actuated.

c. actuated **OR** the **ROD DOWN** microswitch is **NOT** actuated.

d. **NOT** actuated **OR** the **ROD DOWN** microswitch is actuated.

A.01 c REF: Shutdown ρ = (K-1)/K = -0.047 ΔK/K. $7.00 added = 7(0.007) = +0.049 ΔK/K. -0.047 + 0.049 = + 0.002, i.e. supercritical. Exam 1

A.02 a REF: Reference 1, Volume 2, Module 3, Enabling Objective 1.2. Exam 1

A.03 b REF: Reference 1, Volume 1, Module 2, Enabling Objective 2.3.

A.04 c REF: Reference 1, Volume 1, Module 2, Enabling Objective 1.3. Exam 1

A.05 a REF: Reference 1, Volume 2, Module 4, pg. 6, "Use of 1/M plots. Exam 1

A.06 d REF: Reference 1, Volume 2, Module 3, Enabling Objective 5.3. Exam 1

A.07 c REF: Standard NRC Question

A.08 b REF: Reference 1, Volume 2, Module 4, pg. 24 "Startup" 2nd ¶. Exam 2

A.09 c REF: Reference 1, Volume 1, Module 2, Enabling Objective 2.12. Exam 2

A.10 b REF: Reference 1, Volume 2, Module 3, Enabling Objective 4.1. Exam 2

A.11 c REF: Reference 1, Volume 2, Module 4, Enabling Objective 1.3. Exam 2

A.12 c REF: Reference 1, Volume 2, Module 4, Reactor Kinetics, page 17. Reactor Period = 26/Startup Rate. Exam 3. **$P = P_0 e^{t/\tau}$ τ = 60/ln(10) = 26.06**

A.13 c REF: Reference 1, Volume 2, Module 4, Enabling Objective 2.8. Exam 7

A.14 c REF: Reference 1, Volume 1, Module 2, Enabling Objective 2.13. Exam

A.15 c Ref: Standard NRC Question

A.16 c REF: Standard NRC Question

A.17 b REF: Reference 1, Volume 2, Module 3, pg. 50. Exam 9

A.18 c REF: Reference 1, Volume 1, Module 2, pg. 1, "Neutron Sources." Exam 9

A.19 b REF: Reference 1, Volume 2, Module 4, "Effective Delayed Neutron Fraction." Exam 9

A.20 b REF: Reference 1, Volume 1, Module 1, Enabling Objective 2.5. Exam 10. **$A = A_0 e^{-\lambda T}$ (22 minutes).**

Reference 1 = DOE Fundamentals Handbook, Nuclear Physics and Reactor Theory, Volumes 1 and 2.

B.01 d REF: New NRC Question under development.

B.02 ~~b~~ a REF: Exam 1, Emergency Plan, 3.5. Answer changed per facility comment.

B.03 a, 6; b, 2; c, 2; d, 1 REF: Exam 1, 10 CFR 55.

B.04 b REF: GM tube cannot distinguish between energies, but an ion chamber can.

B.05 a REF: Exam 3, Emergency Plan, section 1.1.

B.06 a, 4; b, 3; c, 5; d, 1; e, 6; f, 2 REF: Standard NRC Question

B.07 a REF: Exam 1, Technical Specifications, I.3(a).

B.08 c REF: Exam 1, Emergency Plan, 4.1.

B.09 b REF: Exam 1, Technical Specifications, Table II

B.10 a REF: Exam 3, Radiation Protection Program, page A-2.

B.11 a, 1; ~~b, 2~~; c, 3; d, 3; REF: Exam 1, Technical Specifications, Table II. Part b deleted per facility comment.

B.12 d REF: 10CFR20.1201

B.13 b REF: Exam 3, Emergency Plan, section 7.1.

B.14 a REF: Exam 3, Administrative Plan, section 5.0.

B.15 b REF: Exam 3, Shim rod + Regulating rod = $3.15. Excess reactivity - $3.15 = -$1.10.

B.16 c REF: Exam 3, 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%.

B.17 d REF: Exam 4, Experiment No. 1, page 4.

B.18 ~~d REF: Facility supplied question, Exam 9~~. Question deleted per facility comment.

C.01 a REF: Standard NRC Question

C.02 b REF: Standard NRC Question

C.03 d REF: Procedure 23, Rewrite of January 2005 NRC examination question.

C.04 c REF: KSU Facility Description page A.1.21

C.05 b REF: Training Manual, page A1-6.

C.06 a REF: Training Manual, page A1-7.

C.07 a REF: Exam 5, SAR, page 5-10.

C.08 a REF: Exam 4, Training Manual, page A1-10.

C.09 a. = 4; b. = 3; c. = 5; d. = 2; e. = 8; f. = 6; g. = 7; h. = 1 REF: Exam 7, KSU Facility Description page A.1.19

C.10 d REF: SAR § 9.7.3(d). Pneumatic Transfer *System (Rabbit)* , Exam 9. Question deleted per facility comment.

C.11 a, 2; b, 3; c, 1; d, 4; REF: Standard NRC cleanup loop question, Exams 8 & 11

~~C.12 d REF: Standard NRC question, Exam 9~~ Question deleted during administration of exam. Drawing was not provided, and facility has permanently removed pneumatic tube system.

C.13 a = 4; b = 3; c = 1; d = 2. REF: Standard TRIGA Mk II question, Exam 8, Exam 11

C.14 c REF: Technical Specification 3.4 Safety and Control Rod Operability, Exam 9

C.15 d REF: NRC Exam April, 2002. Training Manual, page A1-10, Exam 10

C.16 b REF: Procedure No. 23 Automatic Flux Control System, Exam 9

C.17 b REF: NRC Exam April, 2002. Training Manual, page A1-17, Exam 10

U. S. NUCLEAR REGULATORY COMMISSION

RESEARCH & TEST REACTOR OPERATOR LICENSE EXAMINATION

FACILITY: Kansas State University

REACTOR TYPE: TRIGA Mark II

DATE ADMINISTERED: 11/30/2010

CANDIDATE:

INSTRUCTIONS TO CANDIDATE:
Please write answers on the answer sheet provided. Attach the answer sheets to the examination. Points for each question are indicated in brackets for each question. You must achieve a 70% in each section to pass the examination. Examinations will be picked up three (3) hours after the examination starts.

% of Category Value	% of Total	Candidates Score	Category Value	Category
20.00	33.3	______	____	A. Reactor Theory, Thermodynamics and Facility Operating Characteristics
18.50	33.3	______	____	B. Normal and Emergency Operating Procedures and Radiological Controls
18.00	33.3	______	____	C. Facility and Radiation Monitoring Systems
56.50	______	____%		TOTALS FINAL GRADE

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

$$DR_1 d_1^2 = DR_2 d_2^2$$

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

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

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

A.01 a b c d ___

A.02 a b c d ___

A.03 a b c d ___

A.04 a b c d ___

A.05 a b c d ___

A.06 a b c d ___

A.07 a b c d ___

A.08 a b c d ___

A.09 a b c d ___

A.10 a b c d ___

A.11 a b c d ___

A.12 a b c d ___

A.13 a b c d ___

A.14 a b c d ___

A.15 a b c d ___

A.16 a b c d ___

A.17 a b c d ___

A.18 a b c d ___

A.19 a b c d ___

A.20 a b c d ___

B.01 a b c d ___

B.02 a b c d ___

B.03a 1 2 3 6 ___

B.03b 1 2 3 6 ___

B.03c 1 2 3 6 ___

B.03d 1 2 3 6 ___

B.04 a b c d ___

B.05 a b c d ___

B.06a 1 2 3 4 5 6 ___

B.06b 1 2 3 4 5 6 ___

B.06c 1 2 3 4 5 6 ___

B.06d 1 2 3 4 5 6 ___

B.06e 1 2 3 4 5 6 ___

B.06f 1 2 3 4 5 6 ___

B.07 a b c d ___

B.08 a b c d ___

B.09 a b c d ___

B.10 a b c d ___

B.11a 1 2 3 4 ___

B.11b 1 2 3 4 ___

B.11c 1 2 3 4 ___

B.11d 1 2 3 4 ___

B.12 a b c d ___

B.13 a b c d ___

B.14 a b c d ___

B.15 a b c d ___

B.16 a b c d ___

B.17 a b c d ___

B.18 a b c d ___

C.01 a b c d ___

C.02 a b c d ___

C.03 a b c d ___

C.04 a b c d ___

C.05 a b c d ___

C.06 a b c d ___

C.07 a b c d ___

C.08 a b c d ___

C.09a 1 2 3 4 5 6 7 8 ___

C.09b 1 2 3 4 5 6 7 8 ___

C.09c 1 2 3 4 5 6 7 8 ___

C.09d 1 2 3 4 5 6 7 8 ___

C.09e 1 2 3 4 5 6 7 8 ___

C.09f 1 2 3 4 5 6 7 8 ___

C.09g 1 2 3 4 5 6 7 8 ___

C.09h 1 2 3 4 5 6 7 8 ___

C.10 a b c d ___

C.11a 1 2 3 4 ___

C.11b 1 2 3 4 ___

C.11c 1 2 3 4 ___

C.11d 1 2 3 4 ___

C.12 a b c d ___

C.13a 1 2 3 4 ___

C.13b 1 2 3 4 ___

C.13c 1 2 3 4 ___

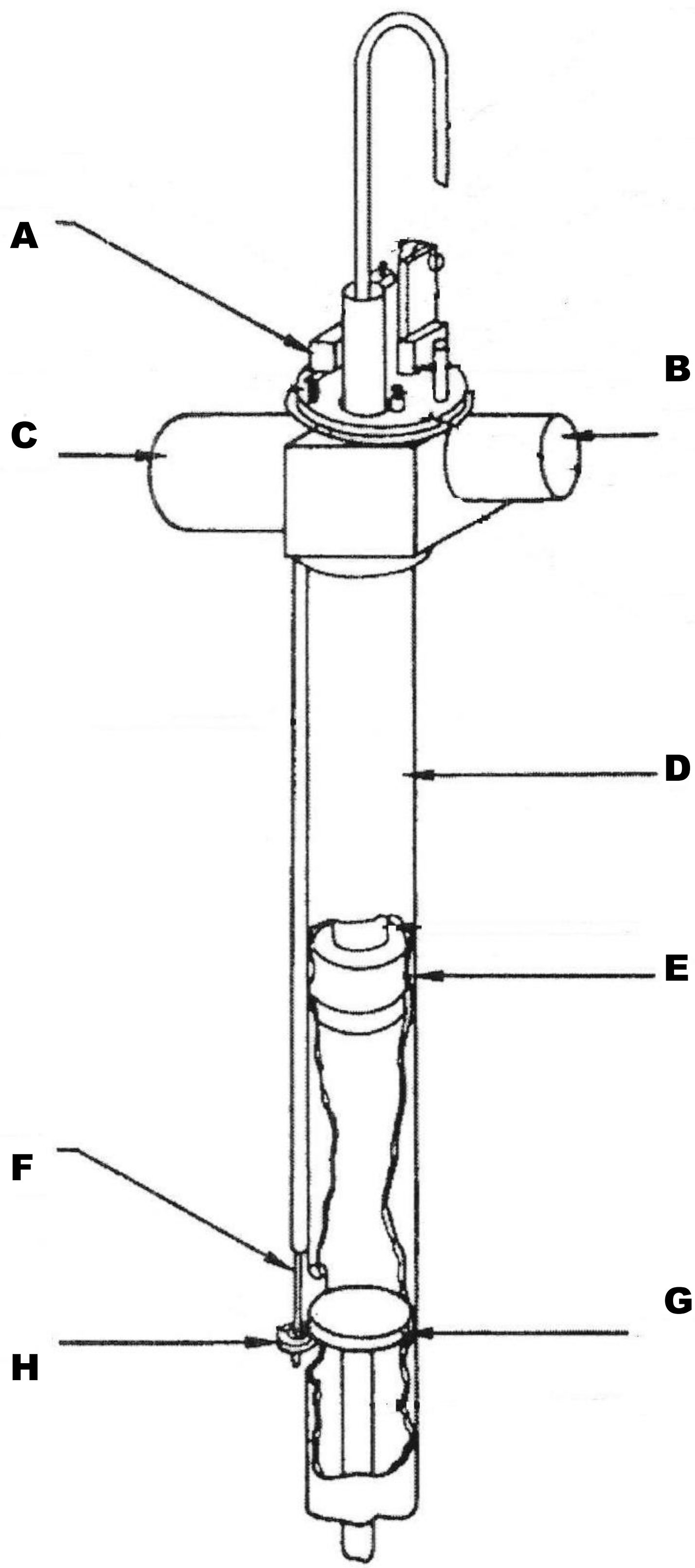
C.13 d 1 2 3 4 ___

C.14 a b c d ___

C.15 a b c d ___

C.16 a b c d ___

C.17 a b c d ___



Standard rod drive mechanism