May 2, 2013

Dr. Jeffrey A. Guether, Manager
KSU Nuclear Reactor Facility
Department of Mechanical and Nuclear Engineering
112 Ward Hall
Kansas State University
Manhattan, KS 66506-2500

SUBJECT: EXAMINATION REPORT NO. 50-188/OL-13-02, KANSAS STATE UNIVERSITY

Dear Dr. Guether:

During the week of April 15, 2013, the U.S. Nuclear Regulatory Commission (NRC) administered operator licensing examination at your KSU Nuclear Reactor Facility. The examination was conducted according to NUREG-1478, "Operator Licensing Examiner Standards for Research and Test Reactors," Revision 2, published in June 2007. Examination questions and preliminary findings were discussed at the conclusion of the examination with those members of your staff identified in the enclosed report.

In accordance with Title 10, Section 2.390 of the Code of Federal Regulations, 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 Public Electronic Reading Room). The NRC is forwarding the individual grades to you in a separate letter which will not be released publicly. If you have any questions concerning this examination, please contact Patrick Isaac at 301-415-1019 or via email at patrick.isaac@nrc.gov.

Sincerely,
/RA/

Gregory T. Bowman, Chief
Research and Test Reactors Oversight Branch
Division of Policy and Rulemaking
Office of Nuclear Reactor Regulation

Docket No. 50-188

Enclosures:
1. Examination Report No. 50-188/OL-13-02
2. Written Examination

cc w/o enclosures: See next page

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OFFICE	PROB:CE	IOLB:LA	PROB:BC
NAME	PIsaac	CRevelle	GBowman
DATE	04/30/2013	05/01/2013	05/02/2013

OFFICIAL RECORD COPY

cc:

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

EXAMINATION REPORT NO: 50-188/OL-13-02

FACILITY: KSU Nuclear Reactor Facility

FACILITY DOCKET NO.: 50-188

FACILITY LICENSE NO.: R-88

SUBMITTED BY: ____________**/RA/**____________ 04/29/13__
Patrick J. Isaac, Chief Examiner Date

SUMMARY:

During the week of April 15, 2013, NRC administered a retake of Section A of the Operator Licensing Examinations to one Reactor Operator (RO) candidate. The candidate passed the examinations.

REPORT DETAILS:

1. Examiner:

   Patrick J. Isaac

2. Results:

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

3. Facility Comments:

Dr. Guether recommended that question A.20 be deleted because it is not applicable for the KSU reactor. The examiner agreed with the recommendation and question A.20 has been deleted from the written examination.

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

FACILITY: Kansas State University

REACTOR TYPE: TRIGA-II

DATE ADMINISTERED: 04/15/2013

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 parentheses for each question. A 70% is required to pass the examination. Examinations will be picked up one (1) hour after the examination starts.

Category Value	% of Total	Candidates Score	% of Category Value	Category
19.0	100	_______	_______	A. Reactor Theory, Thermodynamics and Facility Operating Characteristics

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

____
Candidate's Signature

ENCLOSURE 2

NRC RULES AND GUIDELINES

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 not received or 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.

6. Fill in the date on the cover sheet of the examination (if necessary).

7. Print your name in the upper right hand corner of the first page of each section of your answer sheets.

8. The point value for each question is indicated in parentheses after the question.

9. Partial credit will NOT be given.

EQUATION SHEET

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

$$T_{½} = \frac{0.693}{\lambda}$$

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

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

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

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

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

1 Curie = 3.7×10^{10} dis/sec

1 kg = 2.21 lbm

1 MW = 3.41×10^6 BTU/hr

1 BTU = 778 ft-lbf

°F = 9/5 °C + 32

1 gal (H_2O) ≈ 8 lbm

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.

MULTIPLE CHOICE

01 a b c d ___

02 a b c d ___

03 a b c d ___

04 a b c d ___

05 a b c d ___

06 a b c d ___

07 a b c d ___

08 a b c d ___

09 a b c d ___

010 a b c d ___

011 a b c d ___

012 a b c d ___

013 a b c d ___

014 a b c d ___

015 a b c d ___

016 a b c d ___

017 a b c d ___

018 a b c d ___

019 a b c d ___

~~020 a b c d~~ ___

A. Reactor Theory, Thermodynamics and Facility Operating Characteristics

QUESTION: 01 (1.0)

The reactor is operating at steady state full power when the Rotary Specimen Rack (RSR) floods, as a result reactor power would:

a. increase.

b. decrease.

c. remain constant.

d. initially increase then return back to its initial value.

QUESTION: 02 (1.0)

During a fuel loading, if the fuel elements are loaded to the core one by one starting near the source and proceeding toward the detector, which ONE of the following statements describes the effect of this loading sequence on the 1/M plot?

a. The sequence has no effect on the 1/M plot.

b. The 1/M plot will have a less angular slope, predicting criticality for a larger number of elements.

c. The 1/M plot will have a steeper slope, initially predicting criticality for a fewer number of elements.

d. The 1/M plot will approach infinity. Predicting criticality would be difficult.

QUESTION: 03 (1.0)

Which ONE of the following describes how delayed neutrons affect control of the reactor?

a. More delayed neutrons are produced than prompt neutrons resulting in a longer time to reach a stable subcritical countrate.

b. Delayed neutrons are born at higher energies than prompt neutrons resulting in a shorter reactor period from increased leakage.

c. Delayed neutrons take longer to thermalize than prompt neutrons resulting in a longer reactor period.

d. Delayed neutrons increase the average neutron lifetime resulting in a longer reactor period.

A. Reactor Theory, Thermodynamics and Facility Operating Characteristics

QUESTION: 04 (1.0)

With the reactor on a constant positive period, which ONE of the following power changes will take the SHORTEST time?

a. 5% power - from 1% to 6% power.

b. 10% power - from 10% to 20% power.

c. 15% power - from 20% to 35% power.

d. 20% power - from 40% to 60% power.

QUESTION: 05 (1.0)

Given a source strength of 10 neutrons per second (N/sec) and a multiplication factor (Keff) of 0.8, the expected stable neutron count rate would be?

a. 80 N/sec

b. 250 N/sec

c. 50 N/sec

d. 80 N/sec

QUESTION: 06 (1.0)

The primary reason a neutron source is installed in the core is to:

a. allow for testing and irradiation experiments when the reactor 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.

A. Reactor Theory, Thermodynamics and Facility Operating Characteristics

QUESTION: 07 (1.0)

Which ONE of the following describes the reason for the constant rate of power change several minutes after a reactor scram from full power?

a. The decay of the longer lived delayed neutron precursors.

b. The reactivity added by the fuel temperature coefficient.

c. The decay of fission products producing photoneutrons.

d. The subcritical multiplication of source neutrons.

QUESTION: 08 (1.0)

Which ONE of the following describes the time period in which the maximum amount of Xe-135 will be present in the core?

a. 4 to 6 hours after a power decrease from 10% to 50%.

b. 4 to 6 hours after a power increase from 50% to 10%.

c. 6 to 11 hours after a startup to 10% power.

d. 6 to 11 hours after shutdown from 8 hours of 10% power operation.

QUESTION: 09 (1.0)

Which ONE of the following coefficients will respond first to turn power during a power increase from 50% power?

a. Fuel Temperature

b. Moderator Temperature

c. Power

d. Void

A. Reactor Theory, Thermodynamics and Facility Operating Characteristics

QUESTION: 10 (1.0)

Which ONE of the following terms of the six factor formula is most affected by "Poisons"?

a. Fast Fission Factor

b. Reproduction Factor

c. Thermal Utilization Factor

d. Thermal Non Leakage Probability

QUESTION: 11 (1.0)

The reactor is shutdown by 0.05 $\Delta K/K$, this would correspond to a Keff of:

a. 0.9995.

b. 0.9524.

c. 0.7750.

d. 0.050.

QUESTION: 12 (1.0)

The principal source of heat following a scram from full power is from:

a. delayed neutrons.

b. the installed source.

c. fission product decay.

d. radioactive decay of structural material.

QUESTION: 13 (1.0)

With a 30 second period, power would double in approximately:

a. 15 seconds.

b. 21 seconds.

c. 30 seconds.

d. 60 seconds.

QUESTION: 14 (1.0)

For a thermal reactor, a reflector is used to:

a. absorb excess high energy neutrons.

b. provide the media for slowing down neutrons.

c. absorb excess thermal and fast neutrons.

d. reduce the amount of fuel required to achieve criticality.

QUESTION: 15 (1.0)

Which ONE of the following is associated with the most amount of energy from fission?

a. Kinetic energy of fission products.

b. Fission product gamma energy.

c. Fission product beta energy.

d. Fast neutron energy.

A. Reactor Theory, Thermodynamics and Facility Operating Characteristics

QUESTION: 16 (1.0)

If a control rod withdrawal for a reactor startup is conducted without the source inserted, which ONE of the following is the result?

Assume the rod withdrawal rate is the same as a normal startup, criticality will:

a. occur at a lower count rate than normal.

b. occur at a higher count rate than normal.

c. occur much later than normal.

d. not occur.

QUESTION: 17 (1.0)

Which one of the following reactivity insertions above "just critical" on delayed neutrons will make the reactor "just prompt critical"?

a. 0.1%

b. 1%

c. 10 cents

d. 1 dollar

QUESTION: 18 (1.0)

Which ONE of the following factors is the most significant in determining the differential worth of a control rod?

a. The rod speed.

b. Reactor power.

c. The flux shape.

d. The amount of fuel in the core.

A. Reactor Theory, Thermodynamics and Facility Operating Characteristics

QUESTION: 19 (1.0)

Using the normal operating parameters associated with the TRIGA cooling systems and with a primary side temperature difference of 6 °C, the temperature difference across the SECONDARY side of the heat exchanger would be:

a. 2.9 °C.

b. 3.8 °C.

c. 9.6 °C.

d. 10.5 °C.

~~QUESTION: 20 (1.0)~~ DELETED

The TRIGA reactor is not allowed to be pulsed from power levels above 1kw. The reason for this requirement is:

a. The additional fast neutron flux from the pulse could dangerously embrittle fuel cladding.

b. The additional heat from the pulse could cause pool temperature limits to exceed operating specifications.

c. The additional thermal neutron flux from the pulse could dangerously embrittle fuel cladding.

d. The additional heat from the pulse could cause fuel temperature limits to be exceeded.

(***** End of Examination *****)

A. Reactor Theory, Thermodynamics and Facility Operating Characteristics

ANSWER: 01 (1.0)
b
REF: KSU Exam 4/28/93

ANSWER: 02 (1.0)
b
REF: Theory of Operation, Multiplication & Criticality

ANSWER: 03 (1.0)
d
REF: Period - Reactivity Relationships

ANSWER: 04 (1.0)
d
REF: $P = P_0 e^{\frac{t}{\tau}}$

ANSWER: 05 (1.0)
c
REF: CR=S/(1-K) = 10/0.2 = 50 N/sec

ANSWER: 06 (1.0)
c
REF: Theory of Operation, Multiplication & Criticality

ANSWER: 07 (1.0)
a
REF: Theory of Operation, Period - Reactivity Relationships

ANSWER: 08 (1.0)
d
REF: Theory of Operation, Poison Compensation

ANSWER: 09 (1.0)
a
REF: Theory of Operation, Temperature Compensation

ANSWER: 010 (1.0)
c
REF: Theory of Operation, Poison Compensation

ANSWER: 011 (1.0)
b
REF: $\rho = \frac{(K_{eff}-1)}{K_{eff}}$; k=0.9524

A. Reactor Theory, Thermodynamics and Facility Operating Characteristics

ANSWER: 012 (1.0)
c
REF: Lamarsh, Introduction to Nuclear Engineering, p 313.

ANSWER: 013 (1.0)
b
REF: $P = P_0 e^{\frac{t}{T}}$; Ln2=t/30; 0.693=t/30; t=20.8

ANSWER: 014 (1.0)
d
REF: Lamarsh, Section 6.6, p 221.

ANSWER: 015 (1.0)
a
REF: KSU Exam 4/28/93

ANSWER: 016 (1.0)
a
REF: $CR_1(1-K_{eff_1}) = CR_2(1-K_{eff_2})$; If initial CR low then as Keff approaches 1.0, so will the resultant CR.

ANSWER: 017 (1.0)
d
REF: Lamarsh pg. 286

ANSWER: 018 (1.0)
c
REF: Lamarsh, Section 7.2, p 270.

ANSWER: 019 (1.0)
b
REF: Q=MCpΔT; Qp=Qs; (110 gpm)Cp(6C)= 176Cp(X); X = 660/176 = 3.8 degrees-C.

~~ANSWER: 020 (1.0)~~ DELETED
~~d~~
~~REF: KSU SAR Section 7~~

EQUATION SHEET

$$Q = mc_p \Delta T = m \Delta H = UA \Delta T$$

$$\beta = 0.007$$

$$\ell^* = 1 \times 10^{-5} \text{ seconds}$$

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

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

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

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

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$$\rho = \frac{\Delta K_{eff}}{k_{eff}}$$

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

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

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

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

DR — mRem, Ci — curies,
E — Mev, R — feet

1 Curie = 3.7×10^{10} dis/sec

1 kg = 2.21 lbm

1 Horsepower = 2.54×10^3 BTU/hr

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