January 7, 2009

Mr. Stephen G. Frantz, Director
Reed Reactor Facility
Reed College
3203 SE Woodstock Blvd.
Portland, OR 97202

SUBJECT: RETAKE EXAMINATION REPORT NO. 50-288/OL-09-01, REED COLLEGE TRIGA REACTOR

Dear Mr. Frantz:

On December 12, 2008, you administered an NRC prepared operator licensing examination at your Reed College TRIGA reactor. The examination was prepared and proctored 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 pvd@nrc.gov.

Sincerely,

/RA/

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

Docket No. 50-288

Enclosures:
1. Retake Examination Report No. 50-288/OL-09-01
2. Written examination with facility comments incorporated

cc without enclosures: See next page

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DISTRIBUTION w/ encls.:
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RidsNRRDPRPRTB Facility File (CRevelle) O-13 D-07

ADAMS ACCESSION #: ML083570104 **TEMPLATE #:NRR-074**

OFFICE	PRTB:CE		IOLB:LA	E	PRTB:SC	
NAME	PDoyle pvd		CRevelle car		JEads jhe	
DATE	12/30/08		1/7/09		1/7/09	

OFFICIAL RECORD COPY

cc:

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Portland, OR 97204

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Dean of Faculty
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Terry D. Lindsey, Program Director
Radiation Control Program
Oregon Health Services
Department of Human Services
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Portland, OR 97232-2162

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

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

REPORT NO.: 50-288/OL-09-01

FACILITY DOCKET NO.: 50-288

FACILITY LICENSE NO.: R-112

FACILITY: Reed Reactor Facility

EXAMINATION DATES: December 12, 2008

SUBMITTED BY: **/RA/** 12/31/2008
Paul V. Doyle Jr., Chief Examiner Date

SUMMARY:

Mr. John Nguyen prepared Section A of a written examination for one candidate who had failed Section A of the NRC written examination administered in May 2008 at the Reed Reactor Facility. The candidate passed the examination.

REPORT DETAILS

1. Examiners:
   Paul V. Doyle Jr., Chief Examiner, NRC
   John Nguyen, Examiner in Training, NRC

2. Results:

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

3. Exit Meeting:

Due to the nature of this examination there was no exit meeting.

OPERATOR LICENSING
RETAKE EXAMINATION
With Answer Key

UNITED STATES NUCLEAR REGULATORY COMMISSION

REED COLLEGE
DECEMBER 12, 2008

ENCLOSURE 2

QUESTION A.01 [2.0 points, 0.5 each]
Match each term in column A with the correct definition in column B.

	Column A		Column B
a.	Prompt Neutron	1.	a neutron in equilibrium with its surroundings.
b.	Fast Neutron	2.	a neutron born directly from fission.
c.	Thermal Neutron	3.	a neutron born due to decay of a fission product.
d.	Delayed Neutron	4.	a neutron at an energy level greater than its surroundings.

QUESTION A.02 [1.0 point]
Which one of the following combinations describes a reactor that is EXACTLY critical?

a. $K_{eff} = 0$; $\Delta k/k = 0$

b. $K_{eff} = 0$; $\Delta k/k = 1$

c. $K_{eff} = 1$; $\Delta k/k = 0$

d. $K_{eff} = 1$; $\Delta k/k = 1$

QUESTION A.03 [1.0 point]
Xenon-135 is produced in the reactor by two methods. One is directly from fission; the other is indirectly from the decay of:

a. Xenon-136

b. Samarium-136

c. Cesium-135

d. Iodine-135

QUESTION A.04 [1.0 point]
Which factor of the Six Factor formula is most affected when the REG rod material is changed from Boron to Samarium?

a. Thermal Utilization Factor (f)

b. Reproduction Factor˜()

c. Fast Fission Factor ()

d. Fast Non-Leakage Factor (L_f)

QUESTION A.05 [1.0 point]
Which of the following does **NOT** affect the Effective Multiplication Factor (K_{eff})?

a. The moderator-to-fuel ratio.

b. The physical dimensions of the core.

c. The strength of installed neutron sources.

d. The current time in core life.

QUESTION A.06 [1.0 point]
The neutron interaction in the reactor core that is MOST efficient in thermalizing fast neutrons occurs with the:

a. Hydrogen atoms in the water molecules

b. Oxygen atoms in the water molecules

c. Boron atoms in the control rods

d. Xenon atoms in the fuel elements

QUESTION A.07 [1.0 point]
Reactor power decreases on a stable negative period after a reactor scram, following an initial prompt drop. Which ONE (1) of the following is the reason for this?

a. This rate of power change is dependent on the **MEAN** lifetime of the longest lived delayed neutron precursor.

b. This rate of power change is dependent on the **MEAN** lifetime of the shortest lived delayed neutron precursor.

c. All prompt neutrons decay during the prompt drop, and the subsequent rate of power change is dependent **ONLY** on the half-life of the longest lived prompt gamma emitter.

d. This rate of power change is dependent on the **CONSTANT** decay rate of prompt neutrons following a scram.

QUESTION A.08 [1.0 point]
The total amount of reactivity added by withdrawing a control rod from a reference height to any other rod height is called?

a. differential rod worth

b. shutdown reactivity

c. integral rod worth

d. reference reactivity

QUESTION A.09 [1.0 point]
K_{eff} for the reactor is 0.98. If you place an experiment worth **+$1.00 (β = 0.0075)** into the core, what will the new K_{eff} be?

a. 0.982

b. 0.987

c. 1.013

d. 1.018

QUESTION A.10 [1.0 point]
About two minutes following a reactor scram, period has stabilized, and is decreasing at a CONSTANT rate. If reactor power is 10^{-5} % full power what will the power be in three minutes?

a. 5 □ 10^{-6} % full power

b. 2 □ 10^{-6} % full power

c. 1 x 10^{-6} % full power

d. 5 □ 10^{-7} % full power

QUESTION A.11 [1.0 point]
A reactor contains three safety blades and a regulating blade. Which one of the following would result in a determination of the excess reactivity of this reactor?

a. The reactor is critical at a low power level, with all safety blades full out and the regulating blade at some position. The reactivity remaining in the regulating blade (i.e. its worth from its present position to full out) is the excess reactivity.

b. The reactor is shutdown. Two safety blades are withdrawn until the reactor becomes critical. The total blade worth withdrawn is the excess reactivity.

c. The reactor is at full power. The total worth of all blades withdrawn is the excess reactivity.

d. The reactor is at full power. The total worth remaining in all the safety blades and the regulating blade (i.e. their worth from their present positions to full out) is the excess reactivity.

QUESTION A.12 [1.0 point]
INELASTIC SCATTERING is the process by which a neutron collides with a nucleus and …

a. recoils with the same kinetic energy it had prior to the collision.

b. is temporarily absorbed, raising the nucleus to an excited state. The nucleus then emits a gamma ray and a neutron with a lower kinetic energy.

c. is permanently absorbed, raising the nucleus to an excited state. The nucleus then emits a gamma ray.

d. recoils with a higher kinetic energy than it had prior to the collision with the nucleus emitting a gamma ray.

QUESTION A.13 [1.0 point]
For most materials the neutron microscopic cross-section for absorption □$_a$ generally …

a. increases as neutron energy increases

b. decreases as neutron energy increases

c. increases as target nucleus mass increases

d. decreases as target nucleus mass increases

QUESTION A.14 [1.0 point]
Which one of the following is the correct reason that delayed neutrons enhance control of the reactor?

a. There are more delayed neutrons than prompt neutrons.

b. Delayed neutrons increase the average neutron generation time.

c. Delayed neutrons are born at higher energies than prompt neutrons and therefore have a greater effect.

d. Delayed neutrons take longer to reach thermal equilibrium.

QUESTION A.15 [1.0 point]
Which one of the following is the **MAJOR** source of energy released during fission?

a. Kinetic energy of the fission neutrons.

b. Kinetic energy of the fission fragments.

c. Decay of the fission fragments.

d. Prompt gamma rays.

QUESTION A.16 [1.0 point]
The term ***PROMPT JUMP*** refers to …

a. the instantaneous change in power due to withdrawal of a control rod.

b. a reactor which has attained criticality on prompt neutrons alone.

c. a reactor which is critical on both prompt and delayed neutrons.

d. a negative reactivity insertion which is less than. $_{eff}$.

A.01 a, 2; b, 4; c, 1; d, 3
REF: Reference 1: volume 1, module 1, pg. 50, module 2, pg. 10 and module 2, pg. 29.

A.02 c
REF: Reference 1: volume 2, module 3 pages 8 & 18.

A.03 d
REF: Reference 1: volume 2, module 3 pg. 35

A.04 a
REF: Reference 1: volume 1, module 2, pg. 5.

A.05 c
REF: Reference 1: volume

A.06 a
REF: Reference 1: volume 1, module 2, pg. 27

A.07 a
REF: Reference 1: volume 2, module 4, pg. 32

A.08 c
REF: Reference 1: volume

A.09 b
REF: SDM = $(1-k_{eff})/k_{eff}$ = (1-0.98)/0.98 = 0.02041 or 0.02041/.0075 = \$2.72. Adding +\$1.00 new SDM = \$2.72 - \$1.00 = \$1.72, or .0129081̣K/K □ K_{eff} = 1/(1+SDM) = 1/(1 + 0.0129081) = 0.987

A.10 c
REF: $P = P_0\ e^{-T/□} = 10^{-5}$ □ $e^{(-180sec/80sec)} = 10^{-5}$ □ $e^{-2.25}$ = 0.1054 □ 10^{-5} = 1.054 □ 10^{-6}

A.11 a
REF: Reference 1: volume 2, module 3, pg. 50

A.12 b
REF: Reference 1: volume 1 module 1, pg. 45

A.13 b
REF: Reference 1: volume 1, module 2, pg 9

A.14 b
REF: Reference 1: volume 2, module 4, pg. 10

A.15 b
REF: Reference 1: volume 1, module 1, pg. 6

A.16 a
REF: Reference 1: volume 2, module 4, pg. 14

Reference 1: DOE Handbook *Nuclear Physics and Reactor Theory*

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

FACILITY:	Reed Reactor Facility
REACTOR TYPE:	TRIGA
DATE ADMINISTERED:	12/12/2008
CANDIDATE:	______________________

<u>INSTRUCTIONS TO CANDIDATE:</u>
Answers are to be written on the answer sheet provided. Points for each question are indicated in brackets for each question. A 70% is required to pass the examination. The Examination will be picked up one (1) hour after the examination starts.

Category Value	% of Total	Candidate's Score	Candidates Grade (%)	Category
17	100.0	_______	_______%	℞ Theory, Thermodynamics and Facility Operating Characteristics
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 only to facilitate legible reproductions.

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

6. Mark your answers on the answer sheet provided. USE ONLY THE PAPER PROVIDED AND DO NOT WRITE ON THE BACK SIDE OF THE PAGE.

7. The point value for each question is indicated in [brackets] after the question.

8. If the intent of a question is unclear, ask questions of the examiner only.

9. When turning in your examination, assemble the completed examination with examination questions, examination aids and answer sheets. In addition turn in all scrap paper.

10. Ensure all information you wish to have evaluated as part of your answer is on your answer sheet. Scrap paper will be disposed of immediately following the examination.

11. To pass the examination you must achieve a grade of 70 percent or greater in each category.

12. There is a time limit of three (3) hours for completion of the examination.

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

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

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

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

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

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

$$\ell^* = 1\times10^{-4}\ \sec$$

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

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

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

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

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

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

$$M = \frac{1 - K_{eff_1}}{1 - K_{eff\,2}}$$

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

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

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

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

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

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

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

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

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

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

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

$${}^{135}_{52}Te \xrightarrow{(19\sec)} {}^{135}_{53}I \xrightarrow{(6.6\,hr)} {}^{135}_{54}Xe \xrightarrow{(9.1\,hr)} {}^{135}_{55}Cs \xrightarrow{(2.3\times10^6\ yr)} {}^{135}_{56}Ba$$

---

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.01a	1 2 3 4	___	A.08	a b c d	___
A.01b	1 2 3 4	___	A.09	a b c d	___
A.01c	1 2 3 4	___	A.10	a b c d	___
A.01d	1 2 3 4	___	A.11	a b c d	___
A.02	a b c d	___	A.12	a b c d	___
A.03	a b c d	___	A.13	a b c d	___
A.04	a b c d	___	A.14	a b c d	___
A.05	a b c d	___	A.15	a b c d	___
A.06	a b c d	___	A.16	a b c d	___
A.07	a b c d	___			