March 1, 2005

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

SUBJECT: RETAKE EXAMINATION REPORT NO. 50-288/OL-05-01, REED COLLEGE

Dear Mr. Frantz:

During the week of February 7, 2005, you administered an operator licensing examination at your Reed College Reactor. The examination was conducted according to NUREG-1478, "Non-Power Reactor Operator Licensing Examiner Standards," Revision 1.

In accordance with 10 CFR 2.390 of the Commission's 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 document system (ADAMS). ADAMS is accessible from the NRC Web site at (the Public Electronic Reading Room) http://www.nrc.gov/NRC/ADAMS/indesx.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 Paul V. Doyle, Jr. at 301-415-1058 or via internet E-mail at pvd@nrc.gov.

Sincerely,

/RA/

Patrick M. Madden, Section Chief
Research and Test Reactors Section
New, Research and Test Reactors Program
Division of Regulatory Improvement Programs
Office of Nuclear Reactor Regulation

Docket No. 50-288

Enclosures:
1. Initial Examination Report No. 50-288/OL-05-01
2. Examination and answer key

cc w/encls: Please see next page

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Facility File (EBarnhill) O-6 F-2	DHughes	

EXAMINATION PACKAGE ACCESSION NO.: ML050100331
EXAMINATION REPORT ACCESSION #: ML050550257 **TEMPLATE #: NRR-074**

OFFICE	RNRP:CE		IROB:LA	E	RNRP:SC	
NAME	PDoyle		EBarnhill		PMadden	
DATE	2/ 25 /2005		2/ 28 /2005		2/ 28 /2005	

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cc:

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Salem, OR 97310

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.: 50-288/OL-05-01

FACILITY DOCKET NO.: 50-288

FACILITY LICENSE NO.: R-112

FACILITY: Reed College

EXAMINATION DATES: February 11, 2005

SUBMITTED BY: **/RA/** 2/28/05
Paul V. Doyle Jr., Chief Examiner Date

SUMMARY:

The NRC mailed a Section A only operator licensing written examination to the facility for administration to a Reactor Operator candidate who had failed section a of the examination administered May, 2004. The facility administered the examination on February 11, 2005. The candidate passed the examination.

REPORT DETAILS

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

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:

   There was no exit meeting. The facility mailed the written examination to the NRC where it was graded. The facility had no comments on the examination.

ENCLOSURE 1

U.S. Nuclear Regulatory Commission
OPERATOR LICENSING EXAMINATION
With Answer Key

UNITED STATES NUCLEAR REGULATORY COMMISSION

REED REACTOR FACILITY
Week of February 7, 2005

ENCLOSURE 2

QUESTION A.01 [2.0 points, ½ each]
The listed isotopes are all potential daughter products due to the radioactive decay of $_{35}Br^{87}$. Identify the type of decay necessary (Alpha, Beta, Gamma or Neutron emission) to produce each of the isotopes.

a. $_{33}As^{83}$

b. $_{35}Br^{86}$

c. $_{35}Br^{87}$

d. $_{36}Kr^{87}$

QUESTION A.02 [1.0 point]
What is the definition of reactivity? A measure of the …

a. number of neutrons being produced in the core.

b. number of neutrons being absorbed by the fuel.

c. reactor's multiplication factor.

d. reactor's departure from critical.

QUESTION A.03 [2.0 points, ½ each]
Using the drawing of the Integral Rod Worth Curve provided, identify each of the following reactivity worths.

a. Total Rod Worth

b. Actual Shutdown Margin

c. Technical Specification Shutdown Margin Limit

d. Excess Reactivity

1. B - A
2. C - A
3. C - B
4. D - C
5. E - C
6. E - D
7. E - A

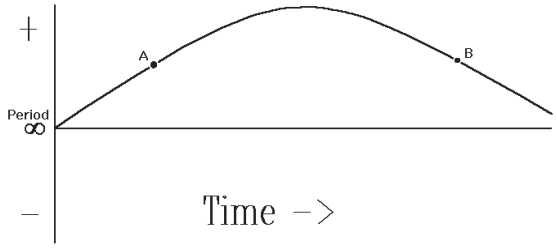
QUESTION A.04 [1.0 point]
Shown below is a trace of reactor period as a function of time. Between points A and B reactor power is:

a. continually increasing.

b. continually decreasing.

c. increasing, then decreasing.

d. constant.



QUESTION A.05 [1.0 point]
What is the kinetic energy range of a thermal neutron?

a. > 1 MeV

b. 100 KeV – 1 MeV

c. 1 eV – 100 KeV

d. < 1 eV

QUESTION A.06 [1.0 point]
Which ONE of the following is the difference between prompt and delayed neutrons? Prompt neutrons …

a. account for less than 1% of the neutron population, while delayed neutrons account for the rest.

b. are released during fast-fission events, while delayed neutrons are released during the decay process.

c. are released during the fission process (fast & thermal), while delayed neutrons are release during the decay process.

d. are the dominating factor in determining reactor period, while delayed neutrons have little effect on reactor period.

QUESTION A.07 [1.0 point]
Suppose the temperature coefficient of a core is -2.5×10^{-4} ΔK/K/EC and the average control rod worth of the regulating control rod is 5.895×10^{-3} ΔK/K/inch. If the temperature ***INCREASES*** by 50EC what will the automatic control command the regulating rod to do? Select the answer that is closest to the calculated value.

a. 5.6 inches in

b. 2.1 inches out

c. 0.5 inches in

d. 4.3 inches out

QUESTION A.08 [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 A.09 [1.0 point]
During a fuel loading of the core, as the reactor approaches criticality, the value of 1/M:

a. Increases toward one

b. Decreases toward one

c. Increases toward infinity

d. Decreases toward zero

QUESTION A.10 [1.0 point]
Which ONE of the following is the major source of energy released during fission?

a. Prompt gamma ray absorption

b. Slowing down of fission fragments

c. Neutrino interactions

d. fission neutron scattering reactions

QUESTION A.11 [1.0 point]
Which one of the following is the definition of the ***FAST FISSION FACTOR***?

a. The ratio of the number of neutrons produced by fast fission to the number produced by thermal fission

b. The ratio of the number of neutrons produced by thermal fission to the number produced by fast fission

c. The ratio of the number of neutrons produced by fast and thermal fission to the number produced by thermal fission

d. The ratio of the number of neutrons produced by fast fission to the number produced by fast and thermal fission

QUESTION A.12 [1.0 point]
In a reactor at full power, the thermal neutron flux (φ) is 2.5 x 10^{12} neutrons/cm^2/sec. and the macroscopic fission cross-section G_f is 0.1 cm^{-1}. The fission reaction rate is:

a. 2.5 x 10^{11} fissions/sec.

b. 2.5 x 10^{13} fissions/sec.

c. 2.5 x 10^{11} fissions/cm^3/sec.

d. 2.5 x 10^{13} fissions/cm^3/sec.

QUESTION A.13 [1.0 point]
The number of neutrons passing through a one square centimeter of target material per second is the definition of which one of the following?

a. Neutron Population (np)

b. Neutron Impact Potential (nip)

c. Neutron Flux (nv)

d. Neutron Density (nd)

QUESTION A.14 [1.0 point]
Which ONE of the following explains the response of a ***SUBCRITICAL*** reactor to equal insertions of positive reactivity as the reactor approaches criticality? Each insertion causes a …

a. ***SMALLER*** increase in the neutron flux resulting in a ***LONGER*** time to stabilize.

b. ***LARGER*** increase in the neutron flux resulting in a ***LONGER*** time to stabilize.

c. ***SMALLER*** increase in the neutron flux resulting in a ***SHORTER*** time to stabilize.

d. ***LARGER*** increase in the neutron flux resulting in a ***SHORTER*** time to stabilize.

QUESTION A.15 [1.0 point]
Which ONE of the following atoms will cause a neutron to lose the most energy in an elastic collision?

a. Uranium^{238}

b. Carbon^{12}

c. Hydrogen^{2}

d. Hydrogen^{1}

QUESTION A.16 [1.0 point]
A thin foil target of 10% copper and 90% aluminum is in a thermal neutron beam. Given $\sigma_{a\ Cu}$ = 3.79 barns, $\sigma_{a\ Al}$ = 0.23 barns, $\sigma_{s\ Cu}$ = 7.90 barns, and $\sigma_{s\ Al}$ =1.49 barns, which ONE of the following reactions has the highest probability of occurring? A neutron …

a. scattering reaction with aluminum

b. scattering reaction with copper

c. absorption in aluminum

d. absorption in copper

QUESTION A.17 [1.0 point]
When performing rod calibrations, many facilities pull the rod out a given increment, then measure the time for reactor power to double (doubling time), then calculate the reactor period. If the doubling time is 42 seconds, what is the reactor period?

a. 29 sec

b. 42 sec

c. 61 sec

d. 84 sec

QUESTION A.18 [1.0 point]
Which ONE of the following statements concerning reactor poisons is NOT true?

a. Following shutdown, Samarium concentration will increase to some value then stabilize.

b. Following shutdown, Xenon concentration will initially increase to some value then decrease exponentially

c. During reactor operation, Samarium concentration is independent of reactor power level.

d. During reactor operation, Xenon concentration is dependent on reactor power level.

A.01 a, alpha; b, neutron; c, gamma; d, Beta
Ref: Training Manual, Reed Reactor Facility § 2.4

A.02 d
REF: Training Manual, Reed Reactor Facility § 9.2

A.03 a, 7; b, 5; c, 6; d, 2
REF: Training Manual, Reed Reactor Facility § 10.2

A.04 a
REF: Standard NRC question

A.05 d
REF: Training Manual, Reed Reactor Facility § 7.3

A.06 c
REF: Training Manual, Reed Reactor Facility § 10.4

A.07 B
REF: Training Manual, Reed Reactor Facility § 10.6
The temperature increase will result in reactivity change of: -2.5×10^{-4} ΔK/K/EC × 50EC = -1.25×10^{-2} ΔK/K. Since the temperature rise is a negative reactivity insertion, the control rod must drive out to add positive reactivity. D = (1.25×10^{-2} ΔK/K) ÷ (5.895×10^{-3} ΔK/K/in.) = 2.12 in.

A.08 b
REF: Training Manual, Reed Reactor Facility § 2.6

A.09 d
REF: Training Manual, Reed Reactor Facility § 8.4

A.10 b
REF: Training Manual, Reed Reactor Facility § 7.1

A.11 c
REF: Training Manual, Reed Reactor Facility § 8.2

A.12 c
REF: $R = \varphi G_f = (2.5 \times 10^{12}) \times 0.1 = 2.5 \times 10^{11}$ NRC Question Bank

A.13 c
REF: Training Manual, Reed Reactor Facility § 6.3

A.14 b
REF: Training Manual, Reed Reactor Facility § 8.4

A.15 d
REF: Training Manual, Reed Reactor Facility § 3.3

A.16 a
REF: Training Manual, Reed Reactor Facility § 6.2

A.17 c
REF: Training Manual, Reed Reactor Facility § 9.4
ln (2) = -time/τ τ = time/(ln(2)) = 60.59 . 61 seconds

A.18 c
REF: Training Manual, Reed Reactor Facility § 10.4

U. S. NUCLEAR REGULATORY COMMISSION
RESEARCH AND TEST REACTOR OPERATOR LICENSING EXAMINATION

FACILITY: Reed College

REACTOR TYPE: TRIGA

DATE ADMINISTERED: 2005/01/____

CANDIDATE: _____

INSTRUCTIONS TO CANDIDATE:
Answers are to be written on the answer sheets provided. Points for each question are indicated in brackets for each question. You must score 70% to pass. Examinations will be picked up one (1) hour after the examination starts.

Category Value	% of Total	% of Candidates Score	Category Value	Category
20.00	100.0	_____	____	A. Reactor Theory, Thermodynamics and Facility Operating Characteristics
20.00		_____	____% 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 proctor 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.

12. There is a time limit of one (1) hour 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

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

$$P_{max} = \frac{(\rho - \beta)^2}{2\rho(1-\beta)}$$

$$k = 3\times10^{-4}\ \text{seconds}$$

$$\Lambda_{eff} = 0.1\ \text{seconds}$$

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

$$CR_1(1-K_{eff1}) = CR_2(1-K_{eff2})$$

$$SUR = 26.06\left[\frac{\Lambda_{eff}}{\beta_{eff}-\rho}\right] = \frac{26.06}{T}$$

$$M = \frac{1-K_{eff0}}{1-K_{eff1}}$$

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

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

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

$$P = \frac{\Lambda(\rho-\beta)}{\beta-\rho}R_0$$

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

$$T = \frac{\Lambda(\rho-\beta)}{\rho\beta}$$

$$T = \frac{\Lambda(\rho-\beta)}{\rho}\left[\frac{\beta-\rho}{\Lambda_{eff}}\right]$$

$$\Delta\rho = \frac{K_{eff2}-K_{eff1}}{K_{eff1}K_{eff2}}$$

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

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

$$DR = DR_0 e^{-\mu x}$$

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

$$DR_1 R_1^2 = DR_2 R_2^2$$

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

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

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 = 3.413 x 10^6 BTU/hr

1 BTU = 778 ft-lbf

EF = 9/5 EC + 32

1 gal (H_2O) . 8.272 lbm

EC = 5/9 (EF - 32)

c_P = 0.998 BTU/hr/lbm/EF

c_p = 0.998 cal/sec/gm/EC

α_T = -3.9 pcm/EF

Pool Volume = 15650 gallons

A.1a alpha beta gamma neutron ____

A.1b alpha beta gamma neutron ____

A.1c alpha beta gamma neutron ____

A.1d alpha beta gamma neutron ____

A.2 a b c d ___

A.3a 1 2 3 4 5 6 7 ____

A.3b 1 2 3 4 5 6 7 ____

A.3c 1 2 3 4 5 6 7 ____

A.3d 1 2 3 4 5 6 7 ____

A.4 a b c d ___

A.5 a b c d ___

A.6 a b c d ___

A.7 a b c d ___

A.8 a b c d ___

A.9 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 ___

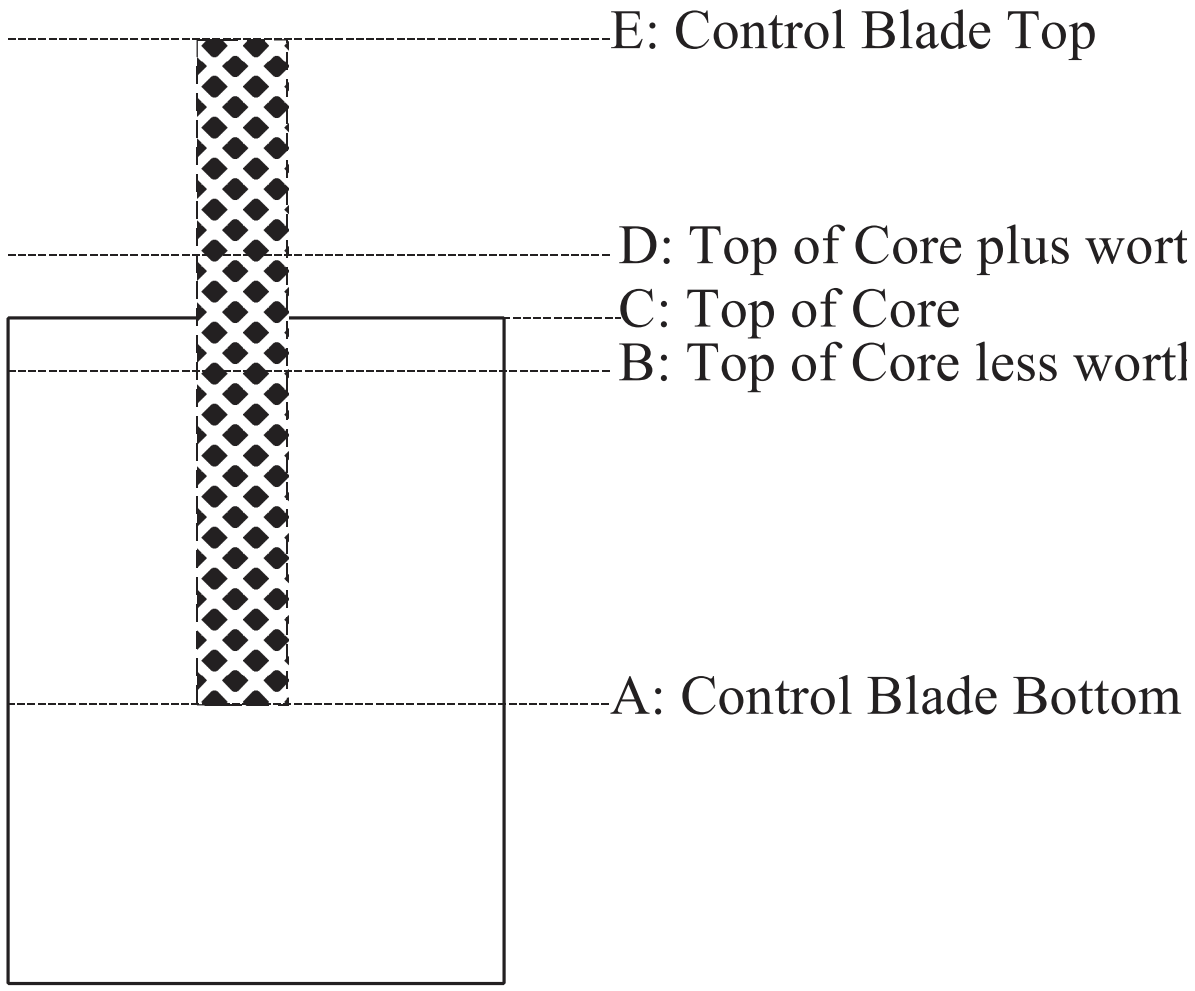
A.14 a b c d ___

A.15 a b c d ___

A.16 a b c d ___

A.17 a b c d ___

A.18 a b c d ___



Reactor at Cold, Clean Critical.