June 3, 2008

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

SUBJECT: INITIAL EXAMINATION REPORT NO. 50-288/OL-08-01, REED COLLEGE TRIGA REACTOR

Dear Mr. Frantz:

During the weeks of May 5 and May 12, 2008, the NRC administered operator licensing examinations at your Reed College 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 Theodore Quay for/

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

Docket No. 50-288

Enclosures: 1. Initial Examination Report No. 50-288/OL-08-01
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 (CHart) O-13 D-07

ADAMS ACCESSION #: ML081490500 **TEMPLATE #:NRR-074**

OFFICE	PRTB:CE		IOLB:LA	E	PRTB:SC	
NAME	PDoyle ovd		CHart cah		TQ for JEads	
DATE	5/28/08		5/31/08		6/3/08	

OFFICIAL RECORD COPY

cc:

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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-08-01

FACILITY DOCKET NO.: 50-288

FACILITY LICENSE NO.:

FACILITY: Reed Research Reactor Facility

EXAMINATION DATES: May 5 – 13, 2008

SUBMITTED BY: /RA/ May27, 2008
Paul V. Doyle Jr., Chief Examiner Date

SUMMARY:

During the weeks of May 5 and May 12, 2008, the NRC administered operator licensing examinations to 15 initial Reactor Operator (RO) license candidates and 5 Senior Reactor Operator Upgrade (SROU) candidates. One initial RO candidate failed one section of the written examination. All other candidates passed all portions of their respective examinations.

REPORT DETAILS

1. Examiners: Paul V. Doyle Jr., Chief Examiner, NRC
Patrick J. Isaac, Examiner, NRC
Gregory M. Schoenebeck, Observer, NRC

2. Results:

	RO PASS/FAIL	SRO PASS/FAIL	TOTAL PASS/FAIL
Written	14/1	0/0	14/1
Operating Tests	15/0	5/0	20/0
Overall	14/1	5/0	19/1

3. Exit Meeting:
Paul V. Doyle Jr., NRC, Examiner
Stephen G. Frantz, Reed College, Director, Reed Research Reactor Facility (RRRF)
Vanessa Holfeltz, Reed College, Associate Director RRRF

The chief examiner thanked the facility management for their support in administering the examinations. The examiner noted that there were no indications of generic weaknesses, and that the candidates were in general well prepared. The examination contained a typo which has been corrected in the examination included with this report.

OPERATOR LICENSING EXAMINATION

With Answer Key

UNITED STATES NUCLEAR REGULATORY COMMISSION

REED COLLEGE

May 05, 2008

ENCLOSURE 2

QUESTION A.01 [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	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

QUESTION A.02 [1.0 point]

Reactor power is rising on a 100 second period. Approximately how long will it take for power to double?

a. 35 seconds

b. 50 seconds

c. 70 seconds

d. 100 seconds

QUESTION A.03 [2 points, ½ each]

Match the description of plant conditions in column A with resulting xenon conditions in column B.

Column A	Column B
a. 4 hours after a power increase (i.e. 40% to 80%)	1. Xenon concentration is increasing to a peak
b. 2 hours after a power decrease (i.e. 80% to 40%)	2. Xenon concentration is decreasing to a trough
c. 16 hours after a “clean” startup	3. Xenon concentration is approximately zero (reactor is “clean”)
d. 72 hours after a shutdown	4. Xenon concentration is “relatively” steady at a “non-zero” value

QUESTION A.04 [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.05 [1.0 point]
The neutron microscopic cross-section for absorption (σ_a) of an isotope 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.06 [2.0 points ½ 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.

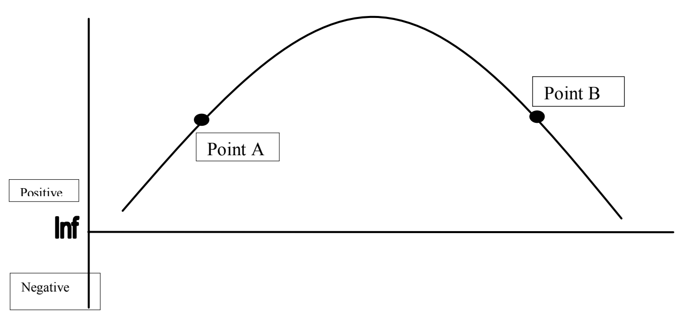
QUESTION A.07 [1.0 point]
Shown below is a trace of reactor period as a function of time. Between points A and B reactor power is:

a. continually increasing.

b. continually decreasing.

c. increasing, then decreasing.

d. constant.



QUESTION A.08 [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.09 [1.0 point]

Which ONE of the reactions below is an example of a **PHOTONEUTRON** source?

a. $_1H^2 + _0\gamma^0$ □ $_1H^1 + _0n^1$

b. $_{92}U^{238}$ □ $_{35}Br^{87} + _{57}La^{148} + 3_0n^1 + _0\gamma^0$

c. $_{51}Sb^{123} + _0n^1$ □ $_1H^1 + _0\gamma^0$

d. $_4Be^9 + _2\alpha^4$ □ $_6C^{12} + _0n^1$

QUESTION A.10 [1.0 point]

ELASTIC SCATTERING is the process by which a neutron collides with a nucleus and the nucleus and any emitted particle …

a. recoil with the same kinetic energy as went into the collision

b. recoil with less kinetic energy than was present prior to the collision with the nucleus emitting a gamma ray.

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

d. recoil with a higher kinetic energy than was present prior to the collision with the nucleus emitting a gamma ray.

QUESTION A.11 [1.0 point]

Which ONE of the following is the major source of energy released during fission?

a. Absorption of prompt gamma rays

b. Slowing down of fission fragments

c. Neutrino interactions

d. Fission neutron scattering

QUESTION A.12 [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 B.01 [2.0 points, ½ each]
Match the type of radiation in column A with its associated Quality Factor (10CFR20) from column B.

	Column A	Column B
a.	alpha	1
b.	beta	2
c.	gamma	5
d.	neutron (unknown energy)	10
		20

QUESTION B.02 [2.0 points, ½ each]
Match the terms in column A with their respective definitions in column B.

a.	Radioactivity	1.	The thickness of a material which will reduce a gamma flux by a factor of two.
b.	Contamination	2.	An impurity which pollutes or adulterates another substance. In radiological safety, contamination refers to the radioactive materials which are the sources of ionizing radiations.
c.	Dose	3.	The quantity of radiation absorbed per unit mass by the body or by any portion of the body.
d.	Half-thickness	4.	That property of a substance which causes it to emit ionizing radiation. This property is the spontaneous transmutation of the atoms of the substance.

QUESTION B.03 [1.0 point]
Many research reactors use different methods to reduce the dose due to N^{16} at the pool top. If the method used keeps the N^{16} ten (10) feet below the surface of the water, and a half-thickness for the N^{16} gamma(s) is one foot for water, then the dose due to N^{16} is reduced (approximately) by a factor of … (Note: Neglect any reduction in dose rate due to half-life.)

a. 20

b. 100

c. 200

d. 1000

QUESTION B.04 [2.0 points, ½ each]
Match type of radiation (a thru d) with the proper penetrating power (1 thru 4). Use each item only once.

a. Gamma	1. Stopped by thin sheet of paper
b. Beta	2. Stopped by thin sheet of metal
c. Alpha	3. Best shielded by 'hydrogenous' material
d. Neutron	4. Best shielded by dense material

QUESTION B.05 [1.0 point]
Based on the Requalification Plan for licensed personnel, each licensed operator must complete a minimum of ______ reactivity manipulations during each 2 year cycle.

a. 4

b. 10

c. 20

d. 28

QUESTION B.06 [1.0 point, a each]
Identify the PRIMARY source (irradiation of air, irradiation of water, or fission product) of EACH of the radioisotopes listed.

a. ${}_{18}Ar^{41}$

b. ${}_{7}N^{16}$

c. ${}_{54}Xe^{135}$

QUESTION B.07 [1.0 point]
Two senior reactor operators are operating the reactor at night. One receives a phone call for an emergency at home. What addition actions must be taken to continue to operate the reactor?

a. none, the single SRO may operate the reactor alone.

b. a second person must be called in to accompany the SRO.

c. a second person licensed as a reactor operator must be called in to operate the reactor.

d. a second person licensed as a licensed senior operator must be called in to either operate or supervise the operation of the reactor.

QUESTION B.08 [1.0 point]
The **CURIE** content of a radioactive source is a measure of

a. the number of radioactive atoms in the source.

b. the amount of energy emitted per unit time by the source

c. the amount of damage to soft body tissue per unit time.

d. the number of nuclear disintegrations per unit time.

QUESTION B.09 [1.0 point]
According to the Emergency Plan, the Emergency Planning Zone (EPZ) is

a. Reactor Bay.

b. Reactor Bay and Control Room

c. Site Boundary (250 foot radius from center of core)

d. Director's Office (Room 102 of Chemistry Building)

QUESTION B.10 [1.0 point]
10CFR50.54(x) states: *"A licensee may take reasonable action that departs from a license condition or a technical specification (contained in a license issued under this part) in an emergency when this action is immediately needed to protect the public health and safety and no action consistent with license conditions and technical specifications that can provide adequate or equivalent protection is immediately apparent."* 10CFR50.54(y) states that the minimum level of management which may authorize this action is …

a. any Reactor Operator licensed at facility

b. any Senior Reactor Operator licensed at facility

c. Facility Manager (or equivalent at facility).

d. NRC Project Manager

QUESTION B.11 [1.0 point]
Which ONE of the following experiments requires the operator to stop at 5 watts power to determine reactivity worth of the sample?

a. A core experiment containing fissionable material

b. A pneumatic tube experiment containing naturally occurring fissionable material, which produces < 2^{10} fissions.

c. A core experiment containing explosive material.

d. A pneumatic tube experiment containing explosive material.

QUESTION B.12 [1.0 point]
You initially remove a sample from the pool reading 1 R/hr at 30 cm from the source. You then replace the sample in the pool. An hour later you remove the sample and the reading is now 390 mR/hr at 30 cm. You again replace the sample back in the pool. How much longer should you wait to be able to bring out the sample without generating a high radiation area?

a. ½ hour

b. 1 hour

c. 1½ hours

d. 2 hours

QUESTION C.01 [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.02 [1.0 point, 1/6 each]
Using the simplified drawing of the ventilation system, identify the conditions of the following on a

a. Fan “A”	1. “ON”
b. Fan “B”	2. “OFF”
c. Damper 10	3. “OPEN”
d. Damper 13	4. “CLOSED”
e. Damper 14	5. “Modulate to supply sufficient air to fan”
f. Damper 15	

QUESTION C.03 [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.04 [1.0 point]
Which ONE of the following is the main function performed by the **DISCRIMINATOR** circuit in the Startup Channel?

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

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

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

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

QUESTION C.05 [2.0 points, ½ each]
Given the configuration of the lights associated with the safety rod listed in column A below, identify the condition of the safety rod and its motor during a scram.

	COLUMN A				COLUMN B
	RED (UP)	WHITE (DOWN)	BLUE (CONT)		
a.	ON	OFF	ON	1.	Motor starts down
b.	ON	OFF	OFF	2.	Motor at bottom
c.	OFF	OFF	OFF	3.	Rod is dropping
d.	OFF	ON	ON	4.	Rod hits bottom

QUESTION C.06 [1.0 point]
Which ONE of the following is correct with regard to operation of the pool skimmer system?

a. Too high a level may cause the primary pump to loose suction.

b. Too high a level may cause too high a pressure thereby damaging the purification filters.

c. Too low a level may cause the introduction of air causing damage to the purification system demineralizers.

d. Too low a level may cause the introduction of air causing damage to the primary system heat exchanger.

QUESTION C.07 [2.0 points, ½ each]
Match each radiation detection system listed in column A with the type of radiation it detects in column B. Items in column B may be used once, more than once or not at all.

	Column A		Column B
a.	RAM	1.	Particulates and Gasses
b.	CAM	2.	Particulates Only
c.	APM	3.	Gasses Only
d.	GSM	4.	Dose Rate

QUESTION C.08 [2.0 points, ½ each]
Match the each of area listed in column A with the correct heat transport mechanism listed in column B. Items in column B may be used once, more than once or not at all.

	Column A		Column B
a.	Within the fuel	1.	Natural convection
b.	Within the clad	2.	Forced Convection
c.	From the clad to the pool	3.	Conduction
d.	From the pool to the heat exchanger	4.	Radiation

QUESTION C.09 [1.0 point]
Four gases used to power pneumatic systems at research reactors are listed below along with the major drawback for each. Which ONE is the gas used at your facility?

a. Air, formation of Ar^{41}.

b. Helium, expense.

c. CO_2, formation of carbonic acid (H_2CO_3).

d. N_2, formation of ammonia (NHO_3).

QUESTION C.10 [1.0 point]
Which ONE of the following methods is actually used to minimize the shock to the control rods on during a reactor scram?

a. A small spring on the pull rod.

b. A piston (part of the connecting rod), drives water out of a dashpot as the rod nears the bottom of its travel.

c. An electro-mechanical brake on the motor energizes as the rod down switch is energized.

d. A small spring on the bottom of the control rod.

QUESTION C.11 [1.0 point]
Which ONE of the following additives is added to the secondary cooling loop every week?

a. Algaecide, to suppress biological growth in the cooling tower.

b. Chromates, to minimize corrosion of the cast iron pipes.

c. Ethylene-Glycol (anti-freeze) to prevent the coolant from freezing in cold temperatures.

d. Sodium Chloride to increase the thermal conductivity of the water.

A.01 a, 7; b, 2; c, 6; d, 5
REF: Standard NRC Question

A.02 c
REF: $P = P_0 e^{t/T}$ —> ln(2) = time ÷ 100 seconds –> time = ln (2) x 100 sec. 0.693 x 100 ≈ 0.7 x 100 ≈ 70 sec.

A.03 a, 2; b, 1; c, 4; d, 3
REF: DOE Fundamentals Handbook, Nuclear Physics and Reactor Theory, Volume

A.04 c
REF: DOE Fundamentals Handbook, Nuclear Physics and Reactor Theory, Volume

A.05 b
REF: DOE Fundamentals Handbook, Nuclear Physics and Reactor Theory, Volume

A.06 a, 2; b, 4; c, 1; d, 3
REF: Burn, R., Introduction to Nuclear Reactor Operations, 8 1988, " 3.2.2, p. 3 7

REF: DOE Fundamentals Handbook, Nuclear Physics and Reactor Theory, Volume

A.09 a
REF: DOE Fundamentals Handbook, Nuclear Physics and Reactor Theory, Volume

A.10 a
REF: DOE Fundamentals Handbook, Nuclear Physics and Reactor Theory, Volume

A.11 a
REF: Standard NRC Question[1]

A.11 b
REF: DOE Fundamentals Handbook, Nuclear Physics and Reactor Theory, Volume

A.12 c
REF: DOE Fundamentals Handbook, Nuclear Physics and Reactor Theory, Volume

B.01 a, 20; b, 1; c, 1; d, 10
REF: 10CFR20.100x

B.02 a, 4; b, 2; c, 3; d, 1
REF: Standard NRC question

B.03 d
REF: Basic Radiological Controls knowledge: “Half-Thickness and Tenth-Thickness". $2^{10} = 1024$

B.04 a, 4; b, 2; c, 1; d, 3
REF: Standard NRC Health Physics Question

B.05 c
REF: Requalification Plan – § 4.2

B.06 a, Water; b, Air; c, Water; d, Fission
REF: Standard NRC question.

B.07 b
REF: Administrative Procedures § 3.1

B.08 d
REF: Standard Health Physics Definition.

B.09 c
REF: Emergency Plan § 2 (Definition for Site Boundary) & § 6 *Emergency Planning Zone*.

B.10 b
REF: 10CFR50.54(y)

B.11 a
REF: Administrative Procedures § 3.3, & Technical Specification § J.6

B.12 c
REF: $I_t = I_0 e^{-\lambda t}$ 390 mR/hr ÷ 1000 mR/hr = $e^{-\lambda 1hr}$ ln(0.39) = -λ * 1 hr. λ = 0.9416 $hour^{-1}$
SOLVING for additional time: If = $I_t e^{-\lambda t}$ 100mR/hr = 390 mR/hr $e^{-0.9416\,(time)}$ ln (0.25) = -0.9163 * time
time = 1.4454

C.01 a, 2; b, 3; c, 1; d, 4
Ref: Standard NRC cleanup loop question.

C.02 a, 2; b, 1; c, 4; d, 4; e, 3; f, 5
REF: Training Manual

C.03 b
REF: Standard NRC question

C.04 b
REF: Standard NRC Question

C.05 a. 3; b. 4; c. 1; d. 2
REF: Reed Training Manual 2007. Table 11.1, pg. 225

C.06 c
REF: Rewrite of facility supplied question C.04. Also Mechanical Manual 5.11.3.

C.07 a, 4; b, 2; c, 2; d, 3
REF: Rewrite of previously administered NRC question.

C.08 a, 3; b, 3; c, 1; d, 2
REF: Rewrite of facility supplied question C.53.

C.09 a
REF: Rewrite of facility supplied question C.59

C.10 b
REF: Rewrite of facility supplied question C.52.

C.11 a
REF: Rewrite of facility supplied question C.60.