December 2, 2010

Dr. Mohamad Al-Sheikly, Director
Department of Materials and Nuclear Engineering
The University of Maryland
College Park, MD 20742

SUBJECT: RETAKE EXAMINATION REPORT NO. 50-166/OL-11-01, UNIVERSITY OF MARYLAND RESEARCH REACTOR

Dear Dr. Mohamad Al-Shiekly:

On October 14, 2010, the U.S. Nuclear Regulatory Commission (NRC) administered operator licensing examinations at your Maryland University Training Reactor (MUTR). 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/

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

Docket No. 50-166

Enclosures:
1. Examination Report No. 50-166/OL-11-01
2. Written Examination

cc w/enclosures: Vince Adams, Facility Coordinator, MUTR
cc w/o enclosures: See next page

December 2, 1010

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Department of Materials and Nuclear Engineering
The University of Maryland
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DISTRIBUTION w/ encls.:
PUBLIC PROB r/f JEads Facility File (CRevelle)
ADAMS ACCESSION #: ML103270016

OFFICE	**PROB:CE**		**IOLB:LA**		**PROB:BC**	
NAME	**PIsaac**		**CRevelle**		**JEads**	
DATE	**11/23/2010**		**11/23/2010**		**12/02/2010**	

OFFICIAL RECORD COPY

cc:

Director, Dept. of Natural Resources
Power Plant Siting Program
Energy & Coastal Zone Administration
Tawes State Office Building
Annapolis, MD 21401

Mr. Roland Fletcher, Director
Center for Radiological Health
Maryland Department of Environment
201 West Preston Street
7th Floor Mail Room
Baltimore, MD 21201

Maureen M. Kotlas, Director
Department of Environmental Safety
3115 Chesapeake Building 338
University of Maryland
College Park, MD 20742

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

EXAMINATION REPORT NO: 50-166/OL-11-01

FACILITY: Maryland University Training Reactor

FACILITY DOCKET NO.: 50-166

FACILITY LICENSE NO.: R-70

SUBMITTED BY: _____**/RA/**_____ 12/01/2010
Patrick J. Isaac, Chief Examiner Date

SUMMARY:

On October 14, 2010, the NRC administered a retake of Section A, Reactor Theory, Thermodynamics and Facility Operating Characteristics, of the operator licensing written examination to two Reactor Operator (RO) candidates. The candidates passed the examination.

REPORT DETAILS

1. Examiner: Patrick J. Isaac, Chief Examiner

2. Results:

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

3. Exit Meeting:

Vince Adams, Facility Coordinator, MUTR
Patrick Isaac, NRC, Examiner

The NRC Examiner thanked Mr. Adams for his support in the administration of the examination.

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

FACILITY: University of Maryland

REACTOR TYPE: TRIGA

DATE ADMINISTERED: 10/14/2010

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

Category Value	% of Total	Candidate's Score	% of Category Value	Category
16.00	100	_____	_____	A. Reactor Theory, Thermodynamics and Facility Operating Characteristics
Final Grade		_____	_____ % Totals	

ALL THE WORK DONE ON THIS EXAMINATIN IS MY OWN. I HAVE NEITHER GIVEN NOR RECEIVED AID.

CANDIDATE'S SIGNATURE _____

ENCLOSURE 2

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 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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

$$T_{‰} = \frac{0.693}{\lambda}$$

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

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

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

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

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 Horsepower = 2.54 x 10^3 BTU/hr

1 BTU = 778 ft-lbf

1 gal (H_2O) ≈ 8 lbm

c_P = 1.0 BTU/hr/lbm/°F

1 kg = 2.21 lbm

1 Mw = 3.41 x 10^6 BTU/hr

°F = 9/5 °C + 32

°C = 5/9 (°F - 32)

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 ___

CANDIDATE'S SIGNATURE_____

QUESTION A.01 [1.0 point]
During a reactor startup, criticality occurred at a **LOWER ROD HEIGHT** than the last startup. Which ONE of the following reasons could be the cause?

a. Xe^{135} increased.

b. Fuel temperature increased.

c. Pool temperature increased.

d. Removing an experiment with negative reactivity from the core.

QUESTION A.02 [1.0 point]
Which ONE of the following is the major source of energy (heat) generated after SHUTDOWN?

a. Prompt gamma ray.

b. Fission product decay.

c. Kinetic energy of the fission neutrons.

d. Kinetic energy of the fission fragments.

QUESTION A.03 [1 point]
Which ONE of the following best describes the beta decay (β_{-1}) of a nuclide?

a. The atomic mass number unchanged, and the number of protons increases by 1

b. The atomic mass number unchanged, and the number of protons decreases by 1

c. The atomic mass number increases by 1, and the number of protons decrease by 1.

d. The atomic mass number increases by 2, and the number of protons increase by 1.

QUESTION A.04 [1.0 point]
Which ONE of the following is the stable reactor period which will result in a power rise from 1% to 100% power in 60 seconds?

a. 6 seconds.

b. 13 seconds.

c. 28 seconds.

d. 80 seconds.

QUESTION A.05 [1.0 point]
Delayed neutrons are produced by:

a. decay of O-16.

b. Photoelectric Effect.

c. decay of fission fragments.

d. directly from the fission process.

QUESTION A.06 [1.0 point]
The FAST FISSION FACTOR is defined as a ratio of:

a. the number of fast neutrons produced by all fission events over the number of fast neutrons produced by thermal fission.

b. the number of fast neutrons produced by fission in a generation over the number of total neutrons produced by fission in the previous generation.

c. the number of fast neutrons produced by U-238 over the number of thermal neutrons absorbed in fuel.

d. the number of neutrons that reach thermal energy over the number of fast neutrons that start to slow down.

QUESTION A.07 [1.0 point]
Which ONE of the following is the time period in which the MAXIMUM amount of Xe-135 will be present in the core?

a. 7 to 11 hours after a power increase from 0% to 50%.

b. 7 to 11 hours after a power increase from 50% to 100%.

c. 7 to 11 hours after a start up to 100%power.

d. 7 to 11 hours after a scram from 100% power.

QUESTION A.08 [1.0 point]
The reactor is SHUTDOWN by 5% Δk/k with the count rate of 100 counts per second (cps). The Shim rods are withdrawn until the count rate is a steady 2000 cps. What is the value of K_{eff} at this point?

a. 0.952

b. 0.973

c. 0.998

.

d. 1.050

QUESTION A.09 [1.0 point]
Assume that the worth of the Safety, Shim, and Reg rods are, respectively, $4.0, $3.5, and $1.5. The reactor is critical at 5 W after WITHDRAWING the following control rod worths: Safety $3.00, Shim $2.00, and Reg $1.20. What is the core excess?

a. -$1.20.

b. $2.20.

c. $2.80.

d. $9.00.

QUESTION A.10 [1.0 point]
Which ONE of the following combinations of characteristics makes a good reflector?

	Scattering Cross Section	Absorption Cross Section
a.	High	High
b.	Low	High
c.	High	Low
d.	Low	Low

QUESTION A.11 [1.0 point]
The reactor is exactly critical with β_{eff} = 0.0075. Which ONE of the following is the MINIMUM reactivity that must be added to produce prompt criticality?

a. Reactivity when K_{eff} equals to 1.0075.

b. Reactivity equals to the β_{eff}.

c. Reactivity when the stable reactor period equals to 3 seconds.

d. Reactivity equals to $1.50.

QUESTION A.12 [1.0 point]
How does the reactor startup source function?

a. The plutonium decays to emit neutrons.

b. Gamma rays from the core strike beryllium atoms that emit neutrons.

c. Alpha particles from plutonium strike beryllium atoms that emit neutrons.

d. Alpha particles from americium strike beryllium atoms that emit neutrons.

QUESTION A.13 [1.0 point]
Which ONE of the following is the MOST affected factor in the six factor formula when a poison in the control rods is changed from BORON (B) to CADMIUM (Cd)?

a. Fast fission factor.

b. Reproduction factor.

c. Thermal utilization factor.

d. Fast non leakage probability.

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?

a. Each insertion causes a SMALLER increase in the neutron flux resulting in a LONGER time to stabilize.

b. Each insertion causes a LARGER increase in the neutron flux resulting in a LONGER time to stabilize.

c. Each insertion causes a SMALLER increase in the neutron flux resulting in a SHORTER time to stabilize.

d. Each insertion causes a LARGER increase in the neutron flux resulting in a SHORTER time to stabilize.

QUESTION A.15 [1.0 point]
Which of the following does NOT affect the Effective Multiplication Factor (Keff)?

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.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 β_{eff}.

********** End of Section A **********
End of Examination

A.01 d
REF: Burn, R., *Introduction to Nuclear Reactor Operations,* © 1982, Sec 8.4, page 8-9.

A.02 b
REF: Burn, R., *Introduction to Nuclear Reactor Operations,* © 1982, Sec 3.3.2, page 3-19.

A.03 a
REF: Chart of the Nuclides

A.04 b
REF: $P = P_0 e^{t/T}$ —> $T= t/Ln(P/ P_0)$
$t= 60/Ln(100)$; $t = 13$ sec.

A.05 c
REF: Burn, R., *Introduction to Nuclear Reactor Operations,* © 1982, Sec 3.2.

A.06 a
REF: Burn, R., *Introduction to Nuclear Reactor Operations,* © 1982, Sec 3.3.1, page 3-16.

A.07 d
REF: Burn, R., *Introduction to Nuclear Reactor Operations,* © 1982, Sec 8.4, page 8-9.

A.08 c
REF: $K_{eff1}=1/1- \rho_1$
$K_{eff1} =1/(1-(-.05))$ —>$K_{eff1}= 0.952$,
$Count_1*(1-K_{eff1}) = Count_{2*}(1-K_{eff2})$ $Count_1*(1-0.952) = Count_{2*}(1-K_{eff2})$
$100*(1-0.952) = 2000(1- K_{eff2})$; $K_{eff2} = 0.998$

A.09 c
REF: Total worth=\$4+\$3.5+\$1.5=\$9; Reactivity at 5 W= \$3.0 + \$2.0 + \$1.2 = \$6.2
Core excess = Total worth – Reactivity at 5 W
\$9.0-\$6.2 = \$2.8

A.10 c
REF: Standard NRC Question

A.11 b
REF: Burn, R., *Introduction to Nuclear Reactor Operations,* © 1982, Sec 4.2.

A.12 c
REF: Requalification Training

A.13 c
REF: Burn, R., *Introduction to Nuclear Reactor Operations,* © 1982, Sec 4.5.

A.14 b
REF: Burn, R., *Introduction to Nuclear Reactor Operations,* © 1988, §

A.15 c
REF: Burn, R., *Introduction to Nuclear Reactor Operations*, © 1982, § 3.3.4, p. 3-21.

A.16 a
REF: Burn, R., *Introduction to Nuclear Reactor Operations,* © 1988, § 4.7, p. 4-21