February 3, 2013

Dr. Warren D. Reece, Director
Texas A&M University System
Nuclear Science Center
1095 Nuclear Science Road
MS 3575
College Station, Texas 77843-3575

SUBJECT: EXAMINATION REPORT NO. 50-128/OL-13-01, TEXAS A&M UNIVERSITY

Dear Dr. Reece:

On January 14, 2013, Mr. Jerry Newhouse administered an NRC-prepared operator licensing examination at your Texas A&M University TRIGA Reactor. The examination was conducted according to NUREG-1478, "Operator Licensing Examiner Standards for Research and Test Reactors," Revision 2.

In accordance with Section 2.390 of Title 10 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 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 Mr. John T. Nguyen at (301) 415-4007 or via email John.Nguyen@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. 50-128

Enclosures: 1. Examination Report No. 50-128/OL-13-01
2. Written Exam

cc: Jerry E. Newhouse
cc: w/o enclosures: See next page

February 3, 2013

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Texas A&M University System
Nuclear Science Center
1095 Nuclear Science Road
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College Station, Texas 77843-3575

SUBJECT: EXAMINATION REPORT NO. 50-128/OL-13-01, TEXAS A&M UNIVERSITY

Dear Dr. Reece:

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Docket No. 50-128

Enclosures: 1. Examination Results Report No. 50-128/OL-13-01
2. Written Exam

cc: Jerry E. Newhouse
cc: w/o enclosures: See next page

DISTRIBUTION w/ encls:
PUBLIC PROB r/f RidsNrrDprProb RidsNrrDprPrlb Facility File (CRevelle)

ADAMS Accession No: ML13030A583

OFFICE	PROB:CE		IOLB:LA	E	PROB:BC
NAME	JNguyen		CRevelle		GBowman
DATE	01/29/2013		01/ 30/2013		02/03/2013

OFFICIAL RECORD COPY

cc:

Mayor, City of College Station
P.O. Box Drawer 9960
College Station, TX 77840-3575

Governor's Budget and
Planning Office
P.O. Box 13561
Austin, TX 78711

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Texas Engineering Experiment Station
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Texas Commission on Environmental Quality
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Test, Research and Training
Reactor Newsletter
202 Nuclear Sciences Center
University of Florida
Gainesville, FL 32611

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

REPORT NO.: 50-128/OL-13-01

FACILITY DOCKET NO.: 50-128

FACILITY LICENSE NO.: R-83

FACILITY: Texas A&M University TRIGA Reactor

EXAMINATION DATES: January 14, 2013

SUBMITTED BY: ____________________________ __________
John T. Nguyen, Chief Examiner Date

SUMMARY:

Mr. Jerry Newhouse administered an NRC-prepared operator licensing retake examination for one reactor operator (RO) candidate and one senior reactor operator instant (SRO-I) candidate who both failed Section A of the NRC written examination administered in August 2012. The candidates passed the retake examination.

REPORT DETAILS

1. Examiners: John T. Nguyen, Chief Examiner, NRC

2. Results:

	RO PASS/FAIL	SRO PASS/FAIL	TOTAL PASS/FAIL
Written	1/0	1/0	2/0
Operating Tests	N/A	N/A	N/A
Overall	1/0	1/0	2/0

3. Exit Meeting:

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

ENCLOSURE 1

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

FACILITY: Texas A&M University

REACTOR TYPE: TRIGA

DATE ADMINISTERED: 01/14/2013

CANDIDATE: ______________________

INSTRUCTIONS TO CANDIDATE:
Answers are to be written on the Answer sheet provided. Attach all Answer sheets to the examination. Point values 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	CANDIDATE'S SCORE	% OF CATEGORY VALUE		CATEGORY
20.00	100%	________	_____	A.	REACTOR THEORY, THERMODYNAMICS AND FACILITY OPERATING CHARACTERISTICS
N/A	N/A	________	_____	B.	NORMAL AND EMERGENCY OPERATING PROCEDURES AND RADIOLOGICAL CONTROLS
N/A	N/A	________	_____	C.	FACILITY AND RADIATION MONITORING SYSTEMS
20.00		________ FINAL GRADE	_____%		TOTALS

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

____
Candidate's Signature

ENCLOSURE 1

A. RX THEORY, THERMO & FAC OP CHARS

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.

A01 a b c d ___

A02 a b c d ___

A03 a b c d ___

A04 a b c d ___

A05 a b c d ___

A06 a b c d ___

A07 a b c d ___

A08 a b c d ___

A09 a b c d ___

A10 a b c d ___

A11 a b c d ___

A12 a b c d ___

A13 a b c d ___

A14 a b c d ___

A15 a b c d ___

A16 a b c d ___

A17 a b c d ___

A18 a b c d ___

A19 a b c d ___

A20 a b c d ___

(***** END OF CATEGORY A *****)

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 three (3) hours for completion of the examination.

EQUATION SHEET

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

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

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

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

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

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

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

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

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

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

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

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

$$M = \frac{1 - K_{eff_1}}{1 - K_{eff_2}}$$

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

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

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

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

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

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

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

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

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

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

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

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

U.S.NRC
UNITED STATES NUCLEAR REGULATORY COMMISSION
Protecting People and the Environment

TEXAS A&M UNIVERSITY TRIGA REACTOR

Operator Licensing Examination

Week of January 14, 2013

ENCLOSURE 2

QUESTION A.1 [1.0 points]
Two common FISSION PRODUCTS that have especially large neutron capture cross sections and play a significant role in reactor physics. One is Sm-149 and the other is:

a. B-10

b. Ar-41

c. Xe-135

d. Cs-137

QUESTION A.2 [1.0 point]
Which ONE of the following is the definition for reactivity (ρ)?

a. The measure of a reactor's departure from criticality

b. The time required for power to change by a factor of "e"

c. The fraction of all fission neutrons that are born as delayed neutrons

d. The faction of number of neutrons of current generation and number of neutrons of the previous generation

QUESTION A.3 [1.0 point]
You are the reactor operator performing two pulsing operations. The first pulse has a reactivity worth of **$1.20** which results in a peak power of **200 MW**. If the second pulse has a peak power of **5000 MW**, the corresponding reactivity worth is:

Given:
β_{eff} =0.0070

a. $1.50

b. $1.75

c. $2.00

d. $2.50

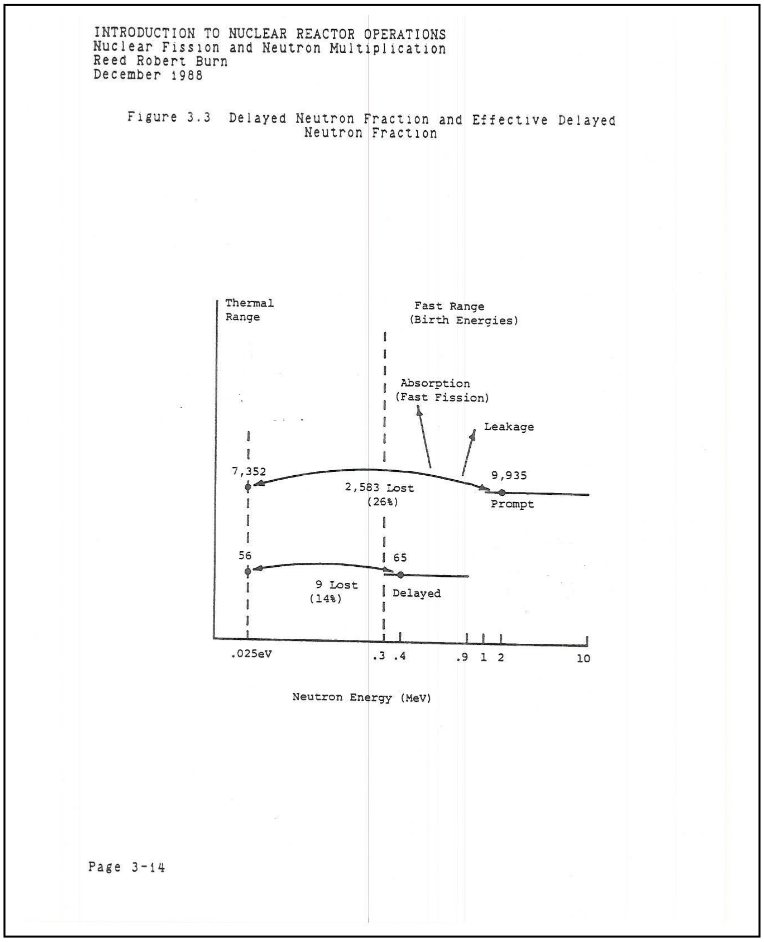
QUESTION A.4 [1.0 point]
Use Figure 3.3 attached. Calculate the effective delayed neutron fraction (β-effective). At birth energies, there are 65 delayed neutrons and 9935 prompt neutrons. In the process of slowing down, there are only 56 delayed neutrons and 7352 prompt neutrons at the thermal range. The resultant β-effective of Figure 3.3 is:

a. 0.00654

b. 0.00756

c. 0.00762

d. 0.00873



QUESTION A.5 [1.0 point]
Given the associated graph, which ONE of the following answers best describes the neutron behavior within Region II?

a. The neutron cross section is inversely proportional to the neutron velocity (1/V)

b. The neutron cross section decreases steadily with increasing neutron energy (1/E).

c. Neutrons of specific energy levels (e.g., 50 ev, 100 kev) have more likely leakage from the reactor core

d. Neutrons of specific energy levels (e.g., 50 ev, 100 kev) are more likely to be absorbed than neutrons at other energy levels.

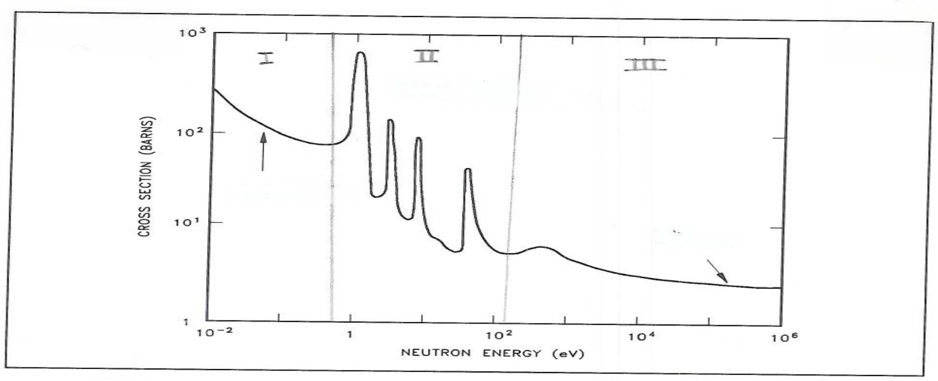


Figure 1 Typical Neutron Absorption Cross Section vs. Neutron Energy

QUESTION A.6 [1.0 point]
Given a source strength of 200 neutrons per second (N/sec) and a multiplication factor of 0.9, which ONE of the following is the expected stable neutron count rate?

a. 180 N/sec

b. 1800 N/sec

c. 2000 N/sec

d. 4000 N/sec

QUESTION A.7 [1.0 point]
Given the following Core Reactivity Data during startup:

Control Rod	Total Rod Worth ($)	Rod Worth removed at 5 watts critical ($)	Rod excess at 5 watts critical ($)
Rod #1	1.50	1.50	0.00
Rod # 2	1.80	1.50	0.30
Rod # 3	2.20	2.00	0.20
Rod # 4	3.50	2.50	1.00
Total Worth	9.00	7.50	1.50

Assume all rods are scrammable. The **SHUTDOWN MARGIN** defined in the TAMU Technical Specifications for this core is:

a. $1.5

b. $4.0

c. $5.5

d. $6.0

QUESTION A.8 [1.0 point, 0.25 each]
The reactor is critical at 5 watts. Which ONE of the following correctly describes the reactor behavior, when a reactivity worth of 0.20 % delta K/K is IMMEDIATELY inserted to the reactor core?

a. Subcritical

b. Critical

c. Supercritical

d. Prompt critical

QUESTION A.9 [1.0 point]
Which ONE of the following correctly describes the SIX- FACTOR FORMULA?

a. $K_\infty = K_{eff}$ * the reproduction factor (η)

b. $K_\infty = K_{eff}$ * the total non-leakage probability ($\mathcal{L}_f \times \mathcal{L}_{th}$)

c. $K_{eff} = K_\infty$ * the total non-leakage probability ($\mathcal{L}_f \times \mathcal{L}_{th}$)

d. $K_{eff} = K_\infty$ * (the resonance escape probability (p)* the reproduction factor (η))

QUESTION A.10 [1.0 point]
Which ONE of the following correctly describes the effect of reactor reactivity when the fuel temperature increases?

a. There are no reactivity effects when fuel temperature increases

b. The increase in fuel temperature will begin to create a positive reactivity effect

c. The increase in fuel temperature will begin to create a negative reactivity effect

d. As the fuel heats up the void in fuel increases, thereby, creating a positive reactivity effect

QUESTION A.11 [1.0 point]
Which ONE of the following best describes the alpha decay of a nuclide?

a. The atomic mass number unchanged and the number of protons decreases by 2

b. The atomic mass number decrease by 2 and the number of protons decreases by 2

c. The atomic mass number increases by 4 and the number of protons increases by 2

d. The atomic mass number decreases by 4 and the number of protons decreases by 2

QUESTION A.12 [1.0 point]
Given a reactor period of 22 seconds, approximately how long will it take for power to triple?

a. 10 seconds

b. 24 seconds

c. 36 seconds

d. 66 seconds

QUESTION A.13 [1.0 point]
Which ONE of the following elements will slow down fast neutrons most quickly, i.e. produces the greatest energy loss per collision?

a. Oxygen-16

b. Uranium-238

c. Hydrogen-1

d. Boron-10

QUESTION A.14 [1.0 point]
Which **ONE** of the following conditions will **DECREASE** the shutdown margin of a reactor?

a. Increase moderator temperature (Assume negative temperature coefficient).

b. Insertion of a negative reactivity worth experiment.

c. Burnout of a burnable poison.

d. Fuel depletion.

QUESTION A.15 [1.0 point]
The number of neutrons passing through a one square centimeter of target material per second is the definition of :

a. Neutron Population (np)

b. Neutron Impact Potential (nip)

c. Neutron Flux (nv)

d. Neutron Density (nd)

QUESTION A.16 [1.0 point]
Which ONE of the following is the **most correct reason** for having an installed neutron source within the core?

An installed neutron source is very important during startup because without of a neutron source...

a. the chain reaction in the reactor core would NOT start

b. the startup channel would NEVER indicate neutron population

c. the compensating voltage on the source range detector doesn’t work

d. the reactor could result in a sudden increase in power if the control rods were pulled out far enough

QUESTION A.17 [1.0 point]
Which ONE of the following is the principle source of heat in the reactor after a shutdown from extended operation at 1 MW?

a. Decay of fission products

b. Spontaneous fission of U^{238}

c. Production of delayed neutrons

d. Production of prompt gamma rays

QUESTION A.18 [1.0 point]
Reactor A increases power from 5% to 10% with a period of 30 seconds. Reactor B increases power from 30% to 50% with a period of also 30 seconds. Compared to Reactor A, the time required for the power increase of Reactor B is:

a. longer than A

b. exactly the same as A

c. twice that of A

d. shorter than A

QUESTION A.19 [1.0 point]
During the time following a reactor scram, reactor power decreases on an negative 80 second period, which corresponds to the half-life of the longest-lived delayed neutron precursors, which is approximately:

a. 80 seconds

b. 55 seconds

c. 40 seconds

d. 20 seconds

QUESTION A.20 [1.0 point]
Which ONE of the following describes the term **PROMPT JUMP**?

a. A reactor is critical at 80-second period.

b. A reactor has attained criticality on prompt neutrons alone.

c. The instantaneous change in power level due to inserting a control rod.

d. The instantaneous change in power level due to withdrawing a control rod.

******************* End of the Exam ***************************

A.1
Answer c
Reference: Burn, R., *Introduction to Nuclear Reactor Operations,* © 1988, Sec 8.1

A.2
Answer: a
Reference: DOE Fundamentals Handbook *Nuclear Physics and Reactor Theory Vol. 2*

A.3
Answer: c

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

ρ =ρ($)*β; ρ1=$1.20*0.007= 0.0084 Δk/k
(Peak1 /Peak2)*$(0.0084-.007)^2$ = $(\rho1- \beta)^2$
0.000049=$(\rho1- \beta)^2$;0.007= ρ1- β or ρ1=0.007+0.007= 0.014 Δk/k or $2.0
Or
Peak2 $(\rho_\$1-\$1)^2$ = Peak1*$(\rho_\$2-\$1 /)^2$
$(\rho_\$1-\$1.0)^2$ = (5000/200)*$(\$1.20-\$1.0)^2$
$\rho_\$1-\$1.0 = \$1.0$, $\rho_\$1 = \$2.0$

A.4
Answer: b
Reference: β-effective =56/(56+7352) =0.00756
Burn, R., *Introduction of Nuclear Reactor Operations*, © 1988, Figure 3.3

A.5
Answer d
Reference: DOE Fundamentals Handbook *Nuclear Physics and Reactor Theory Vol. 2*

A.6
Answer: c
Reference: CR = S/(1-K) → CR = 200/(1 - .9) = 2000

A.7
Answer: b
Reference: Tech Spec SDM = ∑rod worth removed at critical – most reactivity control rod worth= $7.5 -$3.5 = $4.0
or
Tech Spec SDM = total rod worth –(∑(rod excesses) + most reactivity control rod worth)= $9.0 –($1.5+$3.5) = $4.0

A.8
Answer: c
Reference: Burn, R., *Introduction of Nuclear Reactor Operations*, © 1988, Sec 4.2
0.2 % delta-K/K =0.002 delta-K/K <0.007, so reactor is supercritical

A.9
Answer: c
Reference: DOE Handbook Vol 2, ℞ Theory (Nuclear Parameters), E.O. 1.1 a&b, pg. 9

A.10
Answer: c
Reference: DOE Fundamentals Handbook *Nuclear Physics and Reactor Theory Vol. 2*

A.11
Answer d
Reference: Chart of the Nuclides

A.12
Answer: b
Reference: $P=P_oe^{t/\tau}$ $3=1^* e^{t/22}$ t = 22 sec*ln(3) = 24.2 sec

A.13
Answer: c
Reference: DOE Handbook Vol. 1 Section 3.0

A.14
Answer: c
Reference: increasing the core excess results a decrease in shutdown margin

A.15
Answer: c
Reference: DOE Handbook Vol. 2

A.16
Answer: d
Reference: NRC Standard Question

A.17
Answer: a
Reference: Burn, R., *Introduction to Nuclear Reactor Operations,* © 1982, page 4-33

A.18
Answer: d
Reference: The power of reactor A increases by a factor of 2, while the power of reactor B increases by a factor of 1.67. Since the periods are the same (rate of change is the same), power increase B takes a shorter time.

A.19
Answer: b
Reference: Group 1 is the longest-lived delayed neutron precursor for thermal fission in U-235, with a half-life of 55.72 sec. Lamarsh, J. "Introduction to Nuclear Engineering" p. 88

A.20
Answer: d
Reference: Burn, R., *Introduction to Nuclear Reactor Operations,* © 1982, Page 4-21.