September 5, 2002

Dr. B. Don Russell, Deputy Director
Texas Engineering Experiment Station
Texas A&M University
Nuclear Science Center, Bldg. 1095
College Station, TX 77843-3575

SUBJECT: INITIAL EXAMINATION REPORT LETTER NO. 50-128/OL-02-03, TEXAS A&M UNIVERSITY, AUGUST 2002

Dear Dr. Russell:

During the week of August 19, 2002, the NRC administered examinations to employees of your facility who had applied for a license to operate your Texas A&M University Reactor. The examination was conducted in accordance with NUREG-1478, "Non-Power Reactor Operator Licensing Examiner Standards," Revision 1.

In accordance with 10 CFR 2.790 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 Patrick Isaac at 301-415-1019.

Sincerely,

/RA/

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

Docket No. 50-128

Enclosures: 1. Initial Examination Report No. 50-128/OL-02-03
2. Examination and answer key

cc w/encls:
Please see next page

cc:

Texas A&M University System
ATTN: Dr. Warren D. Reece, Director
Nuclear Science Center
Texas Engineering Experiment Station
F.E. Box 89, M/S 3575
College Station, TX 77843

Texas State Department of Health
Radiation Control Program Director
Bureau of Radiation Control
1100 West 49th Street
Austin, TX 78756-3189

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

U.S. Customs Service
Safety Branch
ATTN: Mr. Rick Whitman
6026 Lakeside Boulevard
Indianapolis, IN 46278

U.S. Department of Transportation
Mr. Raymond Lamagdelaine, Special
Investigations Chief
Office of Hazardous Materials Enforcement
DHR-40
400 7th Street, S.W.
Washington, DC 20590

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OFFICE	**RORP:CE**		**IEHB:LA**		**RORP:SC**	
NAME	**PIsaac:rdr**		**EBarnhill**		**PMadden**	
DATE	**08/ 29 /2002**		**08/ 30 /2002**		**09/ 03 /2002**	

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

REPORT NO.: 50-128/OL-02-03

FACILITY DOCKET NO.: 50-128

FACILITY LICENSE NO.: R-129

FACILITY: Texas A&M University

EXAMINATION DATES: August 19, 2002

EXAMINER: Patrick Isaac, Chief Examiner

SUBMITTED BY: ***/RA/*** 08/27/2002
Patrick Isaac, Chief Examiner Date

SUMMARY:

During the week of August 19, 2002, NRC administered retakes of Section A of the written examinations and operating test to one Reactor Operator (RO) candidate. The candidate passed the examinations.

REPORT DETAILS

1. Examiner: Patrick Isaac, Chief Examiner

2. Results:

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

3. Exit Meeting:

Personnel attending:

Michael Spellman, Assistant Director, TAMU
Patrick Isaac, Chief Examiner, USNRC

Mr. Spellman commented on a well written examinations and declined to make any comments. The Chief Examiner thanked Mr. Spellman for his assistance during the examinations.

U. S. NUCLEAR REGULATORY COMMISSION

NON-POWER REACTOR LICENSE EXAMINATION

FACILITY:	Texas A&M
REACTOR TYPE:	TRIGA
DATE ADMINISTERED:	2002/08/19
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**
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 2

A. RX THEORY, THERMO & FAC OP CHARS

ANSWER SHEET

Multiple Choice (Circle or X your choice)
If you change your answer, write your selection in the blank.

001 a b c d ___

002 a b c d ___

003 a b c d ___

004 a b c d ___

005 a ____ b ____ c ____ d ____

006 a b c d ___

007 a b c d ___

008 a b c d ___

009 a b c d ___

010 a b c d ___

011 a b c d ___

012 a b c d ___

013 a b c d ___

014 a b c d ___

015 a b c d ___

016 a b c d ___

017 a b c d ___

018 a b c d ___

019 a b c d ___

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

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.

12. There is a time limit of one (1) hour for completion of the examination.

EQUATION SHEET

$\dot{Q} = \dot{m} c_p \Delta T$

$\dot{Q} = \dot{m} \Delta h$

$\dot{Q} = UA \Delta T$

$SUR = \frac{26.06 (\lambda_{eff}\rho)}{(\beta - \rho)}$

$SUR = 26.06/\tau$

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

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

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

$\tau = (\ell^*/\rho) + [(\beta-\rho)/\bar{\lambda}_{eff}\rho]$

$\rho = (Keff-1)/Keff$

$\rho = \Delta Keff/Keff$

$\bar{\beta} = 0.0075$

$DR_1 D_1^2 = DR_2 D_2^2$

$Cp (H20) = 0.146 \frac{kw}{gpm \cdot {}^\circ F}$

$SCR = S/(1-Keff)$

$CR_1 (1-Keff)_1 = CR_2 (1-Keff)_2$

$M = \frac{(1-Keff)_0}{(1-Keff)_1}$

$M = 1/(1-Keff) = CR_1/CR_0$

$SDM = (1-Keff)/Keff$

$I = I_o e^{-ux}$

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

$\tau = \ell^*/(\rho-\bar{\beta})$

$R = 6 C E n$

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

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

$P = S / (1 - Keff)$

---

1 Curie = 3.7×10^{10} dps

1 kg = 2.21 lbm

1 hp = 2.54×10^3 BTU/hr

1 Mw = 3.41×10^6 BTU/hr

1 BTU = 778 ft-lbf

$^\circ F = 9/5 {}^\circ C + 32$

931 Mev = 1 amu

$^\circ C = 5/9 ({}^\circ F - 32)$

Section A Ŗ Theory, Thermo & Fac. Operating Characteristics

QUESTION: 001 (1.00)
Given a source strength of 100 neutrons per second (N/sec) and a multiplication factor of 0.8, the expected neutron count rate would be:

a. 125 N/sec

b. 250 N/sec

c. 400 N/sec

d. 500 N/sec

QUESTION: 002 (1.00)
With the reactor critical at 10 KW a rod is pulled to insert a positive reactivity of 0.00126 ΔK/K. Which one of the following will be the stable reactor period as a result of this reactivity insertion?

a. 10 seconds

b. 50 seconds

c. 60 seconds

d. 70 seconds

QUESTION: 003 (1.00)
An initial count rate of 100 is doubled five times during a startup. Assuming an initial Keff of 0.950, which one of the following is the new Keff?

a. 0.957

b. 0.979

c. 0.985

d. 0.998

QUESTION: 004 (1.00)
Consider two identical critical reactors, with the exception that one has a beta of 0.0072 and the other has a beta of 0.0060. Each reactor is operating a 10 watts. Which one of the following compares the response of the reactors to a +0.1% delta k/k reactivity insertion?

a. The resulting period will be shorter for the reactor with the 0.0072 beta fraction

b. The resulting period will be shorter for the reactor with the 0.0060 beta fraction

c. The resulting power level will be higher for the reactor with the 0.0072 beta fraction

d. The resulting power level will be higher for the reactor with the 0.0060 beta fraction

QUESTION: 005 (2.00, 0.5 each)
Match the terms in column A with the correct definition in column B

	Column A		Column B
a.	Fast Neutrons	1.	Neutrons released promptly from fission.
b.	Prompt Neutrons	2.	High energy neutrons.
c.	Slow Neutrons	3.	Neutrons released from decay after fission.
d.	Delayed Neutrons	4.	Low energy neutrons.

QUESTION: 006 (1.00)
The reactor is critical and increasing in power. Power has increased from 20 watts to 80 watts in 60 seconds. How long will it take at this rate for power to increase from 0.080 KW to 160 KW?

a. 0.5 minute

b. 2.5 minutes

c. 5.5 minutes

d. 10.5 minutes

QUESTION: 007 (1.00)
A reactor with an initial population of 24000 neutrons is operating with Keff = 1.01. Of the CHANGE in population from the current generation to the next generation, how many are prompt neutrons?

a. 25

b. 238

c. 2500

d. 24240

QUESTION: 008 (1.00)
Which one of the following conditions would INCREASE the shutdown margin of a reactor?

a. Inserting an experiment adding positive reactivity.

b. Lowering moderator temperature if the moderator temperature coefficient is negative.

c. Depletion of a burnable poison.

d. Depletion of uranium fuel.

QUESTION: 009 (1.00)
Which one of the following is the PRIMARY reason that delayed neutrons are so effective at controlling reactor power?

a. Delayed neutrons make up a very large fraction of the fission neutrons in the core.

b. Delayed neutrons have a much longer mean lifetime than prompt neutrons.

c. Delayed neutrons are born at thermal energies.

d. Delayed neutrons are born at lower energies than prompt neutrons.

QUESTION: 010 (1.00)
Which one of the following is the principal source of heat in the reactor after a shutdown from extended operation at 1 MW?

a. Production of delayed neutrons

b. Kinetic energy of fission fragments

c. Spontaneous fission of U-238

d. Gamma interactions

QUESTION: 011 (1.00)
The following data was obtained during a reactor fuel load.

No. of Elements	Detector A (cps)
0	20
8	28
16	30
24	32
32	42
40	80

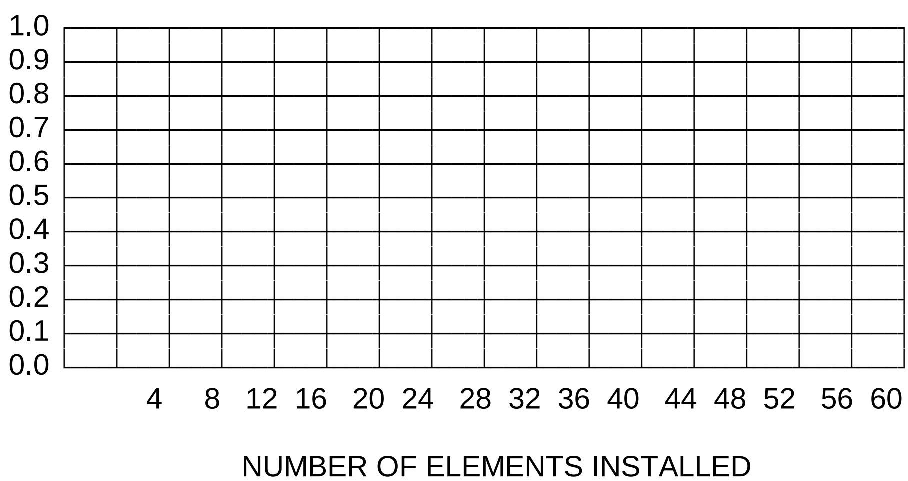
Which one of the following represents the number of fuel elements predicted to reach criticality?

a. 48

b. 52

c. 56

d. 60



QUESTION: 012 (1.00)
Following 8 hours at 1 MW, the reactor operator reduces reactor power to 50%. Rod control is placed in manual mode and all rod motion is stopped. Which one of the following describes the response of reactor power, without any further operator actions, and the PRIMARY reason for its response?

a. Power increases due to the burnout of xenon.

b. Power increases due to the burnout of samarium.

c. Power decreases due to the buildup of xenon.

d. Power decreases due to the buildup of samarium.

QUESTION: 013 (1.00)
Which one of the following is a correct statement concerning the factors affecting control rod worth?

a. Fuel burn up causes the rod worth for periphery rods to decrease.

b. Fuel burn up causes the rod worth to increase in the center of the core.

c. The withdrawal of a rod causes the rod worth of the remaining inserted rods to increase.

d. As Rx power increases rod worth increases.

QUESTION: 014 (1.00)
Pool temperature increases by 20°F. Given αTmoderator = -0.0005 ΔK/K/°F and an average regulating rod worth of 0.004 ΔK/K/inch. By how much and in what direction did the regulating rod move to compensate for the temperature change?

a. 0.25 inches in

b. 0.25 inches out

c. 2.5 inches in

d. 2.5 inches out

QUESTION: 015 (1.00)
Which ONE of the following statements describes the subcritical reactor response as Keff approaches unity?

d. A LARGER change in neutron level results from a given change in Keff and a SHORTER period of time is required to reach the equilibrium neutron level for a given change in Keff.

b. A LARGER change in neutron level results from a given change in Keff and a LONGER period of time is required to reach the equilibrium neutron level for a given change in Keff.

c. A SMALLER change in neutron level results from a given change in Keff and a SHORTER period of time is required to reach the equilibrium neutron level for a given change in Keff.

d. A SMALLER change in neutron level results from a given change in Keff and a LONGER period of time is required to reach the equilibrium neutron level for a given change in Keff.

QUESTION: 016 (1.00)
An experiment to be placed in the central thimble has been wrapped in cadmium.   Which one of the following types of radiation will be most effectively blocked by the cadmium wrapping?

a. Thermal neutrons

b. Fast neutrons

c. Gamma rays

d. X-rays

QUESTION: 017 (1.00)
A thin foil target of 10% copper atoms and 90% atoms aluminum is in a thermal neutron beam. Given σs Al = 3.79 barns, σs Cu = 0.23 barns, σa Al = 7.90 barns and σa Cu = 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: 018 (1.00)
The reactor is operating at 500 KW in steady-state and in manual mode. Which one of the following describes the stable reactor period if a control rod drops fully into the core and no operator action is taken?

a. -34 seconds due to the rapid decrease in prompt neutrons

b. -34 seconds due to the rapid decay of the short lived delayed neutron precursors

c. -80 seconds due to the slowing down length of prompt neutrons

d. -80 seconds due to the decay half life of the long lived delayed neutron precursors

QUESTION: 019 (1.00)
Which one of the following factors in the "six factor" formula is the most strongly affected by the Negative Temperature Coefficient ?

a. The fast fission factor

b. The thermal utilization factor

c. The resonance escape probability

d. The thermal non-leakage probability

ANSWER: 001 (1.00)
d.
REFERENCE:
C.R. = S/(1 - Keff) → C.R. = 100/(1 - 0.8) = 100/0.2 = 500

ANSWER: 002 (1.00)
b.
REFERENCE:
$\tau = (\beta-\rho)/\lambda_{eff}\rho = \frac{.0075 - .00126}{(.1)(.00126)} = 49.5$ seconds

ANSWER: 003 (1.00)
d.
REFERENCE:
CR1 (1-Keff1) = CR2 (1 - Keff2) or M1 (1-Keff1) = M2 (1 - Keff2)
CR2/CR1 = 32 → CR1 (1-Keff1)/CR2 = 1 - Keff2) → 100 (1-0.950)/3200 = 1 - Keff2
Keff2 = 1 - .0015625 = .998

ANSWER: 004 (1.00)
b.
REFERENCE:
Burn, R., Introduction to Nuclear Reactor Operations, © 1982, §§ 3.2.2 — 3.2.3

ANSWER: 005 (1.00)
a, 2; b, 1; c, 4; d, 3
REFERENCE:
Burn, R., Introduction to Nuclear Reactor Operations, © 1988, § 3.2.2 Delayed Neutrons.

ANSWER: 006 (1.00)
c.
REFERENCE:
$P = Poe^{t/T}$ → $80 = 20e^{60\ sec/T}$ → T = 43.28 sec
1.6×10^5 watts = $80e^{t/43.28}$
t = 329 sec = 5.5 minutes

ANSWER: 007 (1.00)
b.
REFERENCE:
PSTR Training Manual, Section 2.9
24000 x 1.01 = 24240 neutrons in next generation
24240 - 24000 = 240 neutrons added
240 neutrons added - 0.7% delayed neutron fraction = 238 prompt neutrons added

ANSWER: 008 (1.00)
d.
REFERENCE:
Burn, R., *Introduction to Nuclear Reactor Operations,* © 1988, § 6.2.3, p. 6-4.

ANSWER: 009 (1.00)
b.
REFERENCE:
Burn, R., Introduction to Nuclear Reactor Operations, © 1982, §§ 3.2.2 — 3.2.3

ANSWER: 010 (1.00)
d.
REFERENCE:
Burn, R., Introduction to Nuclear Reactor Operations, © 1982, § 4.9, pp. 4-23 — 4-26.

ANSWER: 011 (1.00)
a.
REFERENCE:
Burn, R., Introduction to Nuclear Reactor Operations, © 1982, § 5.5, pp. 5-18 — 5-25.

ANSWER: 012 (1.00)
c.
REFERENCE:
Burn, R., Introduction to Nuclear Reactor Operations, © 1988, §§ 8.1 —8.4, pp. 8-3 — 8-14.

ANSWER: 013 (1.00)
c.
REFERENCE:
Burn, R., Introduction to Nuclear Reactor Operations, © 1982, § 7.2 & 7.3, pp. 7-1 — 7-10.

ANSWER: 014 (1.00)
d.
REFERENCE:
+20°F × -0.0005 ΔK/K/°F = - 0.01 ΔK/K. To compensate the rod must add +0.01 ΔK/K.
+0.01ΔK/K ÷ +0.004 ΔK/K/inch = +2.5 inches

ANSWER: 015 (1.00)
b.
REFERENCE:
Burn, R., Introduction to Nuclear Reactor Operations, © 1988, Chapt. 5, pp. 5-1 — 5-28.

ANSWER: 016 (1.00)
a.
REFERENCE:
Glasstone, S. and Sesonske, 1991, § 10.34, pp. 639.

ANSWER: 017 (1.00)
c.
REFERENCE:
Glasstone, S. and Sesonske, 1991, § 2.108 – 2.114, pp. 77 – 80.

ANSWER: 018 (1.00)
d.
REFERENCE:
The amount of reactivity inserted by the blade s much larger than beta; therefore, maximum stable negative period of -80 seconds results.

ANSWER: 019 (1.00)
b.
REFERENCE:
Glasstone, S. and Sesonske, 1991, § 5.98, p. 264.