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

REPORT NO.: 50-188/OL-95-02

FACILITY DOCKET NO.: 50-188

FACILITY LICENSE NO.: R-88

FACILITY: Kansas State University

EXAMINATION DATES: January 10, 1996

EXAMINER: Warren J. Eresian, Chief Examiner

SUBMITTED BY: Warren J. Eresian 1/29/96
Warren J. Eresian, Chief Examiner   Date

SUMMARY:

The NRC administered a retake license examination (written only, Category A) to a Reactor Operator applicant. The applicant passed the examination.

ATTACHMENT 1

REPORT DETAILS

1. Examiners:

   Warren J. Eresian, Chief Examiner

2. Results:

	RO (Pass/Fail)	SRO (Pass/Fail)	Total (Pass/Fail)
NRC Grading:	1/0	0/0	1/0

3. Written Examination:

   The Reactor Operator applicant passed the examination, Category A.

4. Operating Test:

   Applicant was not required to take operating test.

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

FACILITY: Kansas State University

REACTOR TYPE: TRIGA

DATE ADMINISTERED: 01/10/96

REGION: 4

CANDIDATE: ______________________

INSTRUCTIONS TO CANDIDATE:

Answers are to be written on the exam page itself, or the answer sheet provided. Write answers one side ONLY. Attach any answer sheets to the examination. Points for each question are indicated in parentheses for each question. A 70% is required to pass the examination.

Examination will be picked up one (1) hour after the examination starts.

CATEGORY VALUE	% OF TOTAL	CANDIDATE'S SCORE	% OF CATEGORY VALUE	CATEGORY
18	100	______	______	A. REACTOR THEORY, THERMODYNAMICS, AND FACILITY OPERATING CHARACTERISTICS
18		______ FINAL GRADE	______%	

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 not received or 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.

6. Print your name in the upper right-hand corner of the answer sheets.

7. The point value for each question is indicated in parentheses after the question.

8. Partial credit may be given. Therefore, ANSWER ALL PARTS OF THE QUESTION AND DO NOT LEAVE ANY ANSWER BLANK. NOTE: partial credit will NOT be given on multiple choice questions.

9. If the intent of a question is unclear, ask questions of the examiner only.

10. When turning in your examination, assemble the completed examination with examination questions, examination aids and answer sheets. In addition, turn in all scrap paper.

11. When you are done and have turned in your examination, leave the examination area as defined by the examiner. If you are found in this area while the examination is still in progress, your license may be denied or revoked.

QUESTION: 001 (1.00)

Which of the following describes the response of the reactor to equal amounts of reactivity insertion as K_{eff} approaches 1.0?

a. The change in neutron population per reactivity insertion is smaller, and it takes more time to reach a new equilibrium count rate.

b. The change in neutron population per reactivity insertion is larger, and it takes more time to reach a new equilibrium count rate.

c. The change in neutron population per reactivity insertion is larger, and it takes an equal amount of time to reach a new equilibrium count rate.

d. The change in neutron population per reactivity insertion is smaller, and it takes less time to reach a new equilibrium count rate.

QUESTION: 002 (1.00)

A compensating ion chamber (CIC) is used to monitor reactor power. Which ONE of the following describes the response of the meter indication if the compensating voltage is lost?

a. Indicated neutron flux will be HIGHER than actual neutron flux.

b. Indicated neutron flux will be LOWER than actual neutron flux.

c. Indicated neutron flux will be the SAME as actual neutron flux.

d. Indicated neutron flux will be either HIGHER or LOWER than actual neutron flux depending on reactor power.

QUESTION: 003 (1.00)

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

(***** CATEGORY A CONTINUED ON NEXT PAGE *****)

QUESTION: 004 (1.00)

Which ONE of the following elements has the highest thermal neutron absorption cross-section?

a. Uranium-235

b. Samarium-149

c. Boron-10

d. Xenon-135

QUESTION: 005 (1.00)

A reactor is operating at a steady-state power level of 1.000 kW. Reactor power is increased to a new steady-state power level of 1.004 kW. At the higher level, K eff is:

a. 1.004

b. 1.000

c. 0.004

d. 0.000

QUESTION: 006 (1.00)

While operating with the reactor critical at 10 Watts, a rod withdrawal results in a power increase with a doubling time of 40 seconds. Reactor power two minutes later is approximately:

a. 30 Watts

b. 60 Watts

c. 80 Watts

d. 90 watts

(***** CATEGORY A CONTINUED ON NEXT PAGE *****)

QUESTION: 007 (1.00)

The major contributor to the production of Xenon-135 in a reactor operating at full power is:

a. direct from the fission of Uranium-235

b. from the radioactive decay of Iodine

c. from the radioactive decay of Promethium

d. direct from the fission of Uranium-238

QUESTION: 008 (1.00)

Which factor in the six-factor formula is represented by the ratio:

$$\frac{\text{number of neutrons that reach thermal energy}}{\text{number of neutrons that start to slow down}}$$

a. fast non-leakage probability

b. resonance escape probability

c. reproduction factor

d. thermal utilization factor

QUESTION: 009 (1.00)

Starting with a critical reactor at low power, a control rod is withdrawn from position X and reactor power starts to increase. Neglecting any temperature effects, in order to terminate the increase with the reactor again critical but at a higher power, the control rod must be:

a. inserted deeper than position X

b. inserted, but not as far as position X

c. inserted back to position X

d. inserted, but exact position depends on power level

(***** CATEGORY A CONTINUED ON NEXT PAGE *****)

QUESTION: 010 (1.00)

The term "Prompt Critical" refers to:

a. the instantaneous jump in power due to a rod withdrawal.

b. a reactor which is supercritical using only prompt neutrons.

c. a reactor which is critical using both prompt and delayed neutrons.

d. a reactivity insertion which is less than Beta-effective.

QUESTION: 011 (1.00)

K-effective differs from K-infinite in that K-effective takes into account:

a. leakage from the core

b. neutrons from fast fission

c. the effect of poisons

d. delayed neutrons

QUESTION: 012 (1.00)

Which ONE of the following is the description of a thermal neutron?

a. A neutron possessing thermal rather than kinetic energy.

b. The primary source of thermal energy increase in the reactor coolant during reactor operation.

c. A neutron that has been produced in a significant time (on the order of seconds) after its initiating fission took place.

d. A neutron that experiences no net change in energy after several collisions with atoms of the diffusing media.

(***** CATEGORY A CONTINUED ON NEXT PAGE *****)

QUESTION: 013 (2.00)

The following facility parameters are given:

Primary coolant flow rate = 1500 GPM
Secondary system flow rate = 1400 GPM
Primary side delta-T across the heat exchanger = 11 degrees F
Secondary side heat exchanger inlet temperature = 73 degrees F

Which ONE of the following is secondary side heat exchanger EXIT temperature?

a. 82 degrees F

b. 85 degrees F

c. 89 degrees F

d. 92 degrees F

QUESTION: 014 (2.00)

The reactor is operating in automatic control. The primary temperature increases from 120 deg. F to 125 deg. F, with all other conditions remaining constant. Given that the primary temperature coefficient is $-7x10^{-5}$ delta k/k/deg F and that the differential rod worth of the regulating blade is $8.85x10^{-5}$ delta k/k/inch, the change in the position of the Regulating Blade will be:

a. eight (8) inches in.

b. eight (8) inches out.

c. four (4) inches in.

d. four (4) inches out.

QUESTION: 015 (1.00)

Which ONE of the following factors is the most significant in determining the differential worth of a control rod?

a. Reactor power

b. The rod speed

c. The flux shape

d. The amount of fuel in the core

(***** CATEGORY A CONTINUED ON NEXT PAGE *****)

QUESTION: 016 (1.00)

A reactor is subcritical with a K_{eff} of 0.984 and a count rate of 1500 cps. Rods are withdrawn until the count rate is 6000 cps. At this point, what is the value of k_{eff}?

a. 0.992

b. 0.994

c. 0.996

d. 0.998

QUESTION: 017 (1.00)

Which ONE of the following is the reason for operating with thermal neutrons rather than fast neutrons?

a. Efficiency is increased since thermal neutrons are less likely to leak out of the core

b. Neutron absorption in non-fuel materials increases exponentially as neutron energy increases

c. The fission cross section of U-235 is much higher for thermal neutrons

d. Fuel temperature coefficient becomes positive as neutron energy increases

QUESTION: 018 (1.00)

Which ONE of the following parameter changes will require a control rod INSERTION to maintain constant reactor power level following the change?

a. U-235 concentration decrease.

b. Pool water temperature increase.

c. Insertion of a void into the core.

d. Removal of an experiment containing cadmium.

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

EQUATION SHEET

$Q = m c_p \Delta T$	$CR_1 (1-Keff)_1 = CR_2 (1-Keff)_2$
$SUR = 26.06/\tau$	$P = P_0 10^{SUR(t)}$
$P = P_0 e^{(t/\tau)}$	$\tau = (\ell^*/\rho) + [(\beta-\rho)/\lambda_{eff}\rho]$
$\lambda_{eff} = 0.1 \text{ seconds}^{-1}$	$DR_1D_1^2 = DR_2D_2^2$
$DR = DR_o e^{-\lambda t}$	$DR = 6CiE/D^2$
$\rho = (Keff-1)/Keff$	
1 Curie = $3.7x10^{10}$ dps	1 gallon water = 8.34 pounds
1 Btu = 778 ft-lbf	°F = 9/5°C + 32
1 Mw = $3.41x10^6$ BTU/hr	°C = 5/9 (°F - 32)

A. REACTOR THEORY, THERMODYNAMICS AND FACILITY OPERATING CHARACTERISTICS

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 ____

0U7 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 ____

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

A. REACTOR THEORY, THERMODYNAMICS AND FACILITY OPERATING CHARACTERISTICS

ANSWER: 001 (1.00)
C.
REFERENCE:

ANSWER: 002 (1.00)
A.
REFERENCE:
Glasstone $ Sesonske, "Nuclear Reactor Engineering", Section 5.254.

ANSWER: 003 (1.00)
C.
REFERENCE:
Lamarsh, "Introduction to Nuclear Engineering," 2nd. Edition, Page 59.

ANSWER: 004 (1.00)
D.
REFERENCE:
Lamarsh, "Introduction to Nuclear Engineering," 2nd. Edition, Appendix II, Table II.2.

ANSWER: 005 (1.00)
B.
REFERENCE:
Lamarsh, "Introduction to Nuclear Engineering," 2nd. Edition, Page 102.

ANSWER: 006 (1.00)
C.
REFERENCE:
Power doubles every 40 seconds. Two minutes = 120 seconds = three doubling times.
Power = (10 watts)x2x2x2 = 80 watts.

ANSWER: 007 (1.00)
B.
REFERENCE:
Glasstone $ Sesonske, "Nuclear Reactor Engineering", Section 5.62.

ANSWER: 008 (1.00)
B.
REFERENCE:
Lamarsh, "Introduction to Nuclear Engineering," 2nd. Edition, Page 239.

ANSWER: 009 (1.00)
C.
REFERENCE:
Neglecting any temperature effects, there has been no change in core reactivity.

ANSWER: 010 (1.00)
B.
REFERENCE:
Lamarsh, "Introduction to Nuclear Engineering," 2nd. Edition, Page 286.

ANSWER: 011 (1.00)
A.

REFERENCE:
Glasstone $ Sesonske, "Nuclear Reactor Engineering", Section 3.43.

ANSWER: 012 (1.00)
D.
REFERENCE:
Glasstone $ Sesonske, "Nuclear Reactor Engineering", Section 1.39.

ANSWER: 013 (1.00)
B.
REFERENCE:
Energy lost by primary = energy gained by secondary.
1500x11 = 1400x(T_{exit} - 73) ; T_{exit} = 85.

ANSWER: 014 (1.00)
D.
REFERENCE:
Since the temperature coefficient is negative, a temperature increase adds negative reactivity = (5 deg.F)x(-7x10^{-5} delta k/k/deg.F) =
-3.5x10^{-4} delta k/k. The rod must add the same positive reactivity (rod moves out).
Change in position = (3.5x10^{-4})/8.85x10^{-5}) = 4 inches.

ANSWER: 015 (1.00)
C.
REFERENCE:
Glasstone $ Sesonske, "Nuclear Reactor Engineering", Section 5.184.

ANSWER: 016 (1.00)
C.
REFERENCE:
With each count rate doubling, reactor moves halfway to criticality. From 1500 cps -> 3000 cps, K_{eff} -> 0.992. From 3000 cps -> 6000 cps, K_{eff} -> 0.996.

ANSWER: 017 (1.00)
C.
REFERENCE:
Glasstone $ Sesonske, "Nuclear Reactor Engineering", Section 2.178.

ANSWER: 018 (1.00)
D.
REFERENCE:
Since a control rod is inserted, the parameter change must add positive reactivity.