ENCLOSURE 1

EXAMINATION REPORT - 50-297/OL-88-02

Facility Licensee: North Carolina State University
Raleigh, NC 27695-7909

Facility Name: North Carolina State University

Facility Docket No.: 50-297

A Written re-examination was administered at North Carolina State University near Raleigh, North Carolina.

Chief Examiner: Michael E. Ernstes — Date Signed: 5/4/88

Approved by: Kenneth E. Brockman, Chief Operator, Licensing Section 2 — Date Signed: 5/5/88

Summary:

Examination on April 26, 1988.

One candidate was administered a written re-examination of category A; which he passed.

Based on the results described above, one of one RO passed.

REPORT DETAILS

1. Facility Employees Contacted:

   *G. D. Miller, Assiciate Director
   *S. M. Grady, Chief Reactor Operator
   *T. C. Bray, Reactor Operations Manager

   *Attended Exit Meeting

2. Examiner:

   *M. E. Ernstes

   *Chief Examiner

3. Examination Review Meeting

   At the conclusion of the written examination, the examiner provided S. M. Grady, with a copy of the written examination and answer key for review. There were no facility comments.

4. Exit Meeting

   At the conclusion of the site visit the examiner met with representatives of the plant staff to discuss the results of the examination.

   The cooperation given to the examiner was noted and appreciated.

   The licensee did not identify as proprietary any of the material provided to or reviewed by the examiner.

U. S. NUCLEAR REGULATORY COMMISSION
REACTOR OPERATOR LICENSE EXAMINATION

FACILITY: NORTH CAROLINA STATE UNIV.

REACTOR TYPE: TEST

DATE ADMINISTERED: 88/04/26

EXAMINER: ERNSTES M

CANDIDATE: _____

INSTRUCTIONS TO CANDIDATE:

Use separate paper for the answers. Write answers on one side only. Staple question sheet on top of the answer sheets. Points for each question are indicated in parentheses after the question. The passing grade requires at least 70% in this category. Examination papers will be picked up one (1) hour after the examination starts.

CATEGORY VALUE	% OF TOTAL	CANDIDATE'S SCORE	% OF CATEGORY VALUE	CATEGORY
20.00	100.00	_____	_____	A. PRINCIPLES OF REACTOR OPERATION
20.00		_____ Final Grade	_____%	Totals

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. 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.

3. Use black ink or dark pencil only to facilitate legible reproductions.

4. Print your name in the blank provided on the cover sheet of the examination.

5. Fill in the date on the cover sheet of the examination (if necessary).

6. Use only the paper provided for answers.

7. Print your name in the upper right-hand corner of the first page of each section of the answer sheet.

8. Consecutively number each answer sheet, write "End of Category __" as appropriate, start each category on a new page, write only on one side of the paper, and write "Last Page" on the last answer sheet.

9. Number each answer as to category and number, for example, 1.4, 6.3.

10. Skip at least three lines between each answer.

11. Separate answer sheets from pad and place finished answer sheets face down on your desk or table.

12. Use abbreviations only if they are commonly used in facility literature.

13. The point value for each question is indicated in parentheses after the question and can be used as a guide for the depth of answer required.

14. Show all calculations, methods, or assumptions used to obtain an answer to mathematical problems whether indicated in the question or not.

15. Partial credit may be given. Therefore, ANSWER ALL PARTS OF THE QUESTION AND DO NOT LEAVE ANY ANSWER BLANK.

16. If parts of the examination are not clear as to intent, ask questions of the examiner only.

17. You must sign the statement on the cover sheet that indicates that the work is your own and you have not received or been given assistance in completing the examination. This must be done after the examination has been completed.

18. When you complete your examination, you shall:

a. Assemble your examination as follows:

(1) Exam questions on top.

(2) Exam aids - figures, tables, etc.

(3) Answer pages including figures which are part of the answer.

b. Turn in your copy of the examination and all pages used to answer the examination questions.

c. Turn in all scrap paper and the balance of the paper that you did not use for answering the questions.

d. Leave the examination area, as defined by the examiner. If after leaving, you are found in this area while the examination is still in progress, your license may be denied or revoked.

QUESTION A.01 (1.00)

Which one of the following statements concerning control rod worth is NOT TRUE?

a. Control rod worths change during the lifetime of the rod.

b. Control rods are worth more at the center of the reactor because the neutron flux is relatively low at the edges of a reactor.

c. A control rod's worth at any point is approximately proportional to the square of the thermal neutron flux at that point.

d. A control rod's worth is lower at higher moderator temperatures.

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

QUESTION A.02 (1.00)

Which one of the following statements is NOT TRUE concerning an "apparent" startup rate observed while pulling rods during a reactor startup?

a. It is caused by changing the effective multiplication factor from subcritical multiplication level to another.

b. K-eff = 1

c. It will eventually decrease to zero after rod pull is stopped.

d. The neutron population is actually increasing.

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

QUESTION A.03 (1.00)

During a reactor startup you have just verified a constant positive startup rate on SR Nuclear Instruments after rod motion has stopped and no further reactivity is inserted. The actual condition of the core with this indication is:

a. Prompt Critical

b. Critical

c. Supercritical

d. Subcritical

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

QUESTION A.04 (1.00)

Movement of the rods has the greatest effect on which one of the following factors?

a. Reproduction Factor

b. Fast Fission Factor

c. Thermal Utilization Factor

d. Resonance Escape Factor

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

QUESTION A.05 (1.00)

Which one of the following terms is defined as "the energy equivalent of the mass defect"?

a. Excitation energy

b. Binding energy

c. Fission energy

d. Critical energy

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

QUESTION A.06 (1.00)

Which one of the following statements concerning radioactive decay is correct?

a. When an element decays by beta emission, the new element will have increased in atomic number by one and the mass number will remain the same as the original element.

b. When an element decays by alpha emission, the new element will have decreased in atomic number and mass number by two, from the original element.

c. When an element decays by neutron emission, the new element will have increased in atomic number by one and decreased in mass number by one, from the original element.

d. When an element decays by gamma emission, the new element will have increased in atomic number by one and the mass number will remain the same as the original.

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

QUESTION A.07 (1.00)

Which one of the following is the CORRECT reason for operation with thermal instead of fast neutrons?

a. Increased neutron efficiency since thermal neutrons are less likely to leak out of the core than fast neutrons.

b. Reactors operating primarily on fast neutrons are inherently unstable and have a higher risk of going prompt critical.

c. The fission cross section of the fuel is much higher for thermal neutrons than fast neutrons.

d. Doppler and moderator temperature coefficients become positive as neutron energy increases.

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

QUESTION A.08 (1.00)

Figure 1.18 is a representation of how the resonance peaks of U-238 "flatten out" or Doppler broaden as fuel temperature increases. Which one of the following lists the correct labels for the X and Y axes?

a. X is neutron flux, Y is interaction rate

b. X is neutron energy, Y is microscopic capture cross section

c. X is interaction rate, Y is neutron density

d. X is atom density of U-238, Y is neutron flux

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

QUESTION A.09 (1.00)

During a reactor startup, equal increments of reactivity are added and the count rate is allowed to reach equilibrium each time. Choose the bracketed ([]) words that describe what is observed on the Source Range recorder and Startup Rate meter.

a. The change in equilibrium count rate is [larger] [the same] [smaller] each time.

b. The time required to reach equilibrium is [longer] [the same] [shorter] each time.

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

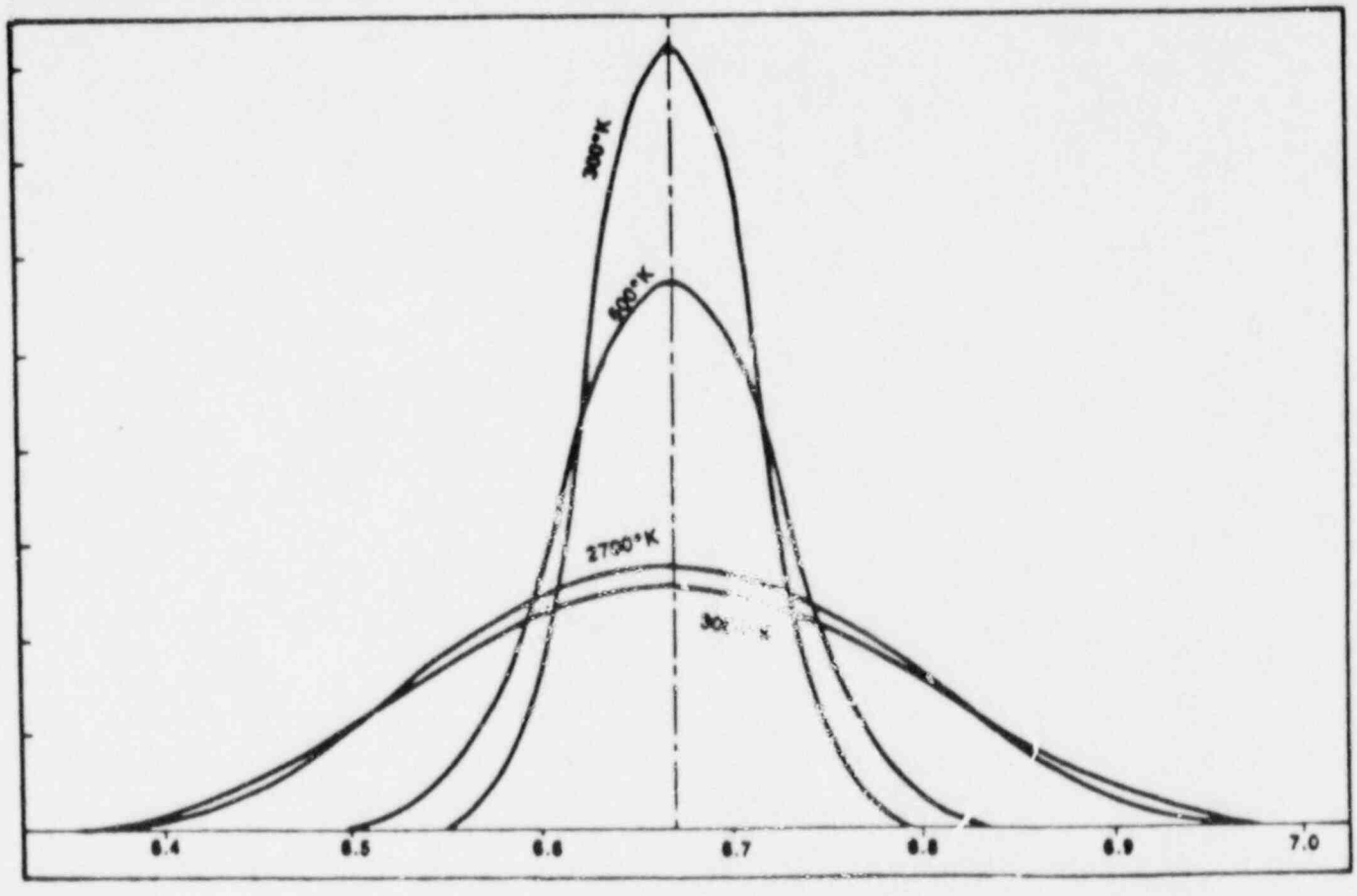


Fig. 1.18

QUESTION A.10 (1.50)

Indicate whether the following conditions will cause the Fuel Temperature Coefficient (pcm/deg F) to become MORE negative, LESS negative or have NO EFFECT. (Assume all other parameters are constant, consider each separately.)

a. The relative ratio of Pu-240 to U-238 increases

b. Moderator temperature decreases (fuel temperature remains constant)

c. Fuel temperature increases

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

QUESTION A.11 (2.00)

STATE how (INCREASE, DECREASE, or REMAIN THE SAME) an increase in moderator temperature will affect EACH of the following parameters.

a. Resonance Escape Probability

b. Thermal Utilization Factor

c. Fast Non-Leakage Probability

d. Fast Fission Factor

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

QUESTION A.12 (1.50)

Answer as TRUE or FALSE each of the following concerning Xenon.

1. The half-life of Xenon-135 is about 40 hrs.
2. Equilibrium xenon is dependent on power level.
3. Peak xenon is independent of power level.

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

QUESTION A.13 (2.00)

For each of the following definitions, STATE the term that is defined.

a. The effective fraction of all neutrons that cause fission that were born delayed.

b. The inverse of the time required to change power by a factor of 10.

c. A material that scatters neutrons back into the core reducing neutron leakage.

d. A plot showing the relationship of the change in reactivity per unit length for a control rod at any position in the reactor.

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

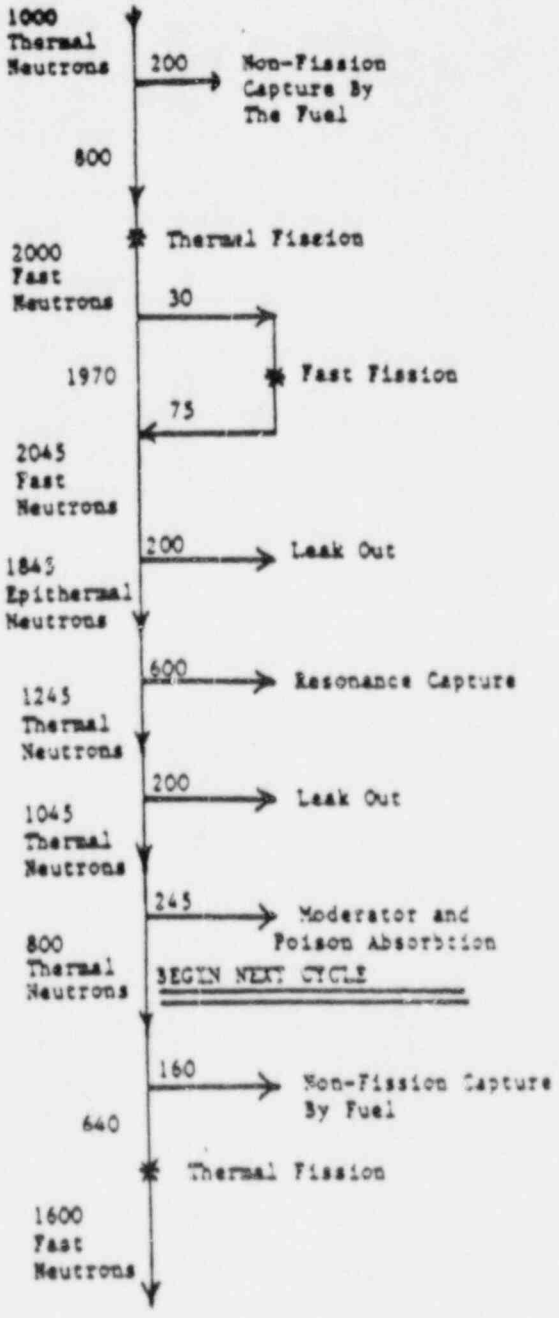
QUESTION A.14 (1.00)

If the reactor is operating in the power range, CALCULATE how long it will take to raise power from 20% to 40% full power with a +0.5 DPM startup rate. Show your work.

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

QUESTION A.15 (3.00)

Using the information from the below figure, CALCULATE the value of each term of the six factor formula.



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

ANSWERS -- NORTH CAROLINA STATE UNIV.-88/04/26-ERNSTES M

ANSWER A.01 (1.00)

(d)

REFERENCE
DPC, Fundamentals of Nuclear Reactor Engineering, p. 135-140

ANSWER A.02 (1.00)

(b)

REFERENCE
DPC, Fundamentals of Nuclear Reactor Engineering, p. 120

ANSWER A.03 (1.00)

(c)

REFERENCE
DPC, Fundamentals of Nuclear Reactor Engineering, p.120
Nuclear Energy Training, Reactor Operations, NUS Corp.
paragraph 12.4
2.8/3.1 001000K554 ...(KA'S)

ANSWER A.04 (1.00)

(c)

REFERENCE
DPC, Fundamentals of Nuclear Reactor Engineering, p. 73

ANSWER A.05 (1.00)

(b)

REFERENCE
DPC, Fundamentals of Nuclear Reactor Engineering, p. 17

ANSWERS -- NORTH CAROLINA STATE UNIV.-88/04/26-ERNSTES M

ANSWER A.06 (1.00)

(a)

REFERENCE
NETRD, S. 7.2, 7.3, 7.4.
DPC, Fundamentals of Nuclear Reactor Engineering, p.159

ANSWER A.07 (1.00)

(c)

REFERENCE
DPC, Fundamentals of Nuclear Reactor Engineering, p. 23

ANSWER A.08 (1.00)

(b)

REFERENCE
CR, Doppler Coefficient, M.G. Woram, p 7.
DPC, Fundamentals of Nuclear Reactor Engineering, p. 147

ANSWER A.09 (1.00)

a. larger
b. longer

REFERENCE
DPC, Fundamentals of Nuclear Reactor Engineering, p.117
3.9/4.0 192008K103 ...(KA'S)

ANSWER A.10 (1.50)

a. more negative (0.5 EACH)
b. less negative
c. less negative

REFERENCE
NUS, Vol 3, unit 9.1
DPC, Fundamentals of Nuclear Reactor Engineering, pp. 146-149

ANSWERS -- NORTH CAROLINA STATE UNIV.-88/04/26-ERNSTES M

ANSWER A.11 (2.00)

a. DECREASE (0.5 each)
b. INCREASE
c. DECREASE
d. INCREASE

REFERENCE
DPC, Fundamentals of Nuclear Reactor Engineering, pp. 61 - 72
Westinghouse Nuclear Training Operations, pp. I-2.31 - 36

ANSWER A.12 ( )

1. FALSE
2. TRUE
3. FALSE

REFERENCE
DPC, Fundamentals of Nuclear Reactor Engineering, pp. 151 - 161

ANSWER A.13 (2.00)

a. B-eff (Beta effective)
b. start up rate
c. reflector
d. differential rod worth curve

REFERENCE
DPC, Fundamentals of Nuclear Reactor Engineering, pp. 38,93,134,137

ANSWER A.14 (1.00)

36 sec. (+/- 1sec)

REFERENCE
DPC, Fundamentals of Nuclear Reactor Engineering, p.94
2.5/2.5 192007K101 ...(KA'S)

ANSWERS -- NORTH CAROLINA STATE UNIV.-88/04/26-ERNSTES M

ANSWER A.15 (3.00)

fast fission (e) :	2045/2000 = 1.0225
fast leakage (Lf) :	1845/2045 = 0.902
resonance capture (p)	1245/1845 = 0.675
thermal leakage (Lth) :	1045/1245 = 0.839
thermal absorption (f) :	800/1045 = 0.766
reproduction (n) :	1600/800 = 2.000

REFERENCE
DPC, Fundamentals of Nuclear Reactor Engineering, p. 86

QUESTION	VALUE	REFERENCE
A.01	1.00	MEE0001335
A.02	1.00	MEE0001338
A.03	1.00	MEE0001330
A.04	1.00	MEE0001336
A.05	1.00	MEE0001337
A.06	1.00	MEE0001339
A.07	1.00	MEE0001341
A.08	1.00	MEE0001343
A.09	1.00	MEE0001329
A.10	1.50	MEE0001340
A.11	2.00	MEE0001342
A.12	1.50	MEE0001334
A.13	2.00	MEE0001333
A.14	1.00	MEE0001331
A.15	3.00	MEE0001332
	20.00	
	20.00	

DOCKET NO 297