October 16, 2012

Mr. Andrew Kaufmann, Associate Director
OSU Nuclear Reactor Laboratory
Ohio State University
142 Hitchcock Hall
2070 Neil Avenue
Columbus, OH 43210

SUBJECT: EXAMINATION REPORT NO. 50-150/OL-12-01, THE OHIO STATE UNIVERSITY

Dear Mr. Kaufmann:

During the week of September 17, 2012, the U.S. Nuclear Regulatory Commission (NRC) administered an operator licensing examination at your Ohio State University reactor. 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 Gary Morlang at 301-415-4092 or via email at gary.morlang@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. 50-150

Enclosures: 1. Examination Report No. 50-150/OL-12-01
2. Corrected Written Examination

cc w/o enclosures: See next page

October 16, 2012

Mr. Andrew Kaufmann, Associate Director
OSU Nuclear Reactor Laboratory
Ohio State University
142 Hitchcock Hall
2070 Neil Avenue
Columbus, OH 43210

SUBJECT: INITIAL EXAMINATION REPORT NO. 50-150/OL-12-01, THE OHIO STATE UNIVERSITY

Dear Mr. Kaufmann:

During the week of September 17, 2012, the U.S. Nuclear Regulatory Commission (NRC) administered an operator licensing examination at your Ohio State University reactor. 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.

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/RA/
Gregory T. Bowman, Chief
Research and Test Reactors Oversight Branch
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DISTRIBUTION w/ enclosures.:
PUBLIC PROB r/f GBowman Facility File (CRevelle)

ADAMS ACCESSION #: ML

OFFICE	PROB:CE		IOLB:LA		PROB:BC	
NAME	GMorlang		CRevelle		GBowman	
DATE	10/09/2012		10/15/2012		10/16/2012	

OFFICIAL RECORD COPY

cc:

Ohio Department of Health
ATTN: Radiological Health
Program Director
246 North High Street
Columbus, OH 43216

Ohio Environmental Protection Agency
Division of Planning
Environmental Assessment Section
P.O. Box 1049
Columbus, OH 43216

Dr. Thomas Blue, Director
Nuclear Reactor Laboratory
Ohio State University
1298 Kinnear Rd.
Columbus, OH 43210

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

EXAMINATION REPORT NO: 50-150/OL-12-01

FACILITY: The Ohio State University

FACILITY DOCKET NO.: 50-150

FACILITY LICENSE NO.: R-75

SUBMITTED BY: **/RA/** 10/09/12
Gary Morlang, Chief Examiner Date

SUMMARY:

During the week of September 17, 2012, the NRC administered an operator licensing examination to one Senior Reactor Operator (SRO) candidate. The candidate passed the examination.

REPORT DETAILS

1. Examiner: Gary Morlang, Chief Examiner

2. Results:

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

3. Exit Meeting:

Andrew Kaufman, The Ohio State University
Gary Morlang, NRC, Examiner

The NRC Examiner agreed to make the following changes to the written examination:

Question A.11 - Accept both “C” and “D” as correct answers

Question B.16 - Delete the question due to no correct answer

Question B.18 - Accept both “C” and “D” as correct answers

Question C.12 - Delete the question as the equipment has been removed

/

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

FACILITY: Ohio State University

REACTOR TYPE: Pool

DATE ADMINISTERED: 9/18/2012

CANDIDATE: Susan White

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 parentheses for each question. A 70% overall is required to pass the examination. Examinations will be picked up three (3) hours after the examination starts.

CATEGORY VALUE	% OF TOTAL	CANDIDATE'S SCORE	% OF CATEGORY VALUE	CATEGORY
20.00	33.3	_____	_____	A. REACTOR THEORY, THERMODYNAMICS AND FACILITY OPERATING CHARACTERISTICS
20.00	33.3	_____	_____	B. NORMAL AND EMERGENCY OPERATING PROCEDURES AND RADIOLOGICAL CONTROLS
20.00	33.3	_____	_____	C. PLANT AND RADIATION MONITORING SYSTEMS
FINAL GRADE		_____	_____	% TOTALS

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

CANDIDATE'S SIGNATURE_____

License Senior Operator Written Examination
With ANSWER KEY

OL-12-01

Ohio State University

September 18, 2012

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 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 in each category.

12. There is a time limit of three (3) hours 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

=

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

$$T_{‰} = \frac{0.693}{\lambda}$$

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

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

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

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

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. 11	a b c d ___
A.02	a b c d ___	A. 12	a b c d ___
A.03	a b c d ___	A.13	a b c d ___
A.04	a b c d ___	A.14	a b c d ___
A.05	a b c d ___	A.15	a b c d ___
A.06	a b c d ___	A.16	a b c d ___
A.07	a b c d ___	A.17	a b c d ___
A.08	a b c d ___	A.18	a b c d ___
A.09	a b c d ___	A.19	a b c d ___
A.10	a b c d ___	A.20	a b c d ___

CANDIDATE'S SIGNATURE_____

B.01 a b c d ___

B.02a 1 2 3 4

B.02b 1 2 3 4

B.02c 1 2 3 4

B.02d 1 2 3 4

B.03 a b c d ___

B.04 a b c d ___

B.05 a b c d ___

B.06 a b c d ___

B.07 a b c d ___

B.08 a b c d ___

B.09 a b c d ___

B.1 0 a b c d ___

B.11 a b c d ___

B.12 a b c d ___

B.13 a b c d ___

B.14 a b c d ___

B.15 a b c d ___

B.16 a b c d ___

B.17 a b c d ___

B.18 a b c d ___

B.19 a b c d ___

B.20 a b c d ___

CANDIDATE'S SIGNATURE_____

C.01 a b c d ___

C.02 a b c d ___

C.03 a b c d ___

C.04 a b c d ___

C.05 a b c d ___

C.06 a b c d ___

C.07 a(__), b(__),c(__),d(__)

C.08 a b c d ___

C.09 a b c d ___

C.10 a b c d ___

C.11 a b c d ___

C.12 a b c d ___

C.13 a b c d ___

C.14 a b c d ___

C.15 a b c d ___

C.16 a b c d ___

C.17 a b c d ___

C.18 a b c d ___

C.19 a(__),b(__),c(__),d(__)

C.20 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. Moving 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]
A reactor has a K_{eff} of 1.1. What are the values of Δk and ρ?

a. $\Delta k = 0.10$ and $\rho = 0.09$

b. $\Delta k = 0.10$ and $\rho = 0.10$

c. $\Delta k = 0.90$ and $\rho = 0.10$

d. $\Delta k = 0.09$ and $\rho = 0.01$

QUESTION A.09 [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.10 [1.0 point]
Which ONE of the following is the reason that causes the reactor power to rapidly decrease in the fuel due to a rapid power excursion (rapid reactivity change)?

a. By increasing of the reproduction factor.

b. By decreasing of Doppler broadening of U-238.

c. By increasing of the resonance escape probability.

d. By decreasing of the thermal non-leakage probability and fast non-leakage probability.

QUESTION A.11 [1.0 point]
The reactor has been stable at 5 W for about an hour. Removing the source from the core causes reactor power to:

a. increase due to an increase in the amount of moderator.

b. decrease since the reactor is under-moderated.

c. stay the same due to keff being constant.

d. decrease due to fast neutron leakage.

QUESTION A.12 [1.0 point]
Assume that the worths of the rods are, respectively, $4.0, $3.5, and $1.5. The reactor is critical at 5 W after WITHDRAWING the following control rod worths: Shim/Safety1 $3.00, Shim/Safety2 $2.00, and Shim/Safety3 $1.20. What is the core excess?

a. -$1.20.

b. $2.20.

c. $2.80.

d. $9.00.

QUESTION A.13 [1.0 point]
Which ONE of the following combinations of characteristics makes a good reflector?

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

QUESTION A.14 [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.15 [1.0 point]
How does the reactor startup source function?

a. The plutoniurm 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.16 [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.17 [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.18 [1.0 point]
K_{eff} for the reactor is 0.85. If you place an experiment worth +17.6% δk/k. into the core, what will the new K_{eff} be?

a. 0.995

b. 0.9995

c. 1.005

d. 1.05

QUESTION A.19 [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.20 [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 **********

QUESTION B.01 [1.0 point]
The radiation from an unshielded Co-60 source is 500 mrem/hr. What thickness of lead shielding will be needed to lower the radiation level to 5 mrem/hr? The HVL (half-value-layer) for lead is 6.5 mm.

a. 26 mm.

b. 33 mm.

c. 38 mm.

d. 44 mm.

QUESTION B.02 [1.0 point, 0.25 each]
Match the Federal regulation in column A with the correct area covered in column B.

Column A		Column B
a.	10 CFR 20.	1. Domestic licensing of production and utilization facilities.
b.	10 CFR 50.	2. Operators' licenses.
c.	10 CFR 55.	3. Domestic licensing of special nuclear material
d.	10 CFR 70.	4. Protection against radiation.

QUESTION B.03 [1.0 point]
What will happen if an operator trainee presses the shim/safety 1 UP button and then the licensed operator presses the shim/safety 2 UP button ?

a. Shim/Safety 1 rod drives down.

b. Shim /Safety 1 rod drives down.

c. Nothing, as the rods are mechanically interlocked so that only one button can be pressed at any given time.

d. Shim/Safety 2 rod oscillates, going up, then down, then up, then down, …

QUESTION B.04 [1.0 point]
A radioactive source reads 35 Rem/hr on contact. Five hours later, the same source reads 1.5 Rem/hr. What will the sample read in another five hours?

a. 55 mrem.

b. 65 mrem.

c. 75 mrem.

d. 750 mrem.

QUESTION B.5 [1.0 point]
Which ONE of the following is the definition of the site boundary for the Ohio State reactor facility?

a. The area inside the reactor bay.

b. 250 feet from the center of the reactor.

c. The physical boundary of campus.

d. The reactor building and the area inside the fence surrounding it..

QUESTION B.06 [1.0 point]
During a reactor startup, the reactor operator calculates that the maximum excess reactivity for reference core conditions is 5.2% Δk/k. For this excess reactivity, which ONE of the following is the best action?

a. Continue to operate because the excess reactivity is within TS limit.

b. Increase power to 100 W and verify the excess reactivity again.

c. Shutdown the reactor; immediately report the result to the supervisor due to excess being above TS limit.

d Continue operation, but immediately report the result to the supervisor since the excess reactivity is exceeding TS limit.

QUESTION B.07 [1.0 point]
An area in which radiation levels could result in an individual receiving a dose equivalent of 20 mRem/hr can be considered as a:

a. Radiation area.

b. Vital Area.

c. High Radiation Area.

d. Very High Radiation Area.

QUESTION B.08 [1.0 point]
What are the MINIMUM staffing requirements for reactor operations?

a. 1 RO on console and 1 person in the facility who can be contacted within 5 minutes.

b. 1 RO on console, 1 person in the facility, and 1 on-call SRO .

c. 2 RO on console and 1 person in the facility.

d. 1 SRO on console and the Reactor Director.

QUESTION B.09 [1.0 point]
The Total Effective Dose Equivalent (TEDE) is defined as the sum of the deep-dose equivalent and the committed effective dose equivalent. The deep-dose equivalent is related to:

a. the dose to organs or tissues.

b. the external exposure to the skin or an extremity.

c. the external exposure to the lens of the eye.

d. the external whole-body exposure.

QUESTION B.10 [1.0 point]
Which ONE of the following radioisotopes will decay with the SHORTEST half-life?

a. Al^{28}

b. N^{16}

c. Ar^{41}

d. Xe^{135}

QUESTION B.11 [1.0 point]
Two sheets of ¼ inch thick lead reduce a radiation beam from 200 mR/hr to 100 mR/hr at one foot. Which ONE of the following will be the radiation measurement at one foot if you add another two (for a total of 4) ¼ inch lead sheets?

a. 20 mR/hr.

b. 35 mR/hr.

c. 50 mR/hr.

d. 70 mR/hr.

QUESTION B.12 [1.0 point]
The linear power level channel shall be calibrated at least _____ by thermal power calibration.

a. monthly

b. quarterly

c. semi-annually

d. annually

QUESTION B.13 [1.0 points]
. Operator Log entries must be initialed by the SRO for:

a. Any unplanned scram

b. Startup after loss of building power.

c. Using the low source bypass

d. All the above.

QUESTION B.14 [1.0 point]
A reactor power calibration must be performed at an indicated power level of _____ and the typical ending water temperature is _____.?

a. 70% of full power; 70 °F

b. 80% of full power; 85 °F

c. 90% of full power; 95 °F

d. 95% of full power; 100 °F

QUESTION B.15 [1.0 point]
Which ONE of the following types of experiments shall **NOT** be irradiated at the OSURR reactor?

a. The experiment contains 4 grains of gun powder.

b. A single movable experiment has an absolute value of reactivity worth of 0.2%. Δk/k

c. The experiment installed does not interfere with nuclear instrumentation.

d. The experiment contains a corrosive material in a single capsule.

~~**QUESTION B.16 [1.0 point]**~~ **DELETED**
Demineralizer resin may need to be changed when ____?

a. Inlet conductivity is decreasing.

b. Reactor pool water clarity is decreasing.

c. The resin has been in use for 2 years.

d. Increasing amounts of dirt are on the reactor pool water surface.

QUESTION B.17 [1.0 point]
Which choice best describes the non-OSU emergency response organizations that are available, by agreement, to provide assistance for reactor emergencies?

a. Columbus Fire Department

b. NRC

c. Cincinnati Police Department

d. Davis-Besse Nuclear Power Station

QUESTION B.18 [1.0 point]
Which choice describes the best locations where radiological instrumentation is available for responding to an emergency in the reactor room? (Assume instruments in reactor room are not usable.)

a. Rx Supervisor's office

b. Control room

c. Room 501 Research Center

d. Radiation Safety Office

QUESTION B.19 [1point]
In the event of an emergency at the facility, who does the Emergency Response Team directly report to:

a. Chief, Regional Services

b. Emergency Director

c. Senior Reactor Operator In Charge

d. Reactor Health Physicis

QUESTION B.20 [1point]
All fuel elements or fueled devices in storage in a safe geometry shall have a K_{eff} of less than ___.

a. 1.0

b. 0.9

c. 0.8

d. 0.7

********** End of Section B **********

Question C.01 [1.0 point]

Which ONE of the following describes a standard fuel element?

a. 19.5% enriched uranium contained within stainless steel plates.

b. 37.5% enriched uranium contained within aluminum plates.

c. 19.5% enriched uranium contained within aluminum plates.

d. 37.5% enriched uranium contained within stainless steel plates.

QUESTION: C.02 [1.0 point]

All positions in the core grid plate are occupied by some type of assembly. This is done so that:

a. there is an even weight distribution on the grid plate.

b. there is no uneven coolant flow distribution through the core.

c. the core is as symmetric as possible to maintain an even reactivity distribution.

d. a predictable control rod worth is maintained.

QUESTION: C.03 [1.0 point]

Which ONE of the following statements is true regarding operation of the neutron source?

a. The neutron source may be moved at any time.

b. The neutron source cannot be moved out of its storage cask while simultaneously withdrawing any control rod.

c. The source is a 5-curie Sb-Be source which provides about $1x10^7$ neutrons/second.

d. When the source is in its fully raised position, it is located near the top of the fuel elements.

QUESTION: C.04 [1.0 point]

Which ONE of the following channels has a signal which will generate a "FAST" scram?

a. Linear Power Monitoring Channel

b. Period Monitoring Channel

c. Period Safety Channel

d. Startup Channel

QUESTION: C.05 [1.0 point]

The aluminum shrouds which surround each control rod have holes in the lower sections. The purpose of these holes is to:

a. provide viscous damping during reactor scrams.

b. provide a cooling water path through the shrouds.

c. provide points where a shroud lifting tool can be attached.

d. smooth out the thermal neutron flux distribution at the bottom of the core.

QUESTION: C.06 [2.00 points, 0.5 each]

Match the Area Radiation Monitor location listed in Column A with the correct detector listed in Column B. Items listed in Column B may be used more than once or not at all.

Column A		Column B
a. Above reactor pool	1.	Proportional counter
b. Thermal column and beam ports	2.	Ionization Chamber
c. Primary coolant heat exchanger	3.	GM detector
d. Water processing system	4.	Scintillation detector

QUESTION: C.07 [1.0 point]

The building evacuation system is activated by two switches. The switch located on the slow scram console in the control room only _____ while the switch located underneath the wall-mounted telephone in the control room only_____.

a. sounds the evacuation horn; turns off all ventilation fans exhausting to the outside of the building.

b. turns off all ventilation fans exhausting to the outside of the building; sounds the evacuation horn.

c. sounds the evacuation horn and turns off all ventilation fans exhausting to the outside of the building; sounds the evacuation horn.

d. sounds the evacuation horn; sounds the evacuation horn and turns off all ventilation fans exhausting to the outside of the building.

QUESTION: C.08 [1.0 point]

Which ONE of the following will prevent the withdrawal of a control rod?

a. Startup source moving out of the core.

b. Movement of fission chamber into the core.

c. Movement of fission chamber out of the core.

d. Green light on in Control Rod Positioning System.

QUESTION: C.09 [1.0 point]

For a control rod, the orange light is ON, the green light is OFF, and the white light is ON. These indicate that:

a. The rod and drive are not in contact, the rod is full out and the drive is full in.

b. The rod and drive are both full out.

c. The rod and drive are both full in.

d. The rod and drive are not in contact, the drive is full out and the rod is full in.

QUESTION: C.10 [1.0 point]

When the building gaseous effluent monitor alarms, which ONE of the following occurs?

a. The reactor scrams.

b. The ventilation exhaust fan stops.

c. The building evacuation horn sounds.

d. No action occurs.

QUESTION: C.11 [2.00 points, 0.5 each]

Match the instrument channel listed in Column A with the correct detector listed in Column B. Items listed in Column B may be used more than once or not at all.

Column A	Column B
a. Logarithmic Power	1. Proportional counter
b. Startup	2. Fission chamber
c. Linear power	3. GM detector
d. Power Level Safety	4. Compensated Ion Chamber
	5. Uncompensated Ion chamber

~~**QUESTION: C.12 [1.0 point]**~~ **DELETED**

Input to the servo system is provided by the:

a. Logarithmic Power Channel.

b. Linear Power Channel.

c. Power Level Channel #1.

d. Power Level Channel #2.

QUESTION: C.13 [1.0 point]

Which ONE of the following switch positions will prohibit a startup?

a. Effluent Monitor Compressor “On”.

b. Period Generator Switch Position “Off”.

c. Log N Amplifier Calibrate Switch “Test”.

d. Log Period Amplifier Calibrate Switch “Norm”.

QUESTION: C.14 [1.0 point]

The reactor is operating at 500 kilowatts, when the SECONDARY coolant pump trips on overload. Assuming NO OPERATOR ACTION, which ONE of the following trips would most likely cause a reactor scram?

a. High Flux

b. Short Period

c. High Coolant Inlet Temperature

d. High power, No pumps

QUESTION: C.15 [1.0 point]

Water from the Makeup Water System is added to the reactor pool:

a. at the suction of the Water Process System pump.

b. at the inlet of the demineralizer in the Water Process System.

c. at the inlet of the ion exchange filters in the Water Process System.

d. at the outlet of the ion exchange filters in the Water Process System.

QUESTION: C.16 [1.0 point]

Which ONE of the following scram functions results in ONLY a slow scram?

a. Reactor fast period.

b. Reactor overpower.

c. Low count rate.

d. Core inlet temperature below setpoint.

QUESTION: C.17 [1.0 point]

The gamma rays incident upon the Startup Channel do not cause a pulse to be counted. Which ONE of the following describes the reason gamma pulses are not counted?

a. The Startup Channel detector has compensating voltage to subtract the gamma pulses from the signal.

b. The design of the detector allows gamma rays to pass through the detector with no interaction.

c. The detector uses a pulse height discriminator, which prevents the smaller gamma pulses from being counted.

d. The number of gamma rays is much smaller than the number of neutrons.

QUESTION: C.18 [1.0 point]

An annunciator lamp switch flashes and an audible signal is emitted to alert the operator to a slow or fast scram condition. Acknowledging the condition will always:

a. silence the alarm and extinguish the light.

b. silence the alarm only if the condition has returned to normal.

c. silence the alarm.

d. extinguish the light.

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 a
REF: Burn, R., *Introduction to Nuclear Reactor Operations,* © 1982, Sec 3.3.4.

A.09 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.10 d
REF: Fuel Moderator Temperature Effects

A.11 c or d accepted per facility comment
REF: NRC Standard question.

A.12 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.13 c
REF: Standard NRC Question

A.14 b
REF: Burn, R., *Introduction to Nuclear Reactor Operations,* © 1982, Sec 4.2.

A.15 c
REF: SAR 3.1.2.2

A.16 c
REF: Burn, R., *Introduction to Nuclear Reactor Operations,* © 1982, Sec 4.5.

A.17 b.
REF: Burn, R., *Introduction to Nuclear Reactor Operations,* © 1988, §

A.18 b.
REF Burn, R., *Introduction to Nuclear Reactor Operations,* © 1988, §
SDM = $(1-k_{eff})/k_{eff}$ = (1-0.85)/0.85 = 0.15/0.85 = 0.1765, or a reactivity worth (ρ) of -0.1765. Adding + 0.176 reactivity will result in a SDM of 0.1765 - 0.1760 = 0.0005. K_{eff} = 1/(1+SDM) = 1/(1 + 0.0005) = 0.9995

A.19 c.
REF: Burn, R., *Introduction to Nuclear Reactor Operations*, © 1982, § 3.3.4, p. 3-21.

A.20 a.
REF: Burn, R., *Introduction to Nuclear Reactor Operations,* © 1988, § 4.7, p. 4-21

B.01 d
REF: $DR = DR_{\circ} * e^{-\mu X}$

HVL (=6.5 mm) means the original intensity will reduce by half when a lead sheet of 6.5 mm is inserted. Find μ if the HVL is given as follows: $1 = 2 * e^{-\mu * 6.5}$; μ = 0.10664

Find X: $5 \text{ mrem/hr} = 500 \text{ mrem/hr} * e^{-0.10664 * X}$; X= 43.2 mm

B.02 a(4) b(1) c(2) d(3)
REF: 10 CFR

B.03 c
REF: SAR 3.3.8

B.04 b
REF $DR = DR_{\circ} * e^{-\lambda t}$

$1.5 \text{ rem/hr} = 35 \text{ rem/hr} * e^{-\lambda(5hr)}$

$\ln(1.5/35) = -\lambda * 5 \rightarrow \lambda = 0.623$; solve for another 5 hour later, DR $DR = 1.5 \text{ Rem} * e^{-0.623*(5)}$

$DR = 6.6 * 10^{-2}$ Rem or ~65 mrem

B.05 d.
REF: Emergency Plan

B.06 c
REF: TS, Section 3.1.1

B.07 a
REF: 10 CFR 20

B.08 b
REF: TS Section 6.1.3

B.09 d.
REF: 10 CFR 20.1201

B.10 b.
REF: Chart of the Nuclides

B.11 c
REF: A ½ thickness is 2 sheets. Add another 2 sheets, a radiation level will reduce by another ½, or 50 mR/hr

B.12 d.
REF: TS 4.2.2

B.13 d.
REF: OM-08

B.14 c
REF: OM-16

B.15 d
REF: Tech Specs 3.7.1

~~B.16 b.~~ Deleted
~~REF: SAR 3.2.4~~

B.17 a
REF: Emergency Plan

B.18 c or d accepted per facility comment
REF: Emergency Plan

B.19 b.
REF: Emergency Plan

B.20 b
REF: Tech Specs 5.4

C.1 c
REF: SAR 3.1.1.2.
Δk
C.2 b
REF: SAR 3.1.1.3.

C.3 a
REF: SAR 3.3.11.

C.4 c
REF: OSU SAR, §§ 3.3.13, 14, 15 & 17

C.5 b
REF: SAR 3.1.2.3

C.6 a, 3 b, 3 c, 3 d, 3
REF: SAR 3.7.

C.7 a
REF: SAR 3.6.6

C.8 c
REF: SAR 3.3.8.3

C.9 b
REF: SAR Table 3.1.

C.10 d
REF: EP-03.

C.11 a, 4 b, 2 c, 4 d, 5
REF: SAR 3.3.12, 13, 14, 15, 16.

~~C.12 b~~ Deleted
~~REF: SAR~~

C.13 c
REF: Technical Specifications, Section 3.2.3.

C.14 d
REF: TS 3.2.3

C.15 d
REF: SAR Figure 3.16.

C.16 c
REF: SAR Table 3.2.

C.17 c

REF: SAR 3.3.14.

C.18 c
REF: SAR 3.6.5.