August 20, 2004

Andrew C. Kauffman, Associate Director
Nuclear Reactor Laboratory
Ohio State University
1298 Kinnear Road
Columbus, OH 43210-1107

SUBJECT: INITIAL EXAMINATION REPORT NO. 50-150/OL-04-01, OHIO STATE UNIVERSITY

Dear Mr. Kauffman:

During the week of July 26, 2004, the NRC administered an operator licensing examination at your Ohio State University Reactor. The examination was conducted according to NUREG-1478, "Non-Power Reactor Operator Licensing Examiner Standards," Revision 1. Examination questions and preliminary findings were discussed with those members of your staff identified in the enclosed report at the conclusion of the examination.

In accordance with 10 CFR 2.390 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 Agencywide Documents Access and Management System (ADAMS). ADAMS is accessible from the NRC Web site at (the Public Electronic Reading Room) http://www.nrc.gov/NRC/ADAMS/index.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 Paul Doyle at (301) 415-1058 or via internet e-mail pvd@nrc.gov.

Sincerely,

/RA/

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

Docket No. 50-150

Enclosures: 1. Initial Examination Report No. 50-150/OL-04-01
2. Examination including NRC resolved facility comments

cc w/encls:
Please see next page

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PUBLIC	RNRP R&TR r/f	PMadden
DHughes	Facility File (EBarnhill) O-6 F-2	

EXAMINATION PACKAGE ACCESSION #: ML040790835
EXAMINATION REPORT ACCESSION #: ML042190437 **TEMPLATE #: NRR-074**

OFFICE	RNRP:CE		IROB:LA	E	RNRP:SC	
NAME	PDoyle		EBarnhill		PMadden	
DATE	8 / 12 /2004		8 / 19 /2004		8 / 20 /2004	

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cc:

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

REPORT NO.: 50-150/OL-04-01

FACILITY DOCKET NO.: 50-150

FACILITY LICENSE NO.: R-75

FACILITY: Ohio State University

EXAMINATION DATES: July 27-28, 2004

SUBMITTED BY: **/RA/** 7/29/04
Paul Doyle, Chief Examiner Date

SUMMARY:

On July 27 & 28, 2004, the NRC administered an operator licensing examination to a Senior Reactor Operator (Instant) candidate at the Ohio State University Research Reactor. The candidate passed all portions of the examination.

REPORT DETAILS

1. Examiners:
   Paul Doyle, Chief Examiner

2. Results:

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

3. Exit Meeting:
   Paul Doyle, NRC, Examiner
   Andrew Kauffman, Associate Director, Ohio State University Research Reactor

   At the exit meeting the facility presented the examiner with their comments on the written examination. The comments have been incorporated into the examination included with this report. The examiner thanked the facility for their assistance in the administration of the examinations.

OHIO STATE UNIVERSITY

With Answer Key

UNITED STATES NUCLEAR REGULATORY COMMISSION

OPERATOR LICENSING EXAMINATION

July 27, 2004

Enclosure 2

QUESTION A.1 [1.0 point]
Core excess reactivity changes with …

a. fuel element burnup

b. control rod height

c. neutron energy level

d. reactor power level

QUESTION A.2 [1.0 point]
You're increasing reactor power on a steady +26 second period. How long will it take to increase power by a factor of 1000?

a. 60 seconds (1 minute)

b. 180 seconds (3 minutes)

c. 300 seconds (5 minutes)

d. 480 seconds (8 minutes)

QUESTION A.3 [1.0 point]
The delayed neutron precursor (β) for U^{235} is 0.0065. However, when calculating reactor parameters you use β_{eff} with a value of ~0.0070. Why is β_{eff} larger than β?

a. Delayed neutrons are born at higher energies than prompt neutrons resulting in a greater worth for the neutrons.

b. Delayed neutrons are born at lower energies than prompt neutrons resulting in less leakage during slowdown to thermal energies.

c. The fuel also contains U^{238} which has a relatively large β for fast fission.

d. U^{238} in the core becomes Pu^{239} (by neutron absorption), which has a higher β for fission.

QUESTION A.4 [1.0 point]
The difference between a moderator and a reflector is that a reflector …

a. increases the fast non-leakage factor and a moderator increases the thermal utilization factor.

b. increases the neutron production factor and a moderator increases the fast fission factor.

c. increases the neutron production factor and a moderator decreases the thermal utilization factor.

d. decreases the fast non-leakage factor and a moderator increases the thermal utilization factor.

QUESTION A.5 [1.0 point]
What is the definition of a cross section?

a. The probability that a neutron will be captured by the nucleus.

b. The most likely energy at which a charged particle will be captured.

c. The length a charged particle travels past the nucleus before being captured.

d. The area of the nucleus including the electron cloud.

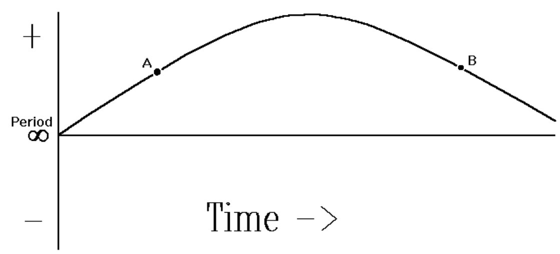
QUESTION A.6 [1.0 point]
Shown below is a trace of reactor period as a function of time. Between points A and B reactor power is:

a. continually increasing.

b. continually decreasing.

c. increasing, then decreasing.

d. constant.



QUESTION A.7 [1.0 point]
The term "reactivity" may be described as…

a. a measure of the core's fuel depletion.

b. negative when K_{eff} is greater than 1.0.

c. a measure of the core's deviation from criticality.

d. being equal to 0.0050 ΔK/K when the reactor is prompt critical.

QUESTION A.8 [1.0 point]
Which ONE of the following is an example of alpha decay?

a. $_{35}Br^{87} \rightarrow {}_{33}As^{83}$

b. $_{35}Br^{87} \rightarrow {}_{35}Br^{86}$

c. $_{35}Br^{87} \rightarrow {}_{34}Se^{86}$

d. $_{35}Br^{87} \rightarrow {}_{36}Kr^{87}$

QUESTION A.9 [1.0 point]
Which ONE of the following is correct with regard to criticality?

a. Critical rod height does NOT depend on how fast control rods are withdrawn.

b. Critical rod height dictates the reactor power level when criticality is first achieved.

c. The slower the approach to criticality, the lower the reactor power level will be when reaching criticality.

d. The reactivity of the reactor increases towards infinity during the approach to criticality.

QUESTION A.10 [1.0 point]
The neutron microscopic cross-section for absorption σ_a generally …

a. increases as neutron energy increases

b. decreases as neutron energy increases

c. increases as target nucleus mass increases

d. decreases as target nucleus mass increases

QUESTION A.11 [1.0 point]
WHICH ONE of the following is the MAJOR source of energy released during fission?

a. Kinetic energy of the fission neutrons.

b. Kinetic energy of the fission fragments.

c. Decay of the fission fragments.

d. Prompt gamma rays.

QUESTION A.12 [1.0 point]
Which ONE of the following is the reason for an installed neutron source within the core? A startup without an installed neutron source …

a. is impossible as there would be no neutrons available to start up the reactor.

b. would be very slow due to the long time to build up neutron population from so low a level.

c. could result in a very short period due to the reactor going critical before neutron population built up high enough to be read on nuclear instrumentation.

d. can be compensated for by adjusting the compensating voltage on the source range detector.

QUESTION A.13 [1.0 point]
Several processes occur that may increase or decrease the available number of neutrons. SELECT from the following the six-factor formula term that describes an INCREASE in the number of neutrons during the cycle.

a. Thermal utilization factor.

b. Resonance escape probability.

c. Thermal non-leakage probability.

d. Reproduction factor.

QUESTION A.14 [1.0 point]
Which one of the following is the definition of the FAST FISSION FACTOR?

a. The ratio of the number of neutrons produced by fast fission to the number produced by thermal fission

b. The ratio of the number of neutrons produced by thermal fission to the number produced by fast fission

c. The ratio of the number of neutrons produced by fast and thermal fission to the number produced by thermal fission

d. The ratio of the number of neutrons produced by fast fission to the number produced by fast and thermal fission

QUESTION A.15 [1.0 point]
By definition, an exactly critical reactor can be made prompt critical by adding positive reactivity equal to …

a. the shutdown margin

b. the K_{excess} margin

c. the β_{eff} value

d. 1.0 %ΔK/K.

QUESTION A.16 [1.0 point]
The number of neutrons passing through a one square centimeter of target material per second is the definition of which one of the following?

a. Neutron Population (np)

b. Neutron Impact Potential (nip)

c. Neutron Flux (nv)

d. Neutron Density (nd)

QUESTION A.17 [1.0 point]
Given the following data, which ONE of the following is the closest to the half life of the material?

TIME	ACTIVITY
0	2400 cps
10 min.	1757 cps
20 min.	1286 cps
30 min.	941 cps
60 min.	369 cps

a. 11 minutes

b. 22 minutes

c. 44 minutes

d. 51 minutes

QUESTION A.18 [1.0 point]
Which ONE of the following is the correct reason that delayed neutrons enhance control of the reactor?

a. There are more delayed neutrons than prompt neutrons.

b. Delayed neutrons increase the average neutron generation time.

c. Delayed neutrons are born at higher energies than prompt neutrons and therefore have a greater effect.

d. Delayed neutrons take longer to reach thermal equilibrium.

QUESTION A.19 [1.0 point]
Regulating rod worth for a reactor is 0.001 ΔK/K/inch. Moderator temperature **INCREASES** by 9°F, and the regulating rod moves 4½ inches inward to compensate. The moderator temperature coefficient α_{Tmod} is …

a. $+5 \times 10^{-4}$ ΔK/K/°F

b. -5×10^{-4} ΔK/K/°F

c. $+2 \times 10^{-5}$ ΔK/K/°F

d. -2×10^{-5} ΔK/K/°F

QUESTION A.20 [1.0 point]
K_{eff} is K_{∞} times …

a. the fast fission factor (ε)

b. the total non-leakage probability ($\mathscr{L}_f \times \mathscr{L}_{th}$)

c. the reproduction factor (η)

d. the resonance escape probability (p)

QUESTION B.1 [1.0 point]
An experiment irradiated in the pool reads 50mr/hr at 2 feet below the pool surface and 100 mr/hr at 1 foot below the pool surface. You decide to place the experiment at 20 feet below the surface of the pool. Based on the attenuation you noted between the 2 foot and 1 foot levels, you would expect the shielding due to 20 feet of water to reduce the dose by a factor of approximately … (Note: Ignore dose decrease due to distance.)

a. 1000

b. 10,000

c. 100,000

d. 1,000,000

QUESTION B.2 [2.0 points, 0.4 each]
Match the terms listed in column A with the respective reactivity limit from column B. (Note: Only one answer for each item in column A. Items in column B may be used more than once or not at all.)

Column A	Column B
a. Single Moveable	1. 0.2% ΔK/K
b. Total Moveable	2. 0.3% ΔK/K
c. Single Secured	3. 0.4% ΔK/K
d. Total Secured	4. 0.5% ΔK/K
	5. 0.6% ΔK/K
	6. 0.7% ΔK/K
	7. 0.8% ΔK/K

QUESTION B.3 [1.0 point, ¼ each]
Match the limitation listed in column A, with the correct minimum authorization in column B.

a. Sample insertion or removal with reactor operating.	1. Reactor Operator
b. Bringing explosive material into the NRL.	2. Senior Operator on Duty
c. Transporting corrosive material beyond the entrance chain of either pool.	3. Senior Operator on Duty in writing
d. Entering the control room	

QUESTION B.4 [1.0 point]
The four Emergency Classifications used by the NRC are listed below. Which ONE of the classifications is the ONLY one applicable to the OSURR? (Note: Items are listed alphabetically, **NOT** in order of severity!)

a. Alert

b. General Emergency

c. Notification of Unusual Event

d. Site Area Emergency.

QUESTION B.5 [1.0 point]
While working on an experiment, you receive the following radiation doses: 100 mrem (β), 25 mrem (γ), and 5 mrem (thermal neutrons). Which ONE of the following is your total dose?

a. 175 mrem

b. 155 mrem

c. 145 mrem

d. 130 mrem

QUESTION B.6 [1.0 point]
In case of an emergency the NORMAL Emergency Support Center (ESC) is the control room, however, if the control room is unavailable the ESC will be setup in the …

a. OSU Research Center Main Lobby

b. library of the Van de Graaff laboratory

c. NRL Director's office

d. Office of Public Safety (OSUPD)

QUESTION B.7 [1.0 point]
The core is fully loaded. The maximum number of control rods which may be out of the core for annual inspection at any time is …

a. one (either a Shim-Safety rod or the regulating rod)

b. the regulating rod and any other rod

c. any two rods

d. none, you must first unload the core.

QUESTION B.8 [2.0 point, 0.5 each]
Identify each of the following as either a Safety Limit (SL), a Limiting Safety System Setting (LSSS) or as a Limiting Condition for Operations (LCO).

a. Reactor Fuel Temperature shall be less than 550°C

b. … and 15 feet of water above core.

c. … core Inlet water temperature shall not exceed 35°C.

d. … shall not exceed 600 Kilowatts during a transient.

QUESTION B.9 [2.0 points, 0.5 each]
Identify whether each of the following experiments has no special requirements (NR), requires Double encapsulation (DOUBLE), or in Not Authorized (NA).

a. Corrosive Materials

b. Cryogenic Materials

c. contains 1.6 milligrams of explosive material

d. the calculated temperature outside the capsule will be 110°C.

QUESTION B.10 [1.0 points, 0.25 each]
Identify the source for the listed radioisotopes. Irradiation of air, water, structural material or fission product.

a. N^{16}

b. Na^{24}

c. Ar^{41}

d. Xe^{133}

QUESTION B.11 [1.0 point]
The CURIE content of a radioactive source is a measure of

a. the number of radioactive atoms in the source.

b. the amount of energy emitted per unit time by the source

c. the amount of damage to soft body tissue per unit time.

d. the number of nuclear disintegrations per unit time.

QUESTION B.12 [1.0 point]
Per procedure, the coolant systems (primary and secondary) must be in operation prior to …

a. latching control rods

b. reaching is criticality.

c. reactor power level exceeding 100 Kilowatts.

d. reactor power level reaching full power.

QUESTION B.13 [1.0 point]
Which ONE of the following conditions is ***NOT*** a Reportable Occurrence per the Technical Specification definition?

a. Operation of the reactor with a minimum shutdown margin (Xenon free, with the most reactive rod in the fully withdrawn position) of 3.0% Δk/k.

b. Pool pH is 9.0.

c. Operation of the reactor with the Gaseous Effluent Monitor (GEM) out of service. The Rabbit Effluent Monitor is operating fine. No experiments are in progress.

d. Operation of the reactor with a pool level of 15.5 ft. above the top of the core.

QUESTION B.14 [1.0 point, 0.25 each]
Identify the correct number which correctly defines the maximum period between testing intervals per the Technical Specifications definitions.

a. Weekly: ___ days

b. Monthly: ___ weeks

c. Quarterly: ___ months

d. Annually: ___ months

QUESTION B.15 [1.0 point]
Which ONE of the following is the definition of a CHANNEL TEST?

a. the combination of sensor, line, amplifier, and output devices which are connected for the purpose of measuring the value of a parameter.

b. an adjustment of the channel such that it output corresponds with acceptable accuracy to known values of the parameter which the channel measures.

c. a qualitative verification of acceptable performance by observation of channel behavior.

d. the introduction of a signal into the channel for verification that It Is operable.

QUESTION B.16 [1.0 point, ¼ each]
Match type of radiation (1 thru 4) with the proper penetrating power (a thru d)

a. Gamma	1. Stopped by thin sheet of paper
b. Beta	2. Stopped by thin sheet of metal
c. Alpha	3. Best shielded by light material
d. Neutron	4. Best shielded by dense material

QUESTION B.17 [1.0 point]
The low neutron count scram may be bypassed provided K_{eff} is less than

a. 1.00% ΔK/K

b. 0.95% ΔK/K

c. 0.90% ΔK/K

d. 0.85% ΔK/K

QUESTION C.1 [1.0 point]
Which ONE of the following is NOT a control rod limit switch?

a. Lead Screw in the up position

b. Lead Screw in the down position

c. Control Rod in the up position

d. Control Rod in the down position

QUESTION C.2 [2.0 points, ½ each]
Match the problems on the left with its possible plant conditions on the right. (No changes to any equipment have been made, e.g. no valves manipulated)

a. High radiation level in demineralizer tanks	1. Resin separation (channeling)
b. High radiation level on demineralizer outlet	2. Fission product release
c. High flow through demineralizer tanks	3. High water temperature
d. High pressure on demineralizer inlet	4. Clogging

QUESTION C.3 [1.0 point]
Which one of the following is NOT a reason for having excess reactivity in the core?

a. Fission Product poisons buildup

b. Pool Temperature changes

c. Insertion of Experiments

d. The use of a neutron source

QUESTION C.4 [1.0 point]
Which ONE of the following detectors is used primarily to measure N^{16} release to the environment?

a. NONE, N^{16} has too short a half-life to require environmental monitoring.

b. Reactor Building Gaseous Effluent Monitor

c. Rabbit Blower Effluent Monitor

d. Area Monitor above the pool

QUESTION C.5 [2.0 point, ⅓ each]
Identify each of the following characteristics as belonging to either the regulating rod (RR) or the shim-safety rods (SSR).

a. The poison section is attached directly to the drive screw.

b. Active length = 26"

c. Rod is smooth

d. Rod is grooved

e. Rod is hollow

f. Poison material is Stainless Steel

QUESTION C.6 [1.0 point]
Which ONE of the following is the main function performed by the DISCRIMINATOR circuit in the Startup Channel?

a. To generate a current signal equal and of opposite polarity as the signal due to gammas generated within the Startup Channel Detector.

b. To filter out small pulses due to gamma interactions, passing only pulses due to neutron events within the Startup Channel Detector.

c. To convert the linear output of the Startup Channel Detector to a logarithmic signal for metering purposes.

d. To convert the logarithmic output of the metering circuit to a δt (delta time) output for period metering purposes.

QUESTION C.7 [1.0 point]
Which ONE of the following correctly describes how a compensated ion chamber detects neutrons. A neutron interacts with the …

a. U^{235} lining of the tube.

b. B^{10} lining of the tube.

c. BF_3 gas which fills the tube

d. N_2 gas which fills the tube.

QUESTION C.8 [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. Low Secondary Flow

QUESTION C.9 [1.0 point]
Secondary Coolant Flow is adjusted by varying the …

a. speed of the positive displacement pump motor.

b. chamber size of the positive displacement pump.

c. level in the surge tank (submergence control of the centrifugal pump).

d. position of the valve in the pump bypass line.

QUESTION C.10 [2.0 points, ¼ each]
Using the drawing of the primary system provided, identify the

a.	1. By-pass Flow Valve
b.	2. City Water Supply
c.	3. Decay Tank
d.	4. Modulating Valve
e.	5. Primary Heat Exchanger
f.	6. Primary Coolant Pump
g.	7. Primary Coolant Return
h.	8. Surge Tank

Note Question #11 was omitted due to typographic error.

QUESTION C.12 [1.0 point]
Normal cooling is using the

a. 100% flow through the fan-forced unit.

b. 100% flow through the tertiary loop.

c. an operator controlled mixture of flow through the fan-forced unit and the tertiary loop.

d. an operator controlled mixture of flow through the fan-forced unit and the bypass leg.

QUESTION C.13 [1.0 point]
Which ONE of the following describes how the signal for regulating rod position indication is generated?

a. A series of magnetic switches (10 per inch) which respond to lead screw position.

b. A tachometer that counts the revolutions of the lead screw.

c. A series of limit switches that are actuated by the ball bearing screw assembly.

d. A Servo Transmitter mounted on the control rod drive mechanism.

QUESTION C.14 [1.0 point]
Which one of the following situations will cause the reactor to automatically SCRAM?

a. Loss of all ventilation exhaust fans.

b. High Radiation level at top of pool.

c. Low pool water level.

d. Sudden decrease in neutron induced signal

QUESTION C.15 [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.16 [1.0 point] Note: No change for this administration of examination. However, the question is modified for future use to make it more correct.

Which ONE of the following conditions will result in a shim-safety control blade withdrawal inhibit?

a. Positive 20 second period on the Period Monitoring Channel

b. Movement of the startup detector~~.~~, outward.

c. Positive 20 second period on the Period Safety Channel

d. Movement of the Regulating Rod

QUESTION C.17 [2.0 points, ¼ each] Choices f and g were removed during the examination, due to the fact that the facility does not operate in the automatic mode. The grading is changed to 2.0 points, ⅓ each.

Match the Lamp colors listed in column B with each of the rod position indicator lights in column A.

a. Bottom	1. Red
b. Down	2. Orange
c. Engage	3. Yellow
d. Intermediate	4. Green
e. Jam	5. Blue
~~f. Servo Permit~~	6. White
~~g. Servo On~~	
h. Up	

A.1 a
REF: Glasstone, S. and Sesonske, A, *Nuclear Reactor Engineering,* Kreiger Publishing, Malabar, Florida, 1991, §

A.2 ~~d~~ b (Typo)
REF: Glasstone, S. and Sesonske, A, *Nuclear Reactor Engineering,* Kreiger Publishing, Malabar, Florida, 1991, § $\ln(P/P0) \times \text{period} = \text{time}$, $\ln(1000) \times 26 = 6.908 \times 26 = 179.6 \approx 180$ seconds

A.3 b
REF: Glasstone, S. and Sesonske, A, *Nuclear Reactor Engineering,* Kreiger Publishing, Malabar, Florida, 1991, §

A.4 a
REF: Glasstone, S. and Sesonske, A, *Nuclear Reactor Engineering,* Kreiger Publishing, Malabar, Florida, 1991, §

A.5 a
REF: Glasstone, S. and Sesonske, A, *Nuclear Reactor Engineering,* Kreiger Publishing, Malabar, Florida, 1991, §

A.6 ~~c~~ a (Typo)
REF: Glasstone, S. and Sesonske, A, *Nuclear Reactor Engineering,* Kreiger Publishing, Malabar, Florida, 1991, §

A.7 c
REF: Glasstone, S. and Sesonske, A, *Nuclear Reactor Engineering,* Kreiger Publishing, Malabar, Florida, 1991, §

A.8 a
REF: Glasstone, S. and Sesonske, A, *Nuclear Reactor Engineering,* Kreiger Publishing, Malabar, Florida, 1991, §

A.9 a
REF: Glasstone, S. and Sesonske, A, *Nuclear Reactor Engineering,* Kreiger Publishing, Malabar, Florida, 1991, §

A.10 b
REF: Glasstone, S. and Sesonske, A, *Nuclear Reactor Engineering,* Kreiger Publishing, Malabar, Florida, 1991, §

A.11 b
REF: Glasstone, S. and Sesonske, A, *Nuclear Reactor Engineering,* Kreiger Publishing, Malabar, Florida, 1991, §

A.12 c
REF: Glasstone, S. and Sesonske, A, *Nuclear Reactor Engineering,* Kreiger Publishing, Malabar, Florida, 1991, §

A.13 d
REF: Glasstone, S. and Sesonske, A, *Nuclear Reactor Engineering,* Kreiger Publishing, Malabar, Florida, 1991, §

A.14 c
REF: Glasstone, S. and Sesonske, A, *Nuclear Reactor Engineering,* Kreiger Publishing, Malabar, Florida, 1991, §

A.15 c
REF: Glasstone, S. and Sesonske, A, *Nuclear Reactor Engineering,* Kreiger Publishing, Malabar, Florida, 1991, §

A.16 c
REF: Glasstone, S. and Sesonske, A, *Nuclear Reactor Engineering,* Kreiger Publishing, Malabar, Florida, 1991, §

A.17 b
1285 is close to ½ activity, so time should be close. Also, $A = A0\ e^{-\lambda t}$ so:
ln (1286/2400) = -λ(20 min) λ = -(ln(1286/2400))/20min = -0.0312 min t = ln(½)/-0.0312 = 22.19
REF: Glasstone, S. and Sesonske, A, *Nuclear Reactor Engineering,* Kreiger Publishing, Malabar, Florida, 1991, §

A.18 b
REF: Glasstone, S. and Sesonske, A, *Nuclear Reactor Engineering,* Kreiger Publishing, Malabar, Florida, 1991, §

A.19 ~~b~~ a (Typo) 0.001 ΔK/K/~~inch~~ × 4.5 ~~inch~~ ÷ 9°F = 0.001 ÷ 2 = 0.0005 = 5×10^{-4} ΔK/K/°F
REF: Glasstone, S. and Sesonske, A, *Nuclear Reactor Engineering,* Kreiger Publishing, Malabar, Florida, 1991, §

A.20 b
REF: Glasstone, S. and Sesonske, A, *Nuclear Reactor Engineering,* Kreiger Publishing, Malabar, Florida, 1991, §

B.1 d
REF: $2^{20} = 1{,}048{,}756 \approx 1{,}000{,}000$

B.2 a, 3 (0.4% ΔK/K); b, 5 (0.6% ΔK/K); c, 6(0.7% ΔK/K); d, 6 (0.7% ΔK/K)
REF: OSU Technical Specifications § 3.7

B.3 a, 1; b, 3; c, 2; d, 2
REF: AP-02, *General Rules*

B.4 c
REF: Emergency Plan § 4

B.5 d
REF: A rem is a rem is a rem.

B.6 b
REF: OSU Emergency Plan § 6.1

B.7 a
REF: OM-02 *Control Rod Annual Inspections,* § IV Precautions F.

B.8 a, SL; b, LCO; c, LSSS; d, LSSS
REF: Technical Specifications

B.9 a, DOUBLE; b, NR; c, NA; d, NA
REF: Technical Specifications § 3.6, *Limitations on Experiments*

B.10 a, water; b, structural material; c, air; d, fission product
REF: Standard NRC Question, source: Chart of the Nuclides

B.11 d
REF: Standard Health Physics Definition.

B.12 c
REF: OM-01 *Reactor Power Changes,* § IV Precautions, step G.

B.13 c or a (2nd correct answer added per facility comment)
REF: Technical Specification 1.1, 3.1.1, 3.1.3,3.5.2,

B.14 a, 10; b, 6; c, 4; d, 15
REF: OSU Technical Specifications, § 1.3 Definitions

B.15 d
REF: OSU Technical Specifications § 1.3 Definitions

B.16 a, 4; b, 2; c, 1; d, 3
REF: Standard NRC Question

B.17 c
REF: Technical Specifications Table 2.1.

C.1 c
REF: OSU FSAR, § 3.3.8.3 Table 3.1

C.2 a, a,2; b,3; c,1; d,4
REF: New NRC Question, 2nd verification.

C.3 d
REF: Standard NRC question.

C.4 a
REF: Standard NRC question

C.5 a, RR; b, SSR; c, RR; d, SSR; e, RR; f, RR
REF:

C.6 b
REF: Standard NRC question

C.7 ~~c~~ b (Typo)
REF: Standard NRC Question Bank.

C.8 ~~c~~ d Answer changed to d, per facility comment (initial scram due to loss of pump)
REF: CAF

C.9 b
REF: OSU SAR as modified by facility supplied errata sheet.

C.10 a, 3; b, 6; c, 4; d, 5; e, 1; f, 8; g, 2; h, 7
REF: SAR § 3, figure 3.14

C.12 ~~a~~ d (Typo)
REF: OSU SAR § 3.2.2.2.

C.13 d
REF: OSU SAR § 3.3.4 4th ¶

C.14 c
REF: OSU SAR Various parts of Chapter 3 and Technical Specifications 3.2.3, 3.3.2, 3.5 and 3.6.1

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

C.16 b
REF: OSU SAR, CAF

C.17 a, 4; b, 4; c, 6; d, 3; e, 1; ~~f, 1; g, 5;~~ h, 2
REF: OSU SAR Table 3.1.

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

FACILITY: Ohio State University

REACTOR TYPE: Pool

DATE ADMINISTERED: 2004/07/12

CANDIDATE: ______________________

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

Category Value	% of Total	% of Candidates Score	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. Facility and Radiation Monitoring Systems
60.00		______	____% 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. 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.

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

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

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

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

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

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

$$R_1(1 - K_{eff_1}) = CR_2(1 - K_{eff_2})$$
$$CR_1(-\rho_1) = CR_2(-\rho_2)$$

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

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

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

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

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

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

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

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

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

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

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

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

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

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

$$DR_1 d_1^2 = DR_2 d_2^2$$

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 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

A.1 a b c d ___

A.2 a b c d ___

A.3 a b c d ___

A.4 a b c d ___

A.5 a b c d ___

A.6 a b c d ___

A.7 a b c d ___

A.8 a b c d ___

A.9 a b c d ___

A.10 a b c d ___

A.11 a b c d ___

A.12 a b c d ___

A.13 a b c d ___

A.14 a b c d ___

A.15 a b c d ___

A.16 a b c d ___

A.17 a b c d ___

A.18 a b c d ___

A.19 a b c d ___

A.20 a b c d ___

B.1 a b c d ___

B.2a 1 2 3 4 5 6 7 ___

B.2b 1 2 3 4 5 6 7 ___

B.2c 1 2 3 4 5 6 7 ___

B.2d 1 2 3 4 5 6 7 ___

B.2e 1 2 3 4 5 6 7 ___

B.3a 1 2 3 ___

B.3b 1 2 3 ___

B.3c 1 2 3 ___

B.3d 1 2 3 ___

B.4 a b c d ___

B.5 a b c d ___

B.6 a b c d ___

B.7 a b c d ___

B.8a SL LSSS LCO ___

B.8b SL LSSS LCO ___

B.8c SL LSSS LCO ___

B.8d SL LSSS LCO ___

B.9a NR Double NA ___

B.9b NR Double NA ___

B.9c NR Double NA ___

B.9d NR Double NA ___

B.10a Water Air Structural Fission ___

B.10b Water Air Structural Fission ___

B.10c Water Air Structural Fission ___

B.10d Water Air Structural Fission ___

B.11 a b c d ___

B.12 a b c d ___

B.13 a b c d ___

B.14a ___ days

B.14b ___ weeks

B.14c ___ months

B.14d ___ months

B.15 a b c d ___

B.16a 1 2 3 4 ___

B.16b 1 2 3 4 ___

B.16c 1 2 3 4 ___

B.16d 1 2 3 4 ___

B.17 a b c d ___

C.1 a b c d ___

C.2a 1 2 3 4 ___

C.2b 1 2 3 4 ___

C.2c 1 2 3 4 ___

C.2d 1 2 3 4 ___

C.3 a b c d ___

C.4 a b c d ___

C.5a RR SR ___

C.5b RR SR ___

C.5c RR SR ___

C.5d RR SR ___

C.5e RR SR ___

C.5f RR SR ___

C.6 a b c d ___

C.7 a b c d ___

C.8 a b c d ___

C.9 a b c d ___

C.10a 1 2 3 4 5 6 7 8 ___

C.10b 1 2 3 4 5 6 7 8 ___

C.10c 1 2 3 4 5 6 7 8 ___

C.10d 1 2 3 4 5 6 7 8 ___

C.10e 1 2 3 4 5 6 7 8 ___

C.10f 1 2 3 4 5 6 7 8 ___

C.10g 1 2 3 4 5 6 7 8 ___

C.10h 1 2 3 4 5 6 7 8 ___

~~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.17a 1 2 3 4 5 6 ___

C.17b 1 2 3 4 5 6 ___

C.17c 1 2 3 4 5 6 ___

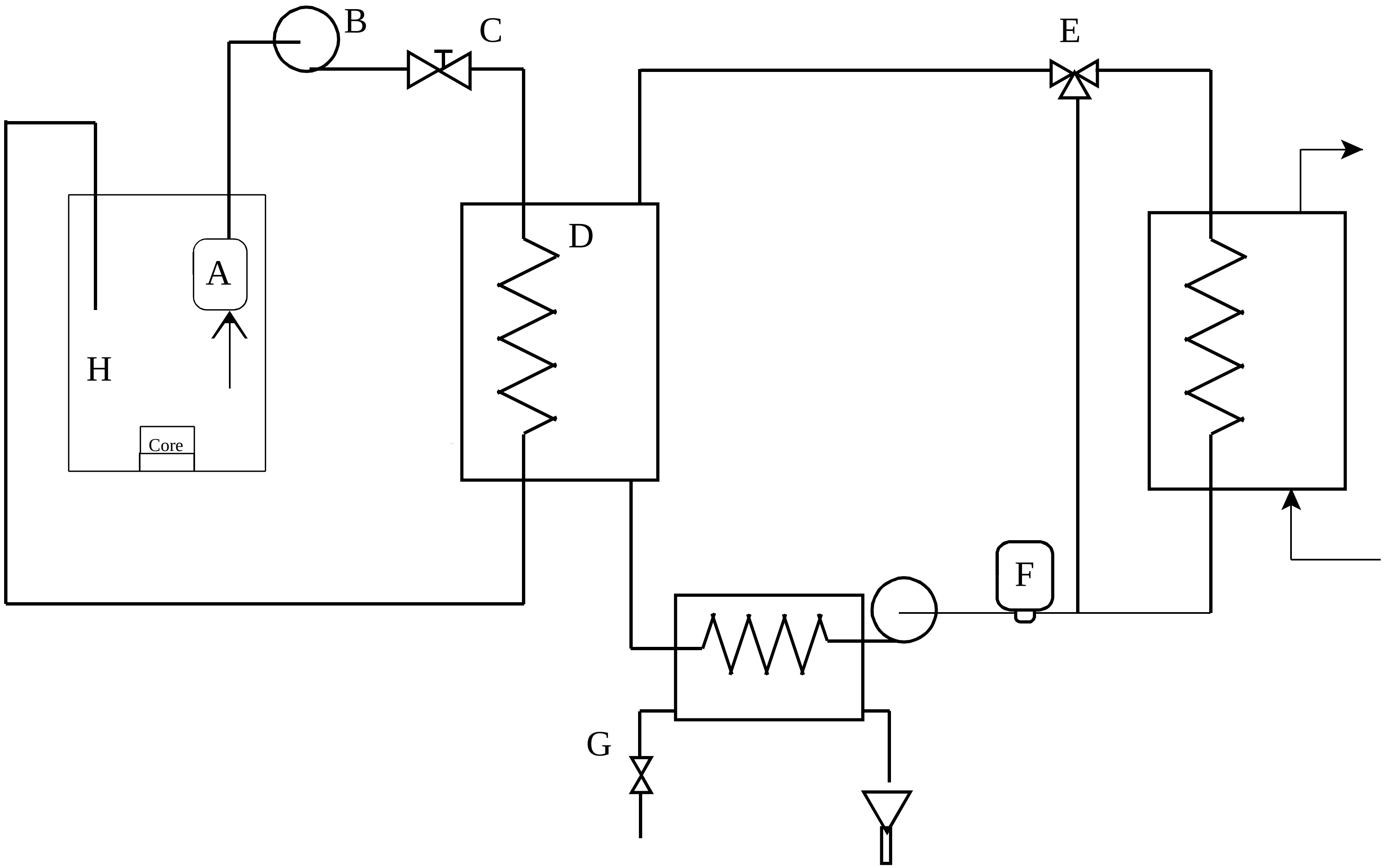
C.17d 1 2 3 4 5 6 ___

C.17e 1 2 3 4 5 6 ___

~~C.17f 1 2 3 4 5 6~~ ___

~~C.17g 1 2 3 4 5 6~~ ___

C.17h 1 2 3 4 5 6 ___


B
C
E
D
A
H
Core
F
G