July 24, 2006

Mr. Richard Denning, Interim Director
Nuclear Reactor Laboratory
Ohio State University
Suite 255
650 Ackerman Road
Columbus, OH 43202

SUBJECT: INITIAL EXAMINATION REPORT NO. 50-150/OL-06-01, OHIO STATE UNIVERSITY

Dear Mr. Denning:

During the week of May 22, 2006, 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/reading-rm/adams.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 Mr. Paul V. Doyle Jr. at (301) 415-1058 or via internet e-mail pvd@nrc.gov.

Sincerely,

/RA/

Johnny Eads, Chief
Research and Test Reactors Branch B
Division of Policy and Rulemaking
Office of Nuclear Reactor Regulation

Docket No. 50-150

Enclosures:
1. Initial Examination Report No. 50-150/OL-06-01
2. Facility comments with NRC resolution
3. Examination and answer key (RO/SRO)

cc w/encls:
Please see next page

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ADAMS ACCESSION #: ML062000155 **TEMPLATE #:NRR-074**

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DATE	07/13/2006	07/19/2006	07/24/2006

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

REPORT NO.: 50-150/OL-06-1

FACILITY DOCKET NO.: 50-150

FACILITY LICENSE NO.: R-75

FACILITY: Ohio State University

EXAMINATION DATES: May 23, 2006

SUBMITTED BY: /RA/ 7/13/2006
Paul V. Doyle Jr., Chief Examiner Date

SUMMARY:

On May 23, 2006, the NRC administered an Operator Licensing Examination to a Senior Reactor Operator license candidate at Ohio State University. The candidate passes all applicable portions of the examination.

REPORT DETAILS

1. Examiner: Paul V. Doyle Jr., 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 V. Doyle Jr., NRC, Examiner
Andrew Kauffman, Ohio State University, Reactor Manager

During the exit meeting the examiner thanked Mr. Kauffman for his support of the examinations. Examination comments are included in attachment 2 to this report.

ENCLOSURE 1

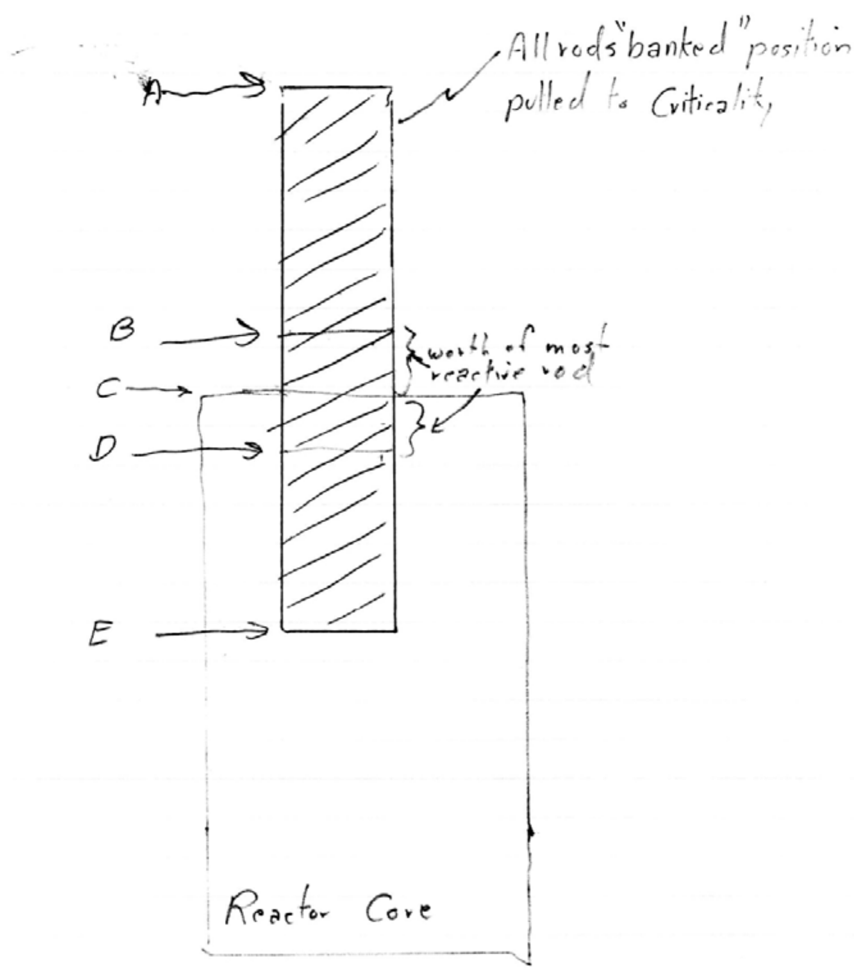
Comments on SRO License Exam
for Kevin Herminghuysen Proctored on 05-23-2006
OSU Nuclear Reactor Lab - Docket # 50-150

Section A

A.4 The answer key calculates shutdown margin with the most reactive rod and the reg rod withdrawn. Prior to administering the exam, the examiner verbally indicated that he wanted the applicant to calculate the "actual" shutdown margin. Therefore, the correct answer should be “b” (6.48%) instead of the answer given in the key (3.80%).

A.14 The figure drawn for this question appears to have been lettered backwards relative to the answers given in the key (i.e. lettered A to E from top-to-bottom instead of bottom-to-top). Based on the figure provided (shown below), the correct answers for parts b through d should be:

- b. 2 (C - A)
- c. 1 (B - A)
- d. 5 (E - C)



Section B

B.1 Our Technical Specifications define a channel check as a qualitative verification of acceptable performance, including comparison to other channels, where possible. A channel test is defined as the introduction of a signal into the channel for verification that it is operable. The terms “Check” and “Test” appear to be switched in the answer key for parts a, b and d.

a. The stated action (placing a source near a detector, noting meter movement and alarm function) meets the definition of a channel test.

b. The stated action (comparing all NI channels, ensuring they track together) meets the definition of a channel check.

d. Comparing the channel reading to an expected value (-80 sec) rises above the level of a check and may be considered a channel test. (In this case, the signal is introduced by the reactor.)

B.3 Based on Administrative Procedure AP-02, the answer to part “c” is SROW and the answer to part “d” is SRO. The answer key is ambiguous because it lists two answers for part “c” and none for part “d”.

B.7 We don't believe there is a correct answer to this question. The answer key selects “a”, but there is no such Tech Spec requirement for our reactor.

B.9 Part “b” specifies an “aluminum clad stainless steel can”. Because boration was not mentioned, the candidate correctly chose the answer of Reg Rod, the same as shown in the answer key. However, we wanted to provide feedback for your future use that our Reg Rod has no aluminum cladding.

B.11 The answers are given in units of dose rate, not dose. This did not affect the candidate’s answer, but we wanted to provide feedback for your future use.

Section C

C.1 There is a slow scram associated with the linear level recorder. A slow scram occurs whenever power exceeds 120% of the selected scale, so “Slow” should be an acceptable answer for “d”.

C.10 The referenced figure is missing. Based on Figure 3.22 in the SAR, the correct answer should be “c” (go to the lead shielded receiving station). This figure in the SAR does not show that the blower pulls air through the solenoid cabinet (it does not blow it through). Given this behavior, de-energized solenoids will result in the carrier return to the shielded receiving station.

C.12 Primary pump flow is governed by the speed of the primary pump motor. Therefore, the correct answer is “a”. The examiner’s answer of “d” is correct with respect to what is stated in the SAR. However, the old primary pump was replaced with a variable-speed pump. The SAR’s list of errata mentions the pump replacement, but does not give specifics about the new system.

C.14 Based on Attachment C to Procedure OM-11, the following answers should be given:

a. Down switch – not numbered on figure
b. Drive motor – 3
c. Position indicator - 1
d. Up switch – 6

NRC Resolution: All comments accepted as written.

OPERATOR LICENSING EXAMINATION
With Answer Key

UNITED STATES NUCLEAR REGULATORY COMMISSION

OHIO STATE UNIVERSITY
May 23, 2006

QUESTION A.01 [1.0 point]
Which ONE of the following describes the characteristics of good moderators and reflectors?

a. High scattering cross-section and low absorption cross-section.

b. Low scattering cross-section and high absorption cross-section.

c. Low scattering cross-section and low absorption cross-section.

d. High scattering cross-section and high absorption cross-section.
A.01 a
REF: x

QUESTION A.02 [1.0 point]
You enter the control room and note that all nuclear instrumentation show a steady neutron level, and no rods are in motion. Which ***ONE*** of the following conditions ***CANNOT*** be true?

a. The reactor is critical.

b. The reactor is subcritical.

c. The reactor is supercritical.

d. The neutron source has been removed from the core.
A.02 c
REF:

QUESTION A.03 [2.0 points, ½ each]
A fissile material is one which will fission upon the absorption of a **THERMAL** neutron. A fertile material is one which upon absorption of a neutron becomes a fissile material. Identify each of the listed isotopes as either fissile or fertile.

a. Th^{232}

b. U^{233}

c. U^{235}

d. Pu^{239}
A.03 a, fertile; b, fissile; c, fissile; d, fissile
REF:

QUESTION A.04 [1.0 point]
A reactor is xenon free, with no experiments in the core. Given the following reactivity worths, calculate the Shutdown Margin.

	worth %ΔK/K		worth %ΔK/K
Shim-Safety Blade #1:	2.41	Shim-Safety Blade #2:	2.32
Shim-Safety Blade #3:	2.49	Shim-Safety Blade #4:	2.60
Regulating rod:	0.084	Excess Reactivity:	3.42

a. 9.90%

b. 6.48%

c 6.40%

d. 3.80%

A.04 ~~d~~ b Question clarified by examiner during administration on purpose requiring an answer change.
REF: SDM (cold/clean) = Total Rod worth - K_{excess} - Most reactive blade - Reg Rod
SDM = (2.41 + 2.32 + 2.49 + 2.60 + 0.084) - 3.42 - 2.60 - 0.084 = 3.80%

QUESTION A.05 [1.0 point]
The reactor is operating at 100 KW. The reactor operator withdraws the Regulating Rod allowing power to increase. The operator then inserts the same rod to its original position, decreasing power. In comparison to the rod withdrawal, the period due to the rod insertion will be …

a. longer due to long lived delayed neutron precursors.

b. shorter due to long lived delayed neutron precursors.

c. same due to equal amounts of reactivity being added.

d. same due to equal reactivity rates from the rod.

A.05 a
REF:

QUESTION A.06 [1.0 point]
Which of the following power manipulations would take the longest to complete assuming the same period is maintained?

a. 1 Kilowatt: from 1 kW to 2 kW

b. 1.5 Kilowatts: from 2 kW to 3.5 kW

c. 2 Kilowatts: from 3.5 kW to 5.5 kW

d. 2.5 Kilowatts: from 5.5 kW to 8 kW

A.06 a
REF: $P = P_0 e^{t/T}$

QUESTION A.07 [1.0 point]
After shutdown, the reactor will stabilize at a -80 second period. Which ONE of the following is the main contributor to this period?

a. The amount of negative reactivity introduced to the core.

b. The decay constant of the longest lived delayed neutron precursor.

c. The degree of neutron absorption by the fission products in the core.

d. The level of the prompt neutron population.

A.07 b
REF:

QUESTION A.08 [1.0 point]
Suppose the source strength in the core is 250 neutrons per second (N/sec) and the effective multiplication factor is 0.80. Select the closest stable neutron count rate from the list below:

a. 313 N/sec

b. 750 N/sec

c. 1250 N/sec

d. 1500 N/sec

A.08 c
REF: Count = $S/(1 - K_{eff})$ = 250/(1 - 0.8) = 250/0.2 = 1250

QUESTION A.09 [1.0 point]
What is the approximate amount of time that it will take the amount of Xenon being produced to reach a peak after the reactor is shut down? On the attached Xenon reactivity curve it is noted as the difference between time T_{SD} and T_{Peak}.

a. 6 hours

b. 15 hours

c. 24 hours

d. 33 hours

A.09 b
REF:

QUESTION A.10 [1.0 point]
During a fuel loading of the core, as the reactor approaches criticality, the value of 1/M:

a. Increases toward one

b. Decreases toward one

c. Increases toward infinity

d. Decreases toward zero

A.10 d
REF:

QUESTION A.11 [1.0 point]
The reactor supervisor tells you that the K_{eff} for the reactor is 0.955. How much reactivity must you add to the reactor to reach criticality?

a. +0.0471

b. +0.0450

c. -0.0471

d. -0.0450

A.11 a
REF: $\Delta\rho = (K_{eff1} - K_{eff2}) \div (K_{eff1} * K_{eff2})$ $\Delta\rho = (0.9550 - 1.0000) \div (0.9550 * 1.0000)$
$\Delta\rho = -0.0450 \div 0.9550 = -0.0471$

QUESTION A.12 [2.0 points, ½ each]
Match each term in column A with the correct definition in column B.

Column A	Column B
a. Prompt Neutron	1. A neutron in equilibrium with its surroundings.
b. Fast Neutron	2. A neutron born directly from fission.
c. Thermal Neutron	3. A neutron born due to decay of a fission product.
d. Delayed Neutron	4. A neutron at an energy level greater than its surroundings.

A.12 a, 2; b, 4; c, 1; d, 3
REF:

QUESTION A.13 [1.0 point]
INELASTIC scattering is the process by which a neutron collides with a nucleus and …

a. recoils with the same kinetic energy it had prior to the collision

b. recoils with a lower kinetic energy than it had prior to the collision, with the nucleus emitting a gamma ray.

c. Is absorbed, with the nucleus emitting a gamma ray.

d. recoils with a higher kinetic energy than it had prior to the collision, with the nucleus emitting a gamma ray.

A.13 b
REF:

QUESTION A.14 [2.0 points, ½ each]
Using the drawing of the Integral Rod Worth Curve provided, identify each of the following reactivity worths.

a. Total Rod Worth	1. B – A
b. Actual Shutdown Margin	2. C – A
c. Technical Specification Shutdown Margin Limit	3. C – B
d. Excess Reactivity	4. D – C
	5. E – C
	6. E – D
	7. E – A

A.14 a, 7; b, ~~5~~2; c, ~~6~~1; d, ~~2~~5 Answers changed per facility comment.
REF:

QUESTION A.15 [1.0 point]
What is the kinetic energy range of a thermal neutron?

a. > 1 MeV

b. 100 KeV – 1 MeV

c. 1 eV – 100 KeV

d. < 1 eV
A.15 d
REF:

QUESTION A.16 [1.0 point]
A thin foil target of 10% copper and 90% aluminum is in a thermal neutron beam. Given σ_a Cu = 3.79 barns, σ_a Al = 0.23 barns, σ_s Cu = 7.90 barns, and σ_s Al =1.49 barns, which ONE of the following reactions has the highest probability of occurring? A neutron …

a. scattering reaction with aluminum

b. scattering reaction with copper

c. absorption in aluminum

d. absorption in copper
A.16 a
REF:

QUESTION A.17 [1.0 point]
When performing rod calibrations, many facilities pull the rod out a given increment, then measure the time for reactor power to double (doubling time), then calculate the reactor period. If the doubling time is 42 seconds, what is the reactor period?

a. 29 sec

b. 42 sec

c. 61 sec

d. 84 sec

A.17 c
REF: $\ln(2) = -\text{time}/\tau$ $\tau = \text{time}/(\ln(2)) = 60.59 \approx 61$ seconds

QUESTION B.1 [2.0 points, ½ each]
Identify each of the following actions as either a channel **CHECK**, a channel **TEST**, or a channel **CAL**ibration.

a. Prior to startup you place a radioactive source near a radiation detector, noting meter movement and alarm function operation.

b. During startup you compare all of your nuclear instrumentation channels ensuring they track together.

c. At power, you perform a heat balance (calorimetric) and determine you must adjust Nuclear Instrumentation readings.

d. During a reactor shutdown you note a -80 second period on Nuclear Instrumentation.

B.1 a, Check or Test; b, ~~Test~~ Check; c, Cal; d, Check Answers changed per facility comment.
REF: Technical Specifications § *1.0 Definitions*

QUESTION B.2 [2.0 points, ½ each]
Match the type of radiation in column A with its associated Quality Factor (10CFR20) from column B.

	Column A	Column B
a.	alpha	1
b.	beta	2
c.	gamma	5
d.	neutron (unknown energy)	10
		20

B.2 a, 20; b, 1; c, 1; d, 10
REF: 10CFR20.1004

QUESTION B.3 [2.0 points, ½ each]
Identify the minimum level of permission required for each of the following. Reactor Operator on Duty (RO), Senior Reactor Operator on Duty (SROD), any Senior Reactor Operator (SRO) or written permission from any Senior Reactor Operator (SROW).

a. Installation or removal of an experiment from the reactor or an experimental facility, while the reactor is operating.

b. Entering the control room area, you are NOT the Reactor Operator on duty.

c. Bringing pyrotechnic material into the NRL.

d. Transporting corrosive material beyond the chains of either pool.

B.3 a, RO; b, SROD; c, ~~SRO~~ SROW; c, ~~SROW~~ SRO Answers changed per facility comment
REF: Admin Procedures AP-02, General Rules,

QUESTION B.4 [1.0 point]
A survey instrument with a window probe was used to measure an irradiated experiment. The results were 100 millirem/hr window open and 60 millirem/hr window closed. What was the gamma dose?

a. 100 millirem/hr

b. 60 millirem/hr

c. 40 millirem/hr

d. 140 millirem/hr

B.4 b
REF: Standard NRC Health Physics Question

QUESTION B.5 [1.0 point]
Which ONE of the following is the definition of ***Emergency Action Level***?

a. a condition that calls for immediate action, beyond the scope of normal operating procedures, to avoid an accident or to mitigate the consequences of one.

b. Specific instrument readings, or observations; radiation dose or dose rates; or specific contamination levels of airborne, waterborne, or surface-deposited radioactive materials that may be used as thresholds for establishing emergency classes and initiating appropriate emergency methods.

c. classes of accidents grouped by severity level for which predetermined emergency measures should be taken or considered.

d. a document that provides the basis for actions to cope with an emergency. It outlines the objectives to be met by the emergency procedures and defines the authority and responsibilities to achieve such objectives.

B.5 b
REF: Emergency Plan, § 2.0 Definitions, p. 6.

QUESTION B.6 [2.0 points, ½ each]
Match the 10CFR55 requirements for maintaining an active operator license in column A with the corresponding time period from column B.

	Column A	Column B
a.	Renew License	1 year
b.	Medical Exam	2 years
c.	Pass Requalification Written Examination	4 years
d.	Pass Requalification Operating Test	6 years

B.6 a, 6; b, 2; c, 2; d, 1
REF: 10CFR55.

~~QUESTION B.7 [1.0 point]~~ Question Deleted per facility comment.
~~Which ONE of the following statements is TRUE with respect to Technical Specifications?~~

~~a. The neutron source shall be positioned vertically between the grid plate and the top of the fuel elements during startup.~~

~~b. A minimum of four channels of nuclear instrumentation shall be on scale, providing meaningful information through all power ranges.~~

~~c. During a critical experiment, subcritical multiplication plots shall be obtained from at least four instrumentation channels.~~

~~d. The maximum reactivity worth of any single independent experiment shall not exceed 0.5% in reactivity.~~

~~e. The reactor shall be operated only when all lattice positions internal to the active fuel boundary are occupied by either a standard or control fuel element.~~
~~B.7 a a. True b. False c. False d. False e. False~~
~~REF: Technical Specifications 4.4.1, 5.4, 10.1, 6.2.3, 7.4, also EQB~~

QUESTION B.8 [1.0 point, ½ each]
Match the control rod indicating lights for the shim-safety rods with their respective color.

a. Jam	1. Green
b. Up	2. Orange
c. Bottom	3. Red
d. Engage	4. White

B.8 a, 3; b, 2; c, 1; d, 4
REF: Old EQB question

QUESTION B.9 [1.0 point]
Identify each of the listed cotrol element attributes as being applicable to either the reg rod (reg) shim-safety rods (SS) or both rods (Both)

a. magnet engage light

b. ~~aluminum clad~~ stainless steel can*

c. borated stainless steel can

d. grooved.
B.9 a, SS; b, reg; c, SS; d, SS
REF: OSURR Hazard Summary Report, sec. 1.8.2
* Correction made for next question use per facility comment.

QUESTION B.10 [1.0 point]
Which ONE of the following operations requires at a minimum a licensed Senior Reactor Operator, a licensed Reactor Operator and a third person?

a. Normal reactor operation.

b. First startup of the day.

c. Startup following an unplanned shutdown.

d. Fuel handling

B.10 d
REF: OSU AP-13, Personnel Required for Reactor Operations, pgs. 1 and 2

QUESTION B.11 [1.0 point]
While working in a radiation area, you note that your pocket dosimeter reads off-scale and immediately leave the area. You had been working for 2 hours at 8 feet from a source reading 2400 mr/hr at a foot. Which one of the following is the estimated dose you received?

a. 600 mr/~~hr~~

b. 300 mr/~~hr~~

c. 75 mr/~~hr~~

d. 37½ mr/~~hr~~*

B.11 c
REF: NRC question administered Jan. 1987 $D_1d_1^2 = D_2d_2^2$ (D is Dose rate, d is distance)
D_1 (82) = 2400 (12) D_1 = 2400/64 = 37½ mr/hr DOSE = Dose Rate x time 37½ mr/hr 2 hr = 75 mr
* Corrections made for next question use per facility comment.

QUESTION B.12 [1.0 point]
Consider two point sources, each having the **SAME** curie strength. Source A's gammas have an energy of 0.5 MeV, while Source B's gammas have an energy of 1.0 MeV. Using a Geiger-Müller detector the reading from source B will be … (NOTE: Ignore detector efficiency.)

a. four times that of source A.

b. twice that of source A.

c. the same.

d. half that of source A.

B.12 c
REF: Standard NRC Health Physics Question. G-M detector is not sensitive to incident energy levels.

QUESTION B.13 [1.0 point]
10CFR50.54(x) states: *"A licensee may take reasonable action that departs from a license condition or a technical specification (contained in a license issued under this part) in an emergency when this action is immediately needed to protect the public health and safety and no action consistent with license conditions and technical specifications that can provide adequate or equivalent protection is immediately apparent."* 10CFR50.54(y) states that the minimum level of management which may authorize this action is …

a. any Reactor Operator licensed at the facility.

b. any Senior Reactor Operator licensed at the facility.

c. Facility Manager (or equivalent at facility).

d. NRC Project Manager

B.13 b
REF: 10CFR50.54(y).

QUESTION B.14 [1.0 point]
Which ONE of the following correctly describes a Safety Limit?

a. Limits on important process variables which are found to be necessary to reasonably protect the integrity of certain physical barriers which guard against the uncontrolled release of radioactivity.

b. The Lowest functional capability of performance levels of equipment required for safe operation of the facility.

c. Settings for automatic protective devices related to those variables having significant safety functions.

d. a measuring or protective channel in the reactor safety system.

B.14 a
REF: Technical Specifications § 1.3 *Definitions*

QUESTION B.15 [1.0 point]
You place a radiation monitor neat to the demineralizer during reactor operation. If you were to open the window on the detector you would expect the meter reading to … (Assume no piping leaks)

a. increase, because you would now be receiving signal due to H^3 and O^{16} betas.

b. remain the same, because the Quality Factors for gamma and beta radiation are the same.

c. increase, because the Quality Factor for betas is greater than for gammas.

d. remain the same, because you still would not be detecting beta radiation.

B.15 d
REF: BASIC Radiological Concept (Betas don't make it through piping.)

QUESTION B.16 [1.0 point]
Which ONE of the following is the maximum K_{eff} allowed (per Technical Specifications) for a fuel storage rack fully loaded with fuel and flooded with water?

a. 0.8

b. 0.85

c. 0.9

d. 0.95

B.16 c
REF: Technical Specification §5.4.

QUESTION C.1 [2.0 points, ⅓ each]
Designate the system response (Fast Scram (**FAST**), Slow Scram (**SLOW**), Alarm Only (**ALARM**) or Not in Service (**NIS**)] associated with each of the conditions listed below.

a. Low count rate ≥ 2 counts/second (Stratup Channel)

b. Indicated Dose above setpoint (ARM system detectors)

c. Reactor Overpower ≤ 120% full scale (Safety Channel 1)

d. Reactor Power Above Setpoint (Linear Level Channel)

e. High Voltage Failure on CICs or UICs

f. Fast reactor period ≤ 5 seconds

C.01 a. SLOW b. ALARM c. FAST d. NIS or SLOW 2nd answer added per facility comment.
e. SLOW f. SLOW

REF: OSURR Hazards Summary Report § 3.6.3, Table 3.2 pp. 74 — 76.

QUESTION C.2 [1.0 point]
Which ONE of the following supplies the primary protection for reactor equipment against disturbances in the building power supply?

a. The auxiliary back-up power system.

b. The input line capacitors.

c. The isolation transformers.

d. The individual circuit power supplies.

C.2 c

REF: SAR §3.3.7

QUESTION C.3 [1.0 point]
A leak from which ONE of the following would result in the lowest reactor coolant level?

a. Primary cooling pump discharge piping.

b. Rabbit tube rupture.

c. Beam Port #1 rupture.

d. Beam Port #2 rupture.

C.3 d

REF: SAR § 8.4.2.2

QUESTION C.4 [1.0 point]
Which ONE of the following is the feature designed to minimize dose due to N^{16} at the top of the pool?

a. Downward flow of warm water from the core into the coolant piping.

b. Flow through the delay tank in the coolant piping.

c. Balanced suction flow from the plenum cap.

d. Return flow from the process system across the pool above the plenum cap.

C.4 d
REF: SAR § 3.2.2.1

QUESTION C.5 [1.0 point]
During a core loading experiment, you notice that the Start-up Channel monitor is indicating less than 2 counts/second. Which ONE of the following actions would be used to allow withdrawal of shim-safety rods?

a. Temporarily raise the gain of the start-up count rate amplifier.

b. Manually position the pointer on the start-up count rate channel recorder to greater than 2 count/second.

c. Place the number 1 bypass keylock switch to the ON position.

d. Place the start-up count rate amplifier to the OFF position.

C.5 c
REF: SAR § 3.3.14

QUESTION C.6 [1.0 point]
Which ONE of the following detectors is used primarily to measure Ar^{41} release to the environment?

a. NONE, Ar^{41} 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

C.6 b
REF:

QUESTION C.7 [1.0 point]
What is the purpose of the small hole in the return leg of the primary coolant loop? The hole provides

a. a method for priming the primary pump.

b. a connection for an RTD to perform Reactor Power Calibrations.

c. a swirling motion of the return coolant to reduce N^{16} concentrations at the pool surface.

d. siphoning protection in the case of a primary loop leak.

C.7 d
REF: SAR § 3.2.2.1

QUESTION C.8 [1.0 point]
What is the purpose of the ***Dash Pot Cylinder*** in the Shim-Safety Control Rod Assembly?

a. To provide indication of the control rod at the top of the core.

b. To provide indication of the control rod at the bottom of the core.

c. To minimize reactivity addition during a rod withdrawal accident.

d. To minimize the mechanical stress of a rod drop.

C.8 d
REF: SAR § 3.1.2.3, p. 33; OM-15 Figure from Attachment C.

QUESTION C.9 [1.0 point]
Which ONE of the following correctly describes how gamma radiation is compensated for in the Log-N channel?

a. A compensating current equal and opposite to the signal due to gammas is generated by the detector.

b. The detector is positioned in towards and out away from the core to compensate for gammas.

c. The output of the detector is put through a discriminator circuit which passes only pulses caused by neutron interactions.

d. Lead shielding around the detector decreases the signal due to gammas low enough such that compensation is not required.

C.9 a
REF: Standard NRC Question

QUESTION C.10 [1.0 point]
While irradiating a sample using the rabbit system, the rabbit control panel fails causing **ALL** of the solenoids to reposition to their deenergized positions (the fan remains energized). Using the figure provided, the rabbit will...

a. stay at the reactor core position.

b. go to the intermediate send position.

c. go to the lead shielded receiving station.

d. go to the "T" connection just outside the core.
C.10 ~~a~~c Answer changed per facility comment.
REF: SAR figure 3.19.

QUESTION C.11 [2.0 points, ½ each]
Match the radiation detection equipment in column A, with its primary use in column B.

Column A: Radiation Equipment	Column B: Primary use
a. Ion Chamber portable radiation detector	1. To measure total dose received by a visitor.
b. Geiger-Müller portable radiation detector	2. To detect the presence of contamination.
c. Film Badge/TLD	3. To measure radiation field strength.
d. Pocket Dosimeter.	4. To measure total dose received by a radiation worker.

C.11 a, 3; b, 2; c, 4; d, 1
REF: Standard NRC question.

QUESTION C.12 [1.0 point]
Primary Pump flow is adjusted by:

a. speed of the centrifugal pump motor.

b. chamber size of the positive displacement pump.

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

d. position of the modulating valve upstream of the heat exchanger.
C.12 ~~d~~a Answer changed per facility comment.
REF: Facility supplied notes on primary system.

QUESTION C.13 [1.0 point]
Which ONE of the following is the reason for the surge tank in the secondary system?

a. To accommodate changes in pressure in the secondary.

b. To minimize changes in temperature

c. To allow addition of chemicals into the secondary system.

d. To allow addition of water to fill the secondary system.

C.13 a
REF: Facility supplied notes on secondary system.

QUESTION C.14 [2.0 point]
Using the figure provided, identified each of the components listed.

a. Down switch

b. Drive motor

c. Position indicator transmitter (fine or course)

d. Up switch

C.14 a, 7 b, ~~23~~ c, 1 d, ~~4~~6 Answers changed per facility comment.
REF: OM-11 attachment C

QUESTION C.15 [1.0 point]
Due to a weather phenomenon, your Area Radiation Monitors alarm due to off-gas from Davis-Besse. The Reactor Supervisor tells you to silence the alarms. Which ONE of the following is the correct method to silence the ARM units?

a. Place the operate switch at the local unit in the SILENCE position.

b. Raise the setpoint at the remote unit.

c. Increase the deadband setting on the local unit.

d. Reduce the proportional gain setting on the remote unit.

C.15 b
REF: SAR § 3.7.3

QUESTION C.16 [1.0 point]
What is the purpose of the small hole in the return leg of the Primary coolant loop? The hole provides …

a. a method for priming the pump.

b. a connection for an RTD to perform Reactor Power Calibrations.

c. a swirling motion of the return coolant to reduce N^{16} concentrations at the pool surface.

d. siphoning projection in the case of a primary loop leak.

C.16 d
REF: SAR § 3.2.2.1

QUESTION C.17 [1.0 point]
Which ONE of the recorders listed below does NOT have a Reactor Trip associated with it?

a. Linear Power Monitoring Channel Recorder

b. Period Monitoring Channel Recorder

c. Logarithmic Power (Log-N) Recorder

d. Startup Channel Recorder

C.17 c
REF: SAR §§ 3.3.12–3.3.15

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

FACILITY: Ohio State University

REACTOR TYPE: Pool

DATE ADMINISTERED: 2006/05/23

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

DR – Rem, Ci – curies, E – Mev, R – feet

$$\frac{(\rho_2 - \beta)^2}{Peak_2} = \frac{(\rho_1 - \beta)^2}{Peak_1}$$

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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.3a fertile fissile ___

A.3b fertile fissile ___

A.3c fertile fissile ___

A.3d fertile fissile ___

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.12a 1 2 3 4 ____

A.12b 1 2 3 4 ____

A.12c 1 2 3 4 ____

A.12d 1 2 3 4 ____

A.13 a b c d ___

A.14a 1 2 3 4 5 6 7 ___

A.14b 1 2 3 4 5 6 7 ___

A.14c 1 2 3 4 5 6 7 ___

A.14d 1 2 3 4 5 6 7 ___

A.15 a b c d ___

A.16 a b c d ___

A.17 a b c d ___

B.1a CHECK TEST CAL ___

B.1b CHECK TEST CAL ___

B.1c CHECK TEST CAL ___

B.1d CHECK TEST CAL ___

B.2a 1 2 5 10 20 ___

B.2b 1 2 5 10 20 ___

B.2c 1 2 5 10 20 ___

B.2d 1 2 5 10 20 ___

B.3a RO SROD SROW ___

B.3b RO SROD SROW ___

B.3c RO SROD SROW ___

B.3d RO SROD SROW ___

B.4 a b c d ___

B.5 a b c d ___

B.6a 1 2 4 6 ___

B.6b 1 2 4 6 ___

B.6c 1 2 4 6 ___

B.6d 1 2 4 6 ___

B.7 a b c d ___

B.8a 1 2 3 4 ___

B.8b 1 2 3 4 ___

B.8c 1 2 3 4 ___

B.8d 1 2 3 4 ___

B.9a SS REG BOTH ___

B.9b SS REG BOTH ___

B.9c SS REG BOTH ___

B.9d SS REG BOTH ___

B.10 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 ___

C.1a ALARM FAST NIS SLOW ___

C.1b ALARM FAST NIS SLOW ___

C.1c ALARM FAST NIS SLOW ___

C.1d ALARM FAST NIS SLOW ___

C.1e ALARM FAST NIS SLOW ___

C.1f ALARM FAST NIS SLOW ___

C.2 a b c d ___

C.3 a b c d ___

C.4 a b c d ___

C.5 a b c d ___

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.10 a b c d ___

C.11a 1 2 3 4 ___

C.11b 1 2 3 4 ___

C.11c 1 2 3 4 ___

C.11d 1 2 3 4 ___

C.12 a b c d ___

C.13 a b c d ___

C.14a 1 2 3 4 5 6 7 ___

C.14b 1 2 3 4 5 6 7 ___

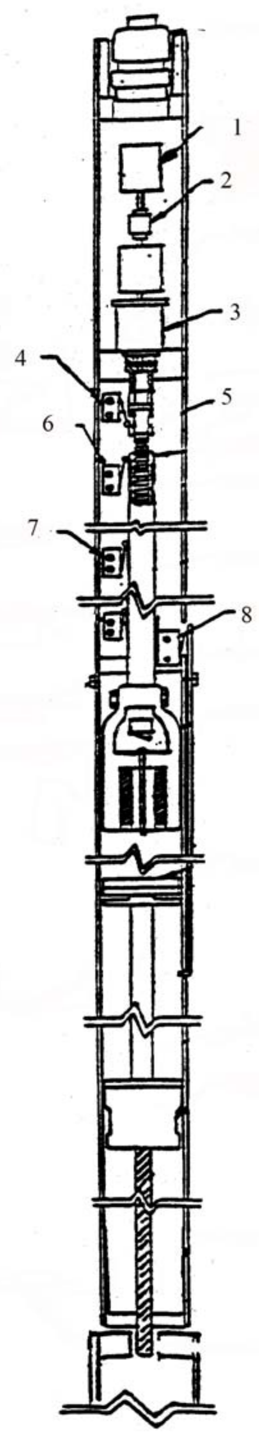
C.14c 1 2 3 4 5 6 7 ___

C.14d 1 2 3 4 5 6 7 ___

C.15 a b c d ___

C.16 a b c d ___

C.17 a b c d ___



OSU Reactor Shim-Safety Control Rod Assembly