January 18, 2007

Mr. Jere Jenkins, Laboratory Director
1290 Nuclear Engineering Bldg.
Department of Nuclear Engineering
Purdue University
West Lafayette, IN 47907

SUBJECT: INITIAL EXAMINATION REPORT NO. 50-182/OL-07-01, PURDUE UNIVERSITY

Dear Mr. Jenkins:

During the week of November 6, 2006, the NRC administered an operator licensing examination at your Purdue 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. 50-182

Enclosures: 1. Initial Examination Report No. 50-182/OL-07-01
2. Examination with facility comments with NRC resolution

cc w/encls:
Please see next page

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DHughes Facility File (EBarnhill) O-6 F-2

ADAMS ACCESSION NO.: Package ML 062140365

ADAMS ACCESSION #: ML070110112 **TEMPLATE #:NRR-074**

OFFICE	PRTB:CE		IOLB:LA	E	PRTB:SC	
NAME	PDoyle:cah		EBarnhill		JEads	
DATE	01 /16 /2007		01/18/2007		01/18/2007	

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cc:

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

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

REPORT NO.: 50-182/OL-07-01

FACILITY DOCKET NO.: 50-182

FACILITY LICENSE NO.: R-87

FACILITY: Purdue University

EXAMINATION DATES: November 07, 2006

SUBMITTED BY: ___/RA/_____ 01/10/2007
Paul V. Doyle Jr., Chief Examiner Date

SUMMARY:

On November 7, 2007, the NRC administered an Operator Licensing examination to one SRO (Instant) candidate. The candidate passed all portions of the administered examination.

REPORT DETAILS

1. Examiners:
   Paul V. Doyle Jr., Chief Examiner

2. Results:

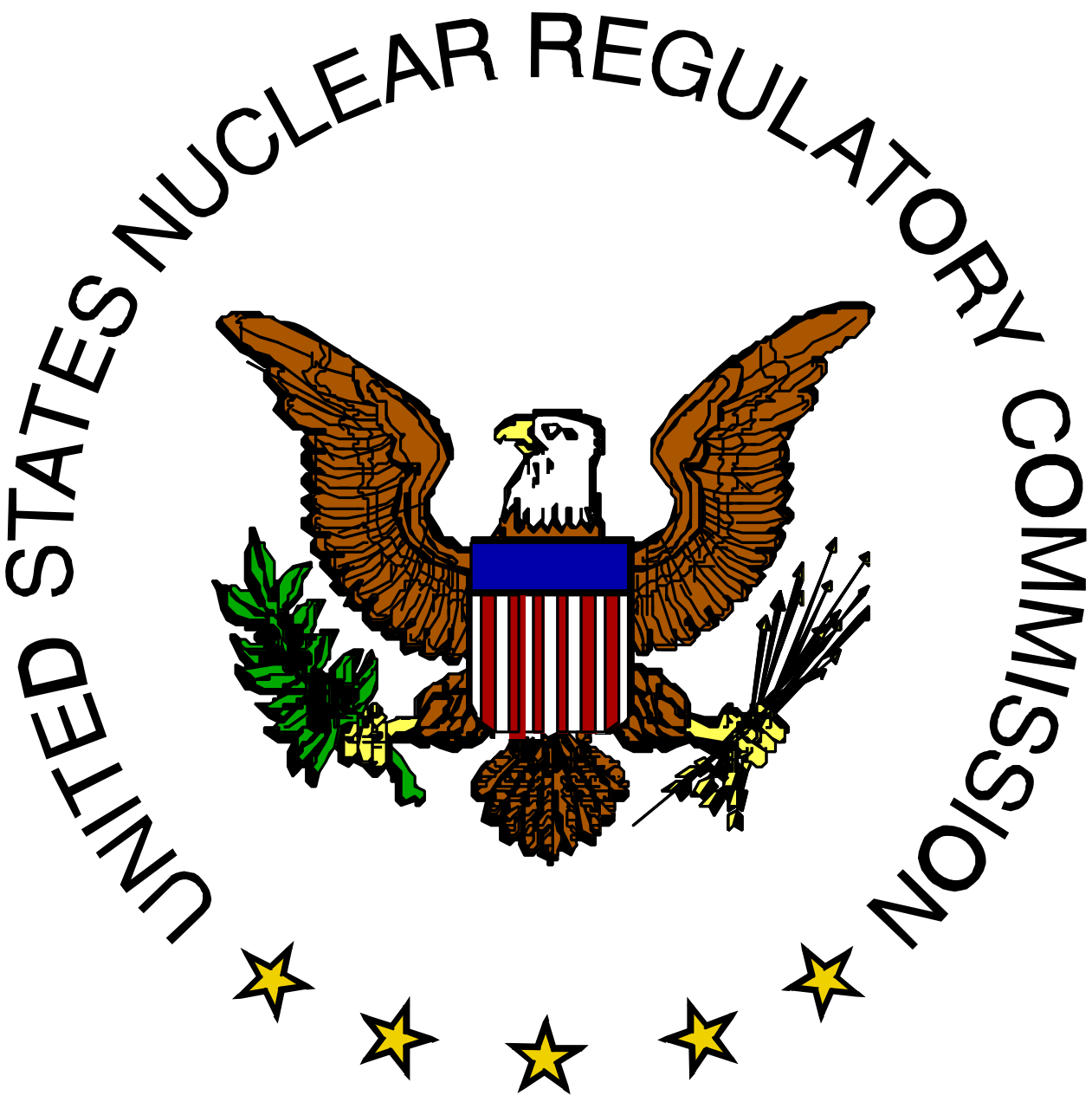
	RO PASS/FAIL	SRO PASS/FAIL	TOTAL PASS/FAIL
Written	0/0	1/0	1/0
Operating Tests	0/0	1/0	1/0
Overall	0/0	1/0	1/0

3. Exit Meeting:
   Paul V. Doyle Jr., NRC, Chief Examiner
   Jere Jenkins, Purdue University, Laboratory Director
   Edward Merritt, Purdue University, Reactor Supervisor

   The examiner thanked the facility for their support of the examination. The facility had minor comments on the examination (e.g. two correct answers) the examination included with this report has all comments included.

OPERATOR LICENSING EXAMINATION

With Answer Key



PURDUE UNIVERSITY
November 07, 2006

ENCLOSURE 2

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

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..

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}

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%

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.

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

QUESTION A.07 [1.0 point]

Which ONE of the following will cause the reactor to reach criticality at a higher rod height?

a. Increase in moderator temperature

b. Increase in barometric pressure

c. adding new fuel

d. inserting a positive reactivity experiment

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

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

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

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

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.

QUESTION A.13 [1.0 point]

B and β_{eff} both describe the total fraction of delayed neutrons. The difference between the two is that β_{eff} is …

a. smaller than β since delayed neutrons are born at lower energy levels than prompt neutrons.

b. larger than β since delayed neutrons are born at lower energy levels than prompt neutrons.

c. smaller than β since delayed neutrons are born at higher energy levels than prompt neutrons.

d. larger than β since delayed neutrons are born at higher energy levels than prompt neutrons.

QUESTION A.14 [1.0 point]

Which one of the following correctly describes the relationship between differential rod worth (DRW) and integral rod worth (IRW)?

a. DRW is the slope of the IRW curve at a given location.

b. DRW is the area under the IRW curve at a given location.

c. DRW is the square root of the IRW curve at a given location.

d. There is no relationship between DRW and IRW.

QUESTION A.15 [1.0 point]

Which ONE of the following atoms will cause a neutron to lose the most energy in an ***ELASTIC*** collision?

a. Uranium (U^{238})

b. Carbon (C^{12})

c. Deuterium (H^{2})

d. Hydrogen (H^{1})

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

QUESTION B.01 [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.

QUESTION B.02 [1.0 point]

When performing a reactor startup, to avoid a reactor setback or scram turn the range switch for channel 3 COUNTER-CLOCKWISE when the console meter reads __?__ and CLOCKWISE when the console meter reads__?__.

	COUNTER-CLOCKWISE	CLOCKWISE
a.	above 75%	between 20 and 25%
b.	between 70 and 75%	below 20%
c.	above 65%	between 20 and 25%
d.	between 65 and 70%	below 20%

QUESTION B.03 [1.0 point]

Identify the condition which is a reportable occurrence.

a. A shutdown margin of 1.5% ΔK/K.

b. Disagreement between actual and expected critical positions of more than 0.25% ΔK/K.

c. An unexpected short-term reactivity change causing a period of 9 seconds.

d. Discovering the setback setpoint for the linear channel was set at 105% power.

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

QUESTION B.04 [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

QUESTION B.05 [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.

QUESTION B.06 [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

QUESTION B.07 [1.0 point]

Which ONE of the following is the SAFETY LIMIT as set by Technical Specifications?

a. Reactor Power TRUE VALUE shall not exceed 50 Kilowatts.

b. Reactor Power MEASURED VALUE shall not exceed 50 Kilowatts.

c. Reactor Power TRUE VALUE shall not exceed 1.2 Kilowatts.

d. Reactor Power MEASURED VALUE shall not exceed 1.2 Kilowatts

QUESTION B.08 [1.0 point]

Two isotopes are monitored for (Regions of Interest) during the Reactor Water Gamma Spec Analysis Standard Operating Procedure. This procedure is used to detect fission products? Which ONE of the following choices shows the two (2) radioisotopes monitored?

a. $_{1}H^{3}$ and $_{7}N^{16}$

b. $_{6}C^{14}$ and $_{8}O^{16}$

c. $_{11}Al^{24}$ and $_{18}Ar^{41}$

d. $_{53}I^{137}$ and $_{55}Cs^{137}$

QUESTION B.09 [1.0 point]

There are two SROs and one non-licensed person on shift when one of the SROs becomes sick. Which ONE of the listed situations is allowed by Technical Specifications?

a. The non-licensed person takes over the control console. The SRO remains within the confines of the annex basement.

b. The SRO takes over the console. The non-licensed person remains within the confines of the Purdue campus.

c. The non-licensed person takes over the control console. The SRO remains at the console to direct the non-licensed person.

d. The SRO takes over the control console. The non-licensed person is free to leave.

QUESTION B.10 [2.0 points, ½ each]

Identify whether each of the following conditions requires (REQ) or does not require (NOT) SRO presence for recovery from an unplanned (unscheduled) shutdown.

a. Building evacuation due to a fire drill initiated by the school administration.

b. High school student on tour accidentally hits scram button.

c. Reactor scram due to trainee generating a 6 second period

d. Loss of electrical power due to electrical storms.

QUESTION B.11 [1.0 point]

All of the following conditions are REPORTABLE OCCURRENCES except…

a. dropping material into the shutdown core, which causes an unplanned criticality.

b. A core excess reactivity of 0.025 ΔK/K.

c. An unexpected short-term reactivity change causing a period of 9 seconds

d. Discovering the scram setpoint for the safety channel was set at 125% power.

QUESTION B.12 [1.0 point]

The ***Quality Factor*** is used to convert …

a. dose in rads to dose equivalent in rems.

b. dose in rems to dose equivalent in rads.

c. contamination in rads to contamination equivalent in rems

d. contamination in rems to contamination equivalent in rads

QUESTION B.13 [1.0 point]

An experimenter wants to perform an experiment. The experiment has approximately the same nuclear characteristics as an experiment previously tried. Which ONE of the following is the minimum level of approval necessary to perform the experiment? The Radiation Management Office and

a. a licensed Reactor Operator.

b. a licensed Senior Reactor Operator.

c. the Reactor Supervisor.

d. the Reactor Supervisor with the approval of the Committee of Reactor Operations.

QUESTION B.14 [1.0 point]

You (a licensed Reactor Operator) and a Senior Reactor Operator (SRO) are operating the reactor on the weekend. No one else is available. In order to meet Technical Specifications requirements if you are on the console the SRO must be …

a. within the reactor control room

b. within the Reactor Building

c. within the confines of the Campus

d. within 30 minutes drive of the Reactor Facility.

QUESTION B.15 [1.0 point]

Technical Specification 5.3 requires “All reactor fuel assemblies shall be stored in a geometrical array where the K_{eff} is less than ____ for all conditions of moderation and reflection.”

a. 0.80

b. 0.85

c. 0.90

d. 0.95

QUESTION C.01 [2.0 points, 0.4 each]

Match the Nuclear Instrumentation channels with their correct functions. (Protection refers to scrams and setbacks, while control relates to input to the automatic circuit for the servo control system.)

Column A	Column B
a. Startup Channel	1. Setback and Slow Scram
b. Log-N Period Channel	2. Setback and Fast Scram
c. Pool Top Radiation Area Monitor	3. Slow Scram Only
d. Safety Channel	4. None
e. Continuous Air Monitor	

QUESTION C.02 [1.0 point]

Which ONE of the following components within the purification system is responsible for maintaining primary conductivity low?

a. conductivity cells

b. water filter

c. chiller unit

d. demineralizer

QUESTION C.03 [1.0 point]

Which one of the following actions are the result of a rod insert (set back) signal?

a. The two shim-safety rods drive downward into the core until the initiating signal is less than the setpoint.

b. All three rods drive downward into the core until the initiating signal is less than the setpoint.

c. The two drive downward into the core until the set back signal is reset manually.

d. All three drive downward into the core until the set back signal is reset manually.

QUESTION C.04 [2.0 points, ⅓ each]

Identify whether each of the following traits is associated with the Shim-Safety Rods (SSR) or the Regulating Rod (RR).

a. Hollow

b. Solid

c. made of Stainless-Steel

d. made of borated stainless-steel

e. magnetic clutch

f. direct drive

QUESTION C.05 [1.0 point]
A visitor inadvertently hits the gang-lower switch. How may the operator stop the rods from inserting?

a. Reenergizing the Log Count Rate Channel.

b. Ranging UP on the Linear Level Channel.

c. Momentarily placing the Raise-Lower switch in either the raise or lower position.

d. Not required. Rod insertion will stop when the gang lower switch is released.

QUESTION C.06 [1.0 point]
What is the purpose of the Startup channel drive mechanism?

a. To maintain the instrument on-scale.

b. To prevent burnout of the U^{235} coating on the detector during high power.

c. To maintain coupling between the fission chamber and the neutron source as they are both withdrawn from the core.

d. To prevent shorting out the preamplifier due to detector saturation.

QUESTION C.7 [1.0 point]
Maximum design flow rate for the Ion Exchanger (Demineralizer) is 20 gpm, but the design flow rate of the pump is 30 gallons per minute. How is the system setup to prevent too much flow to the Demineralizer?

a. A pipe with an orifice bypasses some flow around the Demineralizer.

b. A throttle valve in the system is adjusted to supply proper flow.

c. Cavitation due to inadequate Net Positive Suction Head (NPSH) is used to derate the pump flow rate.

d. Differential pressure across the cartridge type filters is kept high to reduce flow.

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.

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.

QUESTION C.10 [1.0 point]

You just finished working on the Nuclear Instrumentation rate (period) channel. Tests are completed and the reactor supervisor want you to verify channel operation. You perform a startup and you establish a period of 100 seconds-1. Which one of the listed approximate times to double reactor power would indicate the instrument is working properly?

a. 30 seconds

b. 50 seconds

c. 70 seconds

d. 100 seconds

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 cumulative 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 cumulative dose received by a radiation worker.

QUESTION C.12 [1.0 point]

Which ONE of the following is the detector type used in the Radiation Area Monitors?

a. Scintillation Detector

b. Ion Chamber

c. Geiger Muller

d. Proportional Counter

QUESTION C.13 [1.0 point]

Which ONE of the following conditions will NOT prohibit withdrawal of the shim-safety rods?

a. Reactor period at 12 seconds.

b. Linear channel reading 112% range.

c. Startup channel Count Rate at 1 cps.

d. Log Count Rate Selector in USE position.

QUESTION C.14 [2.0 points, ⅓ each]

Using the figure provided, identified each of shim-safety rod micro switches.

a. Engage

b. Jam

c. Lower Limit

d, Rod Lower Limit

e. Shim Range

f. Upper Limit

A.01 a
REF: x

A.02 c
REF:

A.03 a, fertile; b, fissile; c, fissile; d, fissile
REF:

A.04 d
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%

A.05 a
REF:

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

A.07 a
REF:

A.8 c
REF: Count = $S/(1 - K_{eff}) = 250/(1 - 0.8) = 250/0.2 = 1250$

A.09 b or a (2nd correct answer added per facility comment)
REF:

A.10 d
REF:

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

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

A.13 b
REF: x

A.14 a
REF: Burn, R., Introduction to Nuclear Reactor Operations, © 1988, § p.7-5

A.15 d
REF: Burn, R., Introduction to Nuclear Reactor Operations, © 1988, § 2.5.3

A.16 a
REF:

B.01 a, Check; b, Check; c, Cal; d, Test
REF: Technical Specifications § *1.0 Definitions*

B.02 b or d (2nd correct answer added per facility comment)
REF: PUR Procedure 91-1, *Reactor Startup, Operation and Shutdown.* a, 20; b, 1; c, 1; d, 10

B.03 c
REF: Technical Specifications 1.27, 3.1.a, 3.2 Table 1.

B.04 b
REF: Standard NRC Health Physics Question

B.05 b
REF: Emergency Plan, § 2.0 Definitions, p. 6.

B.06 a, 6; b, 2; c, 2; d, 1
REF: 10CFR55.

B.07 a
REF: Technical Specification 2.1

B.08 d
REF: SOP Reactor Water Sampling and Analysis (Revised Jan. 2005)

B.09 c
REF: PUR Technical Specifications, §§ 6.1.6 through 6.1.11.

B.10 a, NOT; b, NOT; c, REQ; d, NOT
REF: Technical Specification 6.1.9.

B.11 d
REF: Technical Specifications §§ 3.2 & 1.27

B.12 a
REF: 10CFR20.1004.

B.13 c
REF: TS § 1.31 “Tried Experiment”, TS § 1.51 “New Experiment, TS § 6.2.5(c), Form B.

B.14 b
REF: TS § 1.25

B.15 a
REF: Technical Specification 5.3(1)

C.01 a, 1; b, 2; c, 3; d, 2; e, 4
REF: Instrumentation Block Diagram

C.02 d
REF: SAR §3.6

C.03 d
REF: SAR § 3.7.1

C.04 a, RR; b, SSR; c, RR; d, SSR; e, SSR; f, RR
REF: SAR § 1.2

C.05 c
REF: PUR-1 Operating Manual 1962, Lockheed Nuclear Products, § 1.5.6.5.

C.06 a or b (2nd correct answer added per facility comment)
REF: PUR-1 Operation Manual 1962, Lockheed Nuclear Products, § 1.5.6.3 *Fission Chamber Drive System*

C.07 b
REF: PUR-1 Operations Manual 1962, Lockheed Nuclear Products, § 1.6 *Process System*

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

C.9 a
REF: ~~Standard NRC Question~~

C.10 c
REF: x time = Ln(2) × 100 = 69.3 sec. (Choice a. represents using Log vs. Ln.)

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

C.12 a
REF: PUR-1 Operating Procedure M-5, *Procedure for Radiation Area Monitor*, figure 1, also SAR § 3.7.7.2

C.13 d
REF: PURDUE Requalification Examination 12/78, question E

C.14 a, 6; b, 1; c, 4; d, 5; e, 3; f, 2
REF: Facility supplied Figure (Shim Safety Rod)

U. S. NUCLEAR REGULATORY COMMISSION
RESEARCH AND TEST REACTOR
INITIAL OPERATOR LICENSING EXAMINATION

FACILITY: Purdue University

REACTOR TYPE: PUR (pool)

DATE ADMINISTERED: 2006/11/08

CANDIDATE: _____

INSTRUCTIONS TO CANDIDATE:
Circle correct answer on the answer sheet provided. If you wish to change your answer, cross out the incorrect answer and write the correct answer on the line provided to the right. If you change you wish to change your answer again, cross the incorrect answer and write the correct answer to the right of the last answer you put down. Points for each question are indicated in brackets for each question. A 70% in each section is required to pass the examination. The examiner will pick up these handouts three (3) hours after the examination starts.

Category Value	% of Total	% of Candidates Score	Category Value	Category
18.00	33.3	_____	____	A. Reactor Theory, Thermodynamics and Facility Operating Characteristics
18.00	33.3	_____	____	B. Normal and Emergency Operating Procedures and Radiological Controls
18.00	33.3	_____	____	C. Facility and Radiation Monitoring Systems
54.00		_____	____%	TOTALS
			FINAL GRADE	

All work done on this examination is my own. I have neither given nor received aid.

_____
Candidate's Signature

NRC RULES AND GUIDELINES FOR OPERATOR LICENSING EXAMINATIONS

The following rules apply during the administration of this examination:

1. Cheating on the examination means an automatic denial of your application and could result in more severe penalties.

2. After you complete the examination you must sign the statement on the cover sheet of the handout indicating that the work is your own and you have neither received nor given assistance in completing the examination.

3. Restroom trips are to be limited and only one candidate at a time may leave. You must avoid all contacts with anyone outside the examination room to avoid even the appearance or possibility of cheating.

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

5. Print your name in the blank provided in the upper right-hand corner of the examination cover sheet.

6. Mark your answers by drawing a circle around the correct answer on the answer sheets provided. If you wish to change your answer cross out the previous answer and write the correct answer on the underlined space 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 number.

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

9. When finished turn in this handout, with the cover sheet signed.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

$$T_{½} = \frac{0.693}{\lambda}$$

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

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

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

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

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 = 3.7×10^{10} dis/sec

1 kg = 2.21 lbm

1 Horsepower = 2.54×10^3 BTU/hr

1 Mw = 3.41×10^6 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.01 a b c d ___

A.02 a b c d ___

A.03a fertile fissile ___

A.03b fertile fissile ___

A.03c fertile fissile ___

A.03d fertile fissile ___

A.04 a b c d ___

A.05 a b c d ___

A.06 a b c d ___

A.07 a b c d ___

A.08 a b c d ___

A.09 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.14 a b c d ___

A.15 a b c d ___

A.16 a b c d ___

B.01a Check Test Cal ___

B.01b Check Test Cal ___

B.01c Check Test Cal ___

B.01d Check Test Cal ___

B.02 a b c d ___

B.03 a b c d ___

B.04 a b c d ___

B.05 a b c d ___

B.06a 1 2 4 6 ___

B.06b 1 2 4 6 ___

B.06c 1 2 4 6 ___

B.06d 1 2 4 6 ___

B.07 a b c d ___

B.08 a b c d ___

B.09 a b c d ___

B.10a REQ NOT ___

B.10b REQ NOT ___

B.10c REQ NOT ___

B.10d REQ NOT ___

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 ___

C.01a 1 2 3 4 ___

C.01b 1 2 3 4 ___

C.01c 1 2 3 4 ___

C.01d 1 2 3 4 ___

C.02 a b c d ___

C.03 a b c d ___

C.04a RR SSR ___

C.04b RR SSR ___

C.04c RR SSR ___

C.04d RR SSR ___

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.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 ___

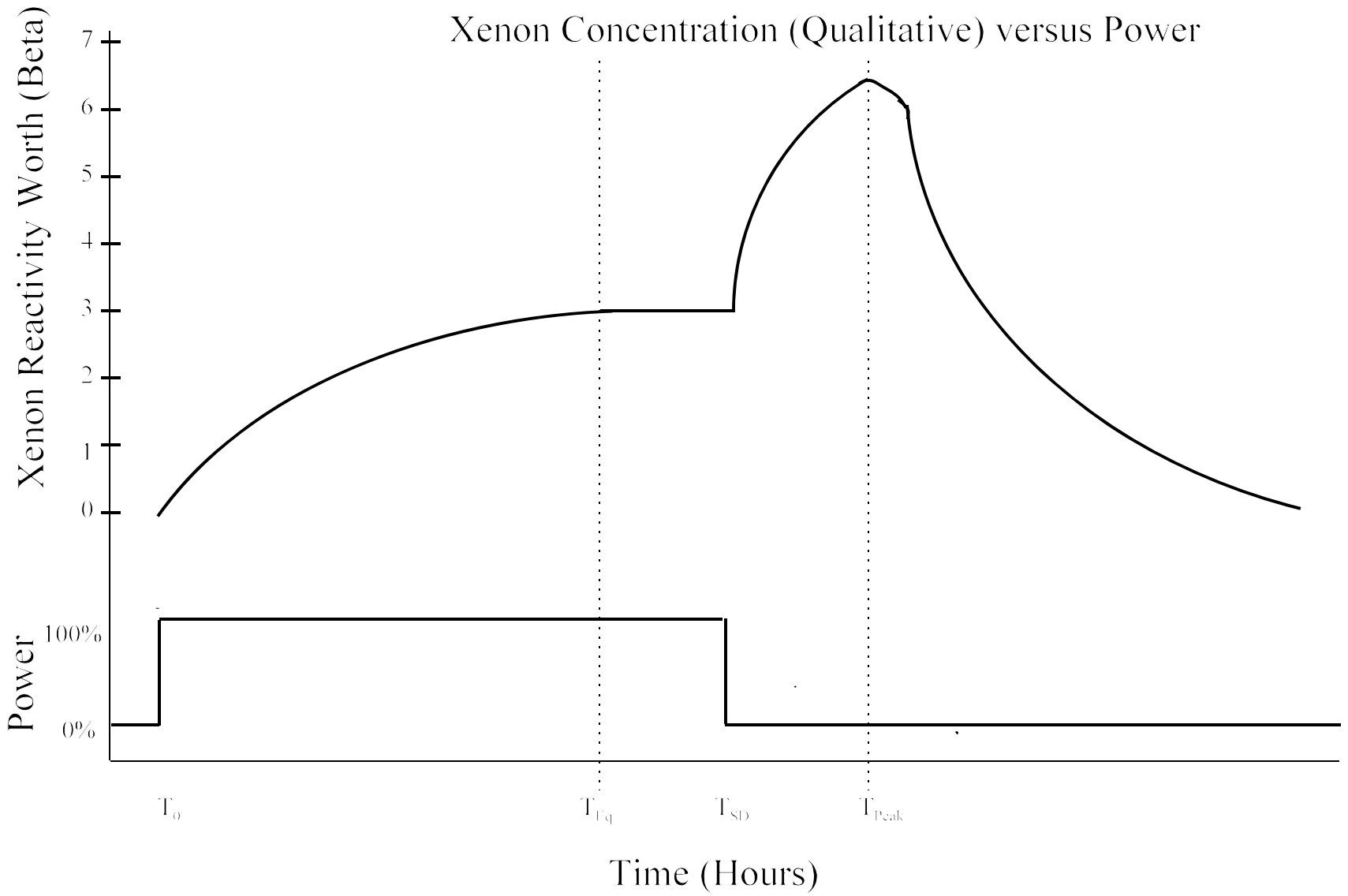
C.14b 1 2 3 4 5 6 ___

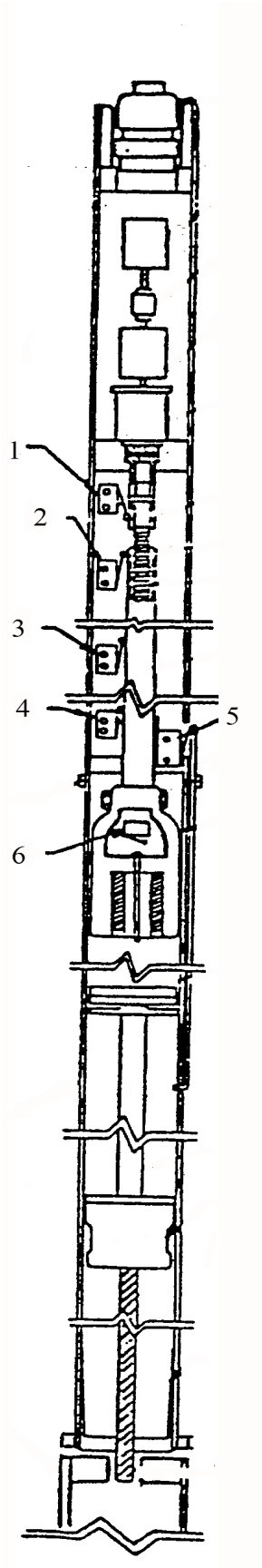
C.14c 1 2 3 4 5 6 ___

C.14d 1 2 3 4 5 6 ___

C.14e 1 2 3 4 5 6 ___

C.14f 1 2 3 4 5 6 ___


Xenon Concentration (Qualitative) versus Power
Xenon Reactivity Worth (Beta)
7
6
5
4
3
2
1
0
Power
100%
0%
T_0
T_{Eq}
T_{SD}
T_{Peak}
Time (Hours)


1
2
3
4
5
6