January 11, 2007

Dr. Donald Wall, Director
Nuclear Radiation Center
Washington State University
Pullman, WA 99164-1300

SUBJECT: INITIAL EXAMINATION REPORT NO. 50-027/OL-07-01, WASHINGTON STATE UNIVERSITY

Dear Dr. Wall:

During the week of December 11, 2006, the NRC administered an operator licensing examination at your Washington 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 Patrick Isaac at 301-415-1019.

Sincerely,

/RA/

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

Docket No. 50-027

Enclosures: 1. Initial Examination Report No. 50-027/OL-07-01
2. Facility comments with NRC resolution
3. Examination and answer key (RO/SRO)

cc w/enclosures:
Please see next page

Washington State University Docket No. 50-27

cc:

Dr. James T. Elliston
Chair, Reactor Safeguards Committee
Nuclear Radiation Center
Washington State University
P.O. Box 641300
Pullman, WA 99164 - 1300

Mr. Eric Corwin
Reactor Supervisor, Nuclear Radiation Center
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Olympia, WA 98504-7827

Office of the Governor
Executive Policy Division
State Liaisons Officer
P.O. Box 43113
Olympia, WA 98504-3113

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

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Nuclear Radiation Center
Washington State University
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Please see next page

DISTRIBUTION:
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ADAMS ACCESSION #: ML070080318 **TEMPLATE #: NRR-074**
PACKAGE ACCESSION #: ML062330220

OFFICE	PRTB:CE		IOLB:LA	PRTB:BC	
NAME	PIsaac		EBarnhill	JEads	
DATE	01/08/2007		01/11/2007	01/11/2007	

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

REPORT NO.: 50-027/OL-07-01

FACILITY DOCKET NO.: 50-027

FACILITY LICENSE NO.: R-76

FACILITY: Washington State University

EXAMINATION DATES: 12/14 - 15/2007

EXAMINER: Patrick Isaac, Chief Examiner

SUBMITTED BY: /RA/ 01/03/2007
Patrick Isaac, Chief Examiner Date

SUMMARY:

During the week of December 11, 2006, NRC administered examinations, consisting of a written examination and an operating test, to one Reactor Operator (RO) and one Senior Operator Instant (SROI) applicant. The applicants passed all portions of the examination.

ENCLOSURE 1

REPORT DETAILS

1. Examiner:

   Patrick Isaac, Chief Examiner

2. Results:

	RO PASS/FAIL	SRO PASS/FAIL	TOTAL PASS/FAIL
Written	**1/0**	**1/0**	**2/0**
Operating Tests	**1/0**	**1/0**	**2/0**
Overall	**1/0**	**1/0**	**2/0**

3. Exit Meeting:

   Personnel attending:

   Eric Corwin, Reactor Supervisor
   Keith Fox, SRO
   Patrick Isaac, NRC

   The licensee commented on a fair and well balanced examination. There were no generic concerns raised by the examiner.

NRC RESOLUTIONS - WRITTEN EXAMINATION

QUESTION A.6 [1.0 point]

The table provided lists data taken during a core loading. Estimate the number of fuel elements needed to go critical.

a. 9

b. 11

c. 13

d. 15

Count Rate	Number for Fuel Elements
842	2
936	4
1123	7
1684	12
2807	16

Answer:
b
Reference:
Standard NRC Question

Facility Comment:

The list of possible answers does not contain the correct answer of ~23 fuel elements. I suggest that this question be removed from the exam.

NRC Resolution:

Agree. Answer key has been modified to delete Question A.6 from the written examination.

QUESTION C.3 [1.0 point]

The gas used to move pneumatic tube "rabbit" samples into and out of the reactor is …

a. H

b. Air

c. CO_2

d. N_2

Answer:
b
Reference:
SAR, Figure 10-3, Pneumatic Transfer System

Facility Comment:

The pneumatic transfer (rabbit) system at the WSUNRC has been inoperable for many years prior to the exam date and as of 12/1/06 has been completely removed from the facility. The SOP for the operation of the rabbit was made inactive in the fall of 2006. I would recommend removing this question, as well as all related "rabbit" questions, from future examinations at Washington State.

NRC Resolution:

The answer key has been modified to delete Question C.3 from the written examination.

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

FACILITY: WASHINGTON STATE UNIVERSITY

REACTOR TYPE: TRIGA

DATE ADMINISTERED: 12/13/2006

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

CATEGORY VALUE	% OF TOTAL	CANDIDATE'S SCORE	% OF CATEGORY VALUE		CATEGORY
19.00	32.8	_____	_____	A.	REACTOR THEORY, THERMODYNAMICS AND FACILITY OPERATING CHARACTERISTICS
20.00	34.4	_____	_____	B.	NORMAL AND EMERGENCY OPERATING PROCEDURES AND RADIOLOGICAL CONTROLS
19.00	32,8	_____	_____	C.	PLANT AND RADIATION MONITORING SYSTEMS
FINAL GRADE		_____	_____ % TOTALS		

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

_____
CANDIDATE'S SIGNATURE

ENCLOSURE 3

A N S W E R S H E E T

Multiple Choice (Circle or X your choice)
If you change your answer, write your selection in the blank.

MULTIPLE CHOICE

001 a b c d ____

002 a b c d ____

003 a b c d ____

004 a b c d ____

005 a b c d ____

~~006 a b c d ____~~ Deleted

007 a b c d ____

008 a b c d ____

009 a b c d ____

010 a b c d ____

011 a b c d ____

012 a b c d ____

013 a b c d ____

014 a b c d ____

015 a b c d ____

016 a b c d ____

017 a b c d ____

018 a b c d ____

019 a b c d ____

020 a b c d ____

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

A N S W E R S H E E T

Multiple Choice (Circle or X your choice)
If you change your answer, write your selection in the blank.

MULTIPLE CHOICE

001 a b c d ___

002 a b c d ___

003 a ___ b ___ c ___ d ___

004 a b c d ___

005 a b c d ___

006 a b c d ___

007 a b c d ___

008 a b c d ___

009 a b c d ___

010 a b c d ___

011 a b c d ___

012 a b c d ___

013 a b c d ___

014 a b c d ___

015 a b c d ___

016 a b c d ___

017 a b c d ___

018 a b c d ___

019 a b c d ___

(***** END OF CATEGORY B *****)

A N S W E R S H E E T

Multiple Choice (Circle or X your choice)
If you change your answer, write your selection in the blank.

MULTIPLE CHOICE

001 a b c d ___

002 a b c d ___

~~003 a b c d~~ ___ Deleted

004 a b c d ___

005 a b c d ___

006 a b c d ___

007 a b c d ___

008 a b c d ___

009 a b c d ___

010 a b c d ___

011 a b c d ___

012 a b c d ___

013 a b c d ___

014 a b c d ___

015 a b c d ___

016 a b c d ___

017 a b c d ___

018 a b c d ___

019 a b c d ___

020 a b c d ___

(********** END OF EXAMINATION **********)

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 not received or given assistance in completing the examination. This must be done after you complete the examination.

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

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

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

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

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

8. The point value for each question is indicated in parentheses after the question.

9. Partial credit will NOT be given.

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

11. When you are done and have turned in your examination, leave the examination area as defined by the examiner.

EQUATION SHEET

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

$\dot{Q} = \dot{m}\, \Delta h$

$\dot{Q} = UA\, \Delta T$

$$SUR = \frac{26.06\,(\lambda_{eff}\rho)}{(\beta - \rho)}$$

$SUR = 26.06/\tau$

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

$P = P_0\, e^{(t/\tau)}$

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

$\tau = (\ell^*/\rho) + [(\bar{\beta}-\rho)/\lambda_{eff}\rho]$

$\rho = (Keff-1)/Keff$

$\rho = \Delta Keff/Keff$

$\bar{\beta} = 0.0077$

$DR_1 D_1^2 = DR_2 D_2^2$

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

1 Curie = 3.7×10^{10} dps

1 hp = 2.54×10^3 BTU/hr

1 BTU = 778 ft-lbf

1 gal $H_2O \approx$ 8 lbm

$$\text{Cycle Efficiency} = \frac{\text{Net Work (out)}}{\text{Energy (in)}}$$

$SCR = S/(1-Keff)$

$CR_1\,(1-Keff)_1 = CR_2\,(1-Keff)_2$

$$M = \frac{(1-Keff)_0}{(1-Keff)_1}$$

$M = 1/(1-Keff) = CR_1/CR_0$

$SDM = (1-Keff)/Keff$

$\dot{Pwr} = W_f\, \dot{m}$

$\ell^* = 1 \times 10^{-5}$ seconds

$\tau = \ell^*/(\rho-\beta)$

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

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

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

DR ≡ , Ci ≡ Curies, E ≡ Mev, R ≡ feet

1 kg = 2.21 lbm

1 Mw = 3.41×10^6 BTU/hr

°F = 9/5°C + 32

°C = 5/9 (°F - 32)

QUESTION A.1 [1.0 point]
Core excess reactivity (ρ_{ex}) changes with …

a. fuel element burnup

b. control rod height

c. neutron energy level

d. reactor power level

QUESTION A.2 [1.0 point]
Which ONE of the following is the definition of the term "*Cross-Section*?"

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

b. The most likely energy at which a charge 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.3 [1.0 point]
A reactor startup is in progress. Each control rod withdrawal is inserting exactly EQUAL amounts of reactivity. Select the EXPECTED neutron population and count rate response as "Keff" approaches 1.0.

The change in neutron population per reactivity insertion is:

a. SMALLER, and it takes LESS time to reach a new equilibrium count rate

b. LARGER, and it takes LESS time to reach a new equilibrium count rate.

c. SMALLER, and it takes MORE time to reach a new equilibrium count rate.

d. LARGER, and it takes MORE time to reach a new equilibrium count rate.

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 increase 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]

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. equal to $.50 when the reactor is prompt critical.

~~QUESTION A.6 [1.0 point]~~ DELETED

The table provided lists data taken during a core loading. Estimate the number of fuel elements needed to go critical.

a. 9

b. 11

c. 13

d. 15

Count Rate	Number for Fuel Elements
842	2
936	4
1123	7
1684	12
2807	16

QUESTION A.7 [1.0 point]

During a startup you increase reactor power from 100 watts to 195 watts in a minute. Which ONE of the following is reactor period?

a. 30 seconds.

b. 60 seconds.

c. 90 seconds.

d. 120 seconds.

QUESTION A.8 [1.0 point]

The reactor has just been started up and has been at 100% power for 3 hours. The Reactor Operator notes that several small control rod withdrawals are required to maintain power at 100%. Which of the following is the reason for the rod withdrawals?

a. Fuel temperatures are decreasing.

b. Xenon is building in to equilibrium concentration.

c. Pool water temperatures are decreasing.

d. Samarium is burning out from equilibrium concentration.

QUESTION A.9 [1.0 point]

The Fast Fission Factor (ε) is defined as "The ratio of the number of neutrons produced by …

a. fast fission to the number produced by thermal fission.

b. thermal fission to the number produced by fast fission.

c. fast and thermal fission to the number produced by thermal fission.

d. fast fission to the number produced by fast and thermal fission.

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

QUESTION A.10 [1.0 point]

Given the data in the table to the right, which ONE of the following is the closest to the half-life of the material?

a. 11 minutes

b. 22 minutes

c. 44 minutes

d. 51 minutes

QUESTION A.11 [1.0 point]

The reactor has just been pulsed to 940 MW from an initial power level of 1 KW. Select the reactivity coefficient that will act FIRST to prevent reactor power from exceeding any pre-established limits after the Transient Rod has been "fired".

a. Fuel Temperature Coefficient

b. Bath Temperature Coefficient

c. Power Coefficient

d. Void Coefficient.

QUESTION A.12 [1.0 point]

The number of neutrons passing through a square centimeter 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.13 [1.0 point]

The reactor has been at 100% power for several hours when a reactor scram occurs. All systems have operated as designed, no experiments have been changed, and no fuel has been removed from the reactor. Several hours after the reactor scram, indicated reactor power will stabilize due to:

a. continuing decay of the shortest-lived delayed neutron precursor.

b. the decay of nuclear instrumentation compensation voltage at low power levels.

c. reaching the nuclear instrumentation minimum detectable level.

d. the continuing subcritical multiplication of source neutrons.

QUESTION A.14 [1.0 point]

A fissile material is one which will fission upon the absorption of a **THERMAL** neutron. Which ONE of following listed isotopes is not a fissile material?

a. Th^{232}

b. U^{233}

c. U^{235}

d. Pu^{239}

QUESTION A.15 [1.0 point]

Which of the following is the PRIMARY advantage of using the homogeneous alloy of uranium fuel and zirconium-hydride moderator (U-ZrH) in the WSU TRIGA reactor?

This alloy combination:

a. gives much longer core life by providing a large amount of "excess reactivity".

b. makes the reactor self-regulating by providing a large negative temperature coefficient.

c. allows the reactor to be pulsed to high power levels with minimal potential for cladding failure.

d. yields more efficient heat transfer from the fuel centerline to the cladding and into the coolant.

QUESTION A.16 [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.17 [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 A.18 [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

QUESTION A.19 [1.0 point]

Identify the PRINCIPAL source of heat in the reactor after shutdown?

a. Stored energy from the reactor and core materials

b. Spontaneous fission within the core

c. Decay of fission products

d. Cosmic radiation causing fission

QUESTION A.20 [1.0 point]

Preparations are being made to "pulse" the reactor. Given the following conditions:

-- Peak power from the previous pulse: 800 MW
-- Reactivity added from the previous pulse: $2.00
-- Reactivity to be added on this pulse: $1.75

What will be the ESTIMATED peak power for the new pulse operation?

a. 450 MW

b. 600 MW

c. 700 MW

d. 1600 MW

QUESTION B.1 [1.0 point]

An accessible area within the facility has general radiation levels of 325 mrem/hour. What would be the EXPECTED posting for this area?

a. "Caution, Very High Radiation Area"

b. "Danger, Airborne Radioactivity Area"

c. "Danger, High Radiation Area"

d. "Caution, Radiation Area"

QUESTION B.2 [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.3 [2.0 points, ½ 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.4 [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."* Per 10CFR50.54(y), which one of the following is the minimum level of authorization for this action?

a. Reactor Operator licensed at the facility.

b. Senior Reactor Operator licensed at the facility.

c. Facility Manager (or equivalent at facility).

d. The U.S. Nuclear Regulatory Commission Project Manager

QUESTION B.5 [1.0 point]
Identify the lowest level of authorization for a change to the Technical Specifications

a. Senior Reactor Operator

b. Facility Director

c. Reactor Safeguards Committee

d. The U.S. Nuclear Regulatory Commission

QUESTION B.6 [1.0 point]
Per Technical Specifications regarding the Ventilation System: "The reactor shall not be operated unless the facility ventilation system is operable, except for periods of time not to exceed _____ hours to permit repair or testing of the ventilation system.".

a. 8

b. 12

c. 24

d. 48

QUESTION B.7 [1.0 point]
Which ONE of the following is the 10 CFR 20 definition of **TOTAL EFFECTIVE DOSE EQUIVALENT (TEDE)**?

a. The sum of the deep does equivalent and the committed effective dose equivalent.

b. The dose that your whole body receives from sources outside the body.

c. The sum of the external deep dose and the organ dose.

d. The dose to a specific organ or tissue resulting from an intake of radioactive material.

QUESTION B.8 [1.0 point]
According to Technical Specification 3.10 "Nonsecured experiments shall have reactivity worths less than …

a. $.25

b. $.50

c. $.75

d. $1.0

QUESTION B.9 [1.0 point]

A small radioactive source is to be stored in the reactor building. The source reads 2 R/hr at 1 foot. Assuming no shielding is to be used, a Radiation Area barrier would have to be erected from the source at least a distance of approximately:

a. 400 feet

b. 40 feet

c. 20 feet

d. 10 feet

QUESTION B.10 [1.0 point]

SOP #4 requires that reactor power be approximately at 300 watts prior to a pulse. Which one of the following is the reason for this limitation on power level?

To prevent exceeding...

a. the maximum power level limit

b. the reactivity insertion limits

c. the fuel element temperature limit

d. the maximum excess reactivity

QUESTION B.11 [1.0 point]

The Pre-critical Reactor checkout reveals that a non-operable instrumentation. The instrument being inoperable will not violate Facility license, technical specifications, written procedures, nor safe practices. What is the minimum level of authorization required before starting the reactor?

a. Reactor Operator

b. Senior Reactor Operator

c. Facility Director

d. Reactor Safeguards Committee

QUESTION B.12 [1.0 point]
Which One of the following conditions is a violation of a Limiting Condition for Operation?

a. Core excess reactivity is $6.00.

b. During a power calibration, actual power was found to be 1.13 MW.

c. Pool conductivity is 6×10^{-5} mhos/cm.

d. During a pulse, a fuel element temperature reached 760°C

QUESTION B.13 [1.0 point]
Which ONE of the following evolutions may be supervised by a Reactor Operator?

a. Irradiated fuel is being removed from the core.

b. New fuel element clusters are being installed in the core.

c. The Transient Control rod is being removed for maintenance.

d. One fuel element cluster is being repositioned in the fuel storage racks.

QUESTION B.14 [1.0 point]
Which ONE of the following is **NOT** a part of the Technical Specifications definition of a *Secured* Reactor?

a. The console key is in the **OFF** position and the key is removed from the console and under the control of the licensed operator.

b. No work is in progress involving withdrawal of in-core experiments.

c. The reactor is in the cold critical condition.

d. The reactor is subcritical by at least 1.00$ of reactivity.

QUESTION B.15 [1.0 point]
You have not performed the functions of an RO or SRO in the past 6 months. Per the Regulations, prior to resuming activities authorized by your license, how many hours must you complete in that function under the direction of an RO or SRO as appropriate?

a. 4

b. 6

c. 12

d. 40

QUESTION B.16 [1.0 point]

Technical Specifications require, whenever practicable, that the reactor be operated at or beyond four (4) inches from the thermal column. IDENTIFY the reason for this distance limitation.

To minimize:

a. neutron embrittlement to the thermal column.

b. the radiation exposure due to iodine isotopes 131 through 135

c. the production of Nitrogen-16.

d. the production of Ar-41.

QUESTION B.17 [1.0 point]

Which of the following, does NOT require the mobilization of the site emergency organization?

a. Following a pulse, the Transient Rod is stuck.

b. Fire in the NRC building outside the reactor operating areas.

c. Civil disturbance directed at the facility.

d. Failure of an in-core experiment.

QUESTION B.18 [1.0 point]

Which one of the following is a Non-License required test?

a. Area radiation monitors alarm operability

b. Building evacuation alarm operability

c. Ventilation system filter D/P check

d. Test pulse

QUESTION B.19 [1.0 point]

The WSU reactor is xenon free, with no experiments in the core. Given the following reactivity worth, calculate the Shutdown Margin.

	worth Dollars		worth Dollars
Safety Blade #1:	2.28	Safety Blade #2:	3.22
Safety Blade #3:	3.31	Safety Blade #4:	4.01
Servo rod:	0.40	Excess Reactivity:	3.42

a. 9.80

b. 9.40

c 5.79

d. 5.39

QUESTION C.1 [1.0 point]

With the reactor secured and the console control power turned off which ONE (1) of the following alarms will result in an automatic activation of the Building Evacuation alarm?

a. High ARM alarm

b. Fire alarm

c. Low pool water level

d. High neutron flux

QUESTION C.2 [1.0 point]

Which ONE (1) of the following Modes of the operation of the reactor ventilation system provides approximately 4500 CFM of treated external air into the pool area?

a. Auto mode

b. Emergency mode

c. Isolation mode

d. Dilution Mode

~~QUESTION C.3 [1.0 point]~~ DELETED

The gas used to move pneumatic tube "rabbit" samples into and out of the reactor is …

a. H

b. Air

c. CO_2

d. N_2

QUESTION C.4 [1.0 point]

The reactivity worth of Standard TRIGA fuel and FLIP fuel are best described by which ONE (1) of the following?

a. FLIP fuel reactivity is much greater that Standard fuel

b. Standard fuel reactivity is much greater than FLIP fuel

c. The reactivities for both fuels are about equal

d. The reactivity of each type fuel is based only on U-235 %

QUESTION C.5 [1.0 point]

Standard TRIGA fuel has a shorter useful core lifetime than FLIP TRIGA fuel. Which ONE (1) of the following characteristics of Standard fuel is a reason for this SHORTER lifetime?

a. Uranium content of 8.5 wt%

b. Required position in the core

c. U-235 enrichment

d. Erbium content of 1.5 wt%

QUESTION C.6 [1.0 point]

The reactor is operating at 1 KW when electrical power is lost to the Diffuser pump. Which one of the following is the reason why radiation dose rates on the bridge will increase?

a. The Nitrogen-16 transport time will decrease.

b. The Nitrogen-16 production rate will increase.

c. The production of Ar-41 will increase.

d. Buildup of radionuclides in the pool water.

QUESTION C.7 [1.0 point]

An experimenter drops and breaks open a sample vial in a laboratory room. He immediately runs out of the room and closes the door. You are called in to assist in the cleanup. Prior to opening the door you would take a reading using a(n)

a. Ion Chamber portable radiation detector to determine the radiation field strength.

b. Geiger-Müller portable radiation detector to determine the radiation field strength.

c. Ion Chamber portable radiation detector to determine whether contamination is present.

d. Geiger-Müller portable radiation detector to determine whether contamination is present.

QUESTION C.8 [1.0 point]

The Reactor Pool Room Ventilation System will shift to the "Dilute" mode upon receipt of a high alarm from the:

a. Reactor Bridge Area Radiation Monitor.

b. Console Area Radiation Monitor.

c. Gaseous Effluent Monitoring System.

d. Continuous Air Monitor System.

QUESTION C.9 [1.0 point]

Which of the following describes how the demineralizer (mixed bed ion exchanger) in the Pool Make-up and Demineralizer System functions to MINIMIZE CORROSION of reactor components?

The demineralizer:

a. maintains the pool water pH at a slightly basic value.

b. removes soluble radioactive impurities from the pool water.

c. removes suspended particles from the pool water.

d. maintains the pool water at a low conductivity.

QUESTION C.10 [1.0 point]

Which ONE of the following neutron flux monitoring channels provides a signal indicating the period of the reactor?

a. Linear Power Channel

b. Count Rate Channel

c. Log Power Channel

d. Percent Power Channel

QUESTION C.11 [1.0 point]
Which one of the following scrams is NOT an input to the Scram Circuitry Logic Element?

a. High fuel temperature

b. Log-N H.V. Failure

c. Short period

d. Safety channel #2 High Flux

QUESTION C.12 [1.0 point]
What is one of the purposes for the neutron count interlock?

a. To preclude the reactor from going super critical before the instrumentation starts to detect the neutron level in the core.

b. To provide a reference point where all instruments undergo a check before the reactor is brought to a critical position.

c. To allow for all experiments to be installed before the reactor is critical.

d. To ensure a sufficient neutron count to start the chain reaction.

QUESTION C.13 [1.0 point]
Which one of the following parameters provides the first and primary indication of a fuel element cladding failure?

a. Increase counts on the Ar-41 monitor.

b. Increasing pool water conductivity.

c. Increasing counts on the Continuous Air Monitoring

d. Increasing N-16 counts.

QUESTION C.14 [1.0 point]
What type of detectors are used in the Argon-41 monitoring systems?

a. Geiger-Mueller

b. Beta-Gamma sensitive scintillator

c. Ionization chamber

d. NaI

QUESTION C.15 [1.0 point]

Which ONE of the following is the mechanism by which clad failure will occur if the fuel elements temperature limit is exceeded?

a. Excessive metallic "creep" in the type 304 stainless steel.

b. Hydrogen overpressurization from the dissociation of zirconium hydride.

c. Swelling of the fuel rod zirconium hydride.

d. Phase changes in the type 304 stainless steel that reduces the clad yield strength.

QUESTION C.16 [1.0 point]

The reactor is operating at 1 MW and a leak has developed in the primary cooling line from the pool cooling heat exchanger returning to the pool. Which one of the following will TERMINATE the pool water level decrease prior to reaching the top of the core?

a. Any leakage is returned is returned to the pool via the drain system.

b. The pool cooling system design physically prevents the pool level from reaching the top of the core.

c. The pool cooling primary pump will automatically trip on lowering pool level.

d. Make-up water from the cooling tower will automatically divert to fill the pool.

QUESTION C.17 [1.0 point]

An emergency has occurred requiring the Reactor Pool Room Ventilation System to be placed in the "Isolate" mode. The Reactor Control Console (Room 201B) is not accessible. Identify the location where the Reactor Pool Room Ventilation System can be placed in the "Isolate" mode.

a. The Radiation Release Monitoring Panel in the Radiochemistry Laboratory.

b. The Emergency Operating Panel in the Reactor Supervisor's Office.

c. The Ventilation System Auxiliary Panel in the main office.

d. The Air Handling Control Panel in the Penthouse.

QUESTION C.18 [1.0 point]

Which ONE of the following statements correctly describes the purpose of the holes drilled at the bottom of the shroud for each control blade?

a. To limit the force on the blade during scrams.

b. To decelerate the last 5 inches of fall.

c. To minimize the effects of viscous damping on the blade fall time.

d. To provide cooling for the blade.

QUESTION C.19 [1.0 point]

Which of the following determines the amount of reactivity that is inserted by the Transient Control Rod during a pulse operation?

a. The air pressure applied to the Transition Rod pneumatic piston.

b. The position of the air cylinder.

c. The anvil of the shock absorber.

d. The Drive Up switch on the air cylinder.

QUESTION C.20 [1.0 point]

How will a LOSS of the facility air supply systems affect the Transient Control Rod (Pulse Rod) during normal operation at power?

a. The rod will begin to insert as the accumulator air pressure decreases.

b. The rod will immediately scram (fully insert).

c. The rod will maintain its present position.

d. The rod will not be capable of individual movement as a control rod.

Answer Key

A.1 a
REF: Reactor Training Manual - *Core Excess and Shutdown Margin.*

A.2 a
REF: Reactor Training Manual - *Cross Section*.

A.3 d
REF: Reactor Training Manual - *Introduction To Nuclear Physics*

A.4 a
REF: Reactor Training Manual - *Reflector* and *Moderation*

A.5 c
REF: Reactor Training Manual - *Reactivity*

A.6 b
REF: Standard NRC question

A.7 c
REF: $P = P_0 e^{t/\tau}$ —> $\tau = t/\ln(P/P_0)$ $\tau = 60/\ln(195/100) = 60/\ln(1.95) = 89.84 \approx 90$ sec.

A.8 b
REF: Reactor Training Manual - *Reactor Physics and Kinetics*

A.9 c
REF: Reactor Training Manual - *Neutron Life Cycle*

A.10 b
REF: Reactor Training Manual - *Reactivity*

A.11 a
REF: Reactor Training Manual - *Reactor Physics and Kinetics*

A.12 c
REF: Reactor Training Manual - *Neutron Flux*

A.13 d
REF: Reactor Training Manual - *Introduction to Nuclear Physics*

A.14 a
REF: Glasstone and Sesonske, *Third Ed. § 1.45*

A.15 b
REF: Reactor Training Manual - *Introduction to TRIGA Reactors*

A.16 a
REF: Reactor Training Manual - *Reactor Physics and Kinetics*

A.17 a
REF: Reactor Training Manual - *Introduction To Nuclear Physics*

A.18 c
REF: $\ln(2) = -\text{time}/\tau$ $\tau = \text{time}/(\ln(2)) = 60.59 \approx 61$ seconds

Answer Key

A.19 c
REF: LaMarsh, pgs 318 - 320

A.20 a
REF: $P_1/(Rho_1-1)^2 = P_2/(Rho_2-1)^2 \rightarrow P_2 = 450$ MW

Answer Key

B.1 c
REF: Reactor Training Manual - *10CFR20*

B.2 d
REF: Reactor Training Manual - *Ionizing Radiation*

B.3 a, 4; b, 2; c, 1; d, 3
REF: Reactor Training Manual - *Health Physics*

B.4 b
REF: 10CFR50.54(y).

B.5 d
REF: WSU Administrative Procedure #3

B.6 d
REF: Technical Specifications § 3.9 Engineered Safety Feature - Ventilation System

B.7 a
REF: 10 CFR 20.1003 *Definitions*

B.8 d
REF: Technical Specification § 3.10

B.9 c
REF:

$$\frac{DR_1}{{X_2}^2} = \frac{DR_2}{{X_1}^2} \qquad {X_2}^2 = \frac{DR_1}{DR_2} X^2 \quad X^2 = \frac{2000}{5} \times 1^2 = 400\, ft^2 \quad X = 20\, ft$$

B.10 c
REF: WSU TS 3.3

B.11 b
REF: SOP #4, A.9

B.12 c
REF: WSU TS 3.0

B.13 c
REF: WSU SOP #7 & #8

B.14 c
REF: Technical Specifications § 1.0 *Definitions*

B.15 b
REF: 10CFR55.53(f)(2))

B.16 d
REF: WSU TS 3.12

Answer Key

B.17 b
REF: WSU EPlan

B.18 b
REF: WSU SOPs for performing preventive maintenance

B.19 d
REF: SOP #5, *Shutdown Margin*

Answer Key

C.1 a
REF: SOP #18, B.5

C.2 a
REF: Emergency plan, Section 8.2 & Pool Room Ventilation System drawing, Fig. 8.2-1

C.3 b
REF: SAR, Figure 10-3, Pneumatic Transfer System

C.4 c
REF: SAR, Section 1.2

C.5 c
REF: Reactor Training Manual

C.6 a
REF: SAR, Section 5.6, Nitrogen-16 Control System

C.7 a
REF: Standard NRC Question

C.8 d
REF: SAR, Section 7.7.2, Continuous Air Monitoring System

C.9 d
REF: WSU Technical Specification 3.13

C.10 c
REF: SAR, Section 7.3.2 & Figure 7-5

C.11 b
REF: SAR, Figure 7-9, Scram Circuitry

C.12 a
REF: SAR, Section 7.3.1

C.13 c
REF: Emergency Plan, Fuel Element Failure

C.14 d
REF: SAR, Section 7.7.3, Argon-41 Monitoring System

C.15 b
REF: SAR, Section 6.3.3, Fuel Operating Temperature

C.16 b
REF: SAR, Section 5.3

C.17 c
REF: SAR, Section 9.1

Answer Key

C.18 c
REF: SAR, Section 4.2.2

C.19 b
REF: SAR, Section 4.2.2

C.20 a
REF: SAR, Section 4.2.2