June 6, 2008

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

SUBJECT: INITIAL EXAMINATION REPORT NO. 50-027/OL-08-01, WASHINGTON STATE UNIVERSITY TRIGA REACTOR

Dear Dr. Wall:

During the week of May 12, 2008, the NRC administered operator licensing examinations at your Washington State University TRIGA Reactor. The examinations were conducted according to NUREG-1478, "Operator Licensing Examiner Standards for Research and Test Reactors," Revision 2. 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 Title 10 of the Code of Federal Regulations Section 2.390, a copy of this letter and the enclosures will be available electronically for public inspection in the NRC Public Document Room or from the Publicly Available Records (PARS) component of NRC's Agencywide Documents Access and Management System (ADAMS). ADAMS is accessible from the NRC Web site at http://www.nrc.gov/reading-rm/adams.html. The 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 paul.doyle@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. 50-027

Enclosures: 1. Initial Examination Report No. 50-027/OL-08-01
2. Written examination with facility comments incorporated

cc w/o enclosures: See next page

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RidsNrrDprPrtb Facility File (CHart) O-12 G-15

ADAMS ACCESSION #: ML081490367 TEMPLATE #:NRR-074

OFFICE	PRTB:CE		IOLB:LA	E	PRTB:SC	
NAME	PDoyle		CHart		JEads	
DATE	05/ 28/2008		05/31/2008		06/06/2008	

OFFICIAL RECORD COPY

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
Washington State University
P.O. Box 641300
Pullman, WA 99164 - 1300

Mr. Steve Eckberg, CHP
Director, Radiation Safety Office
Washington State University
P.O. Box 641302
Pullman, WA 99163-1302

Director
Division of Radiation Protection
Department of Health
7171 Cleanwater Lane, Bldg #5
P.O. Box 47827
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

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

REPORT NO.: 50-027/OL-08-01

FACILITY DOCKET NO.: 50-027

FACILITY LICENSE NO.: R-76

FACILITY: Washington State University TRIGA

EXAMINATION DATES: May 14 – 16, 2008

SUBMITTED BY: ____________________________ __________
Paul V. Doyle Jr., Chief Examiner Date

SUMMARY:

During the week of May 12, 2008, the NRC administered operator licensing examinations to 6 operator licensing candidates at the Washington State University TRIGA reactor. The candidate breakdown was: 1 retake Reactor Operator candidate (Section A only), 1 initial Senior Reactor Operator Instant candidate, 1 initial Senior Reactor Operator Upgrade candidate, and 2 initial Reactor Operator candidates. All license candidates passed their respective examinations.

REPORT DETAILS

1. Examiner: Paul V. Doyle, Chief Examiner, NRC

2. Results:

	RO PASS/FAIL	SRO PASS/FAIL	TOTAL PASS/FAIL
Written	3/0	1/0	4/0
Operating Tests	2/0	2/0	4/0
Overall	3/0	2/0	5/0

3. Exit Meeting: Paul V. Doyle Jr., NRC, Examiner
Donald Wall, Nuclear Radiation Center, Director

The chief examiner (CE) thanked the facility for their support in administering the examinations. The CE also noted that he did not observe any generic weaknesses on the part of the candidates; rather they did very well during their walkthrough examinations.

ENCLOSURE 1

OPERATOR LICENSING EXAMINATION
With Answer Key

UNITED STATES NUCLEAR REGULATORY COMMISSION

WASHINGTON STATE UNIVERSITY
May 15, 2008

Enclosure 2

QUESTION A.01 [2.0 points, 0.5 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

QUESTION A.02 [1.0 point]

Reactor power is rising on a 100 second period. Approximately how long will it take for power to double?

a. 35 seconds

b. 50 seconds

c. 70 seconds

d. 100 seconds

QUESTION A.03 [2 points, 0.5 each]

Match the description of plant conditions in column A with resulting xenon conditions in column B.

Column A	Column B
a. 4 hours after a power increase	1. Xenon concentration is increasing to a peak
b. 2 hours after a power decrease	2. Xenon concentration is decreasing to a trough
c. 16 hours after a “clean” startup	3. Xenon concentration is approximately zero (reactor is “clean”)
d. 72 hours after a shutdown	4. Xenon concentration is “relatively” steady at a “non-zero” value

QUESTION A.04 [1.0 point]

The number of neutrons passing through a one square centimeter of target material per second is the definition of which one of the following?

a. Neutron Population (np)

b. Neutron Impact Potential (nip)

c. Neutron Flux (nv)

d. Neutron Density (nd)

QUESTION A.05 [1.0 point]
The reactor had a shutdown margin of 2.5$, and a source range count rate of 15 counts per minute. After placing samples in the reactor the count rate increased to 30 counts per minute. What is the worth of the sample?

a. -634

b. +634

c. -1.26$

d. +1.26$

QUESTION A.06 [2.0 points. ½ each] **Question modified during administration of examination.**
[2.0 points, ½ each]
Identify each of the listed radio-active decays as either alpha (α), beta (β), gamma (γ), proton (p) or neutron (n).

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

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

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

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

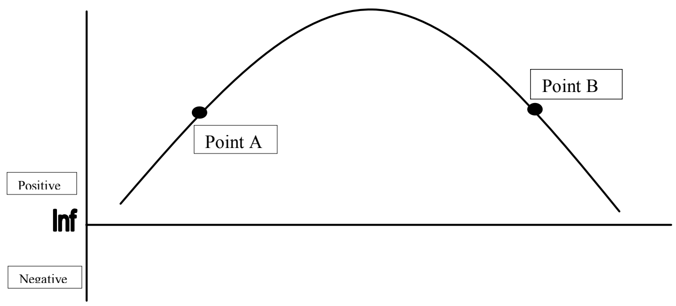
QUESTION A.07 [1.0 point]
Shown below is a trace of reactor period as a function of time. Between points A and B reactor power is:

a. continually increasing.

b. continually decreasing.

c. increasing, then decreasing.

d. constant.



QUESTION A.08 [1.0 point]
A thin foil target of 10% copper and 90% aluminum is in a thermal neutron beam. Given $\sigma_{a\ Cu}$ = 3.79 barns, $\sigma_{a\ Al}$ = 0.23 barns, $\sigma_{s\ Cu}$ = 7.90 barns, and $\sigma_{s\ Al}$ =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.09 [1.0 point]
Which ONE of the reactions below is an example of a **PHOTONEUTRON** source?

a. ${}_1H^2 + {}_0\gamma^0 \rightarrow {}_1H^1 + {}_0n^1$

b. ${}_{92}U^{238} \rightarrow {}_{35}Br^{87} + {}_{57}La^{148} + 3{}_0n^1 + {}_0\gamma^0$

c. ${}_{51}Sb^{123} + {}_0n^1 \rightarrow {}_1H^1 + {}_0\gamma^0$

d. ${}_4Be^9 + {}_2\alpha^4 \rightarrow {}_6C^{12} + {}_0n^1$

QUESTION A.10 [1.0 point]
ELASTIC SCATTERING is the process by which a neutron collides with a nucleus and the resultant particles …

a. recoil with the same kinetic energy the system had prior to the collision

b. recoils with less kinetic energy than the system 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 the system had prior to the collision with the nucleus emitting a gamma ray.

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

a. Absorption of prompt gamma rays

b. Slowing down of fission fragments

c. Neutrino interactions

d. Fission neutron scattering

QUESTION A.12 [1.0 point]
You enter the control room and note that all nuclear instrumentation channels 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.13 [1.0 point]
Which ONE of the following describes the characteristics of good moderators and reflectors?

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

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

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

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

QUESTION A.14 [1.0 point]
You just shutdown the reactor. Reactor period has stabilized and reactor power is at 1000 cpm. What would you expect reactor power to read three minutes later?

a. 500 cpm

b. 333 cpm

c. 100 cpm

d. 10 cpm

QUESTION A.15 [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.16 [1.0 point] **Corrections made during administration of examination.**
The table provided lists data taken during a core loading. Estimate the number of fuel elements needed to go critical.

a. ~~9~~ 18

b. ~~11~~ 22

c. ~~13~~ 26

d. ~~15~~ 30

Count Rate	Number of Fuel Elements
842	2
936	4
1123	7
1684	12
2806	16

QUESTION A.17 [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 B.01 [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

QUESTION B.02 [2.0 points, ½ each]
Match the terms in column A with their respective definitions in column B.

	Column A		Column B
a.	Radioactivity	1.	The thickness of a material which will reduce a gamma flux by a factor of two.
b.	Contamination	2.	An impurity which pollutes or adulterates another substance. In radiological safety, contamination refers to the radioactive materials which are the sources of ionizing radiations.
c.	Dose	3.	The quantity of radiation absorbed per unit mass by the body or by any portion of the body.
e.	Half-thickness	4.	That property of a substance which causes it to emit ionizing radiation. This property is the spontaneous transmutation of the atoms of the substance.

QUESTION B.03 [1.0 point]
Many research reactors use different methods to reduce the dose due to N^{16} at the pool top. If the method used keeps the N^{16} ten (10) feet below the surface of the water, and a half-thickness for the N^{16} gamma(s) is one foot for water, then the dose due to N^{16} is reduced (approximately) by a factor of … (Note: Neglect any reduction in dose rate due to half-life.)

a. 20

b. 100

c. 200

d. 1000

QUESTION B.04 [2.0 points, ½ each]
Match each type of radiation in column A with the proper penetrating power in column B. Each penetrating power listed in column B should be used only once.

Column A	Column B
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.05 [1.0 point, ⅓ each]
Identify the PRIMARY source (irradiation of air, irradiation of water, or fission product) of EACH of the radioisotopes listed.

a. $_{18}Ar^{41}$

b. $_{7}N^{16}$

c. $_{54}Xe^{135}$

QUESTION B.06 [1.0 point]
The **CURIE** content of a radioactive source is a measure of

a. the number of radioactive atoms in the source.

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

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

d. the number of nuclear disintegrations per unit time.

QUESTION B.07 [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 x 10^{-5} mhos/cm.

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

QUESTION B.08 [1.0 point]
You initially remove a sample from the pool reading 1 R/hr at 30 cm from the source. You then replace the sample in the pool. An hour later you remove the sample and the reading is now 390 mR/hr at 30 cm. You again replace the sample back in the pool. How much longer should you wait to be able to bring out the sample without generating a high radiation area?

a. ½ hour

b. 1 hour

c. 1½ hours

d. 2 hours

QUESTION B.09 [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.10 [1.0 point]
Which ONE 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.11 [1.0 point]
Which ONE of the following is the reason that Technical Specifications require, whenever practicable, that the reactor be operated at or beyond four (4) inches from the thermal column? To minimize …

a. neutron embrittlement of the thermal column.

b. the radiation exposure due to iodine isotopes I^{131} through I^{135}.

c. the production of N^{16}.

d. the production of Ar^{41}.

QUESTION B.12 [1.0 point]
SOP #4. Which one of the following is the reason that SOP #4 requires that reactor power be approximately at 300 watts prior to a pulse? 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.13 [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.14 [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, or 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.15 [1.0 point]
Which ONE of the following statements correctly describes the relationship between the Safety Limit (SL) and the Limiting Safety System Setting (LSSS)?

a. The SL is a maximum operationally limiting value that prevents exceeding the LSSS during normal operations.

b. The SL is a parameter that assures the integrity of the fuel cladding. The LSSS initiates protective actions to preclude reading the SL.

c. The LSSS is a parameter that assures the integrity of the fuel cladding. The SL initiates protective action to preclude reaching the LSSS.

d. The SL is a maximum setpoint for instrumentation response. The LSSS is the minimum number of channels required to be operable.

QUESTION B.16 [1.0 point]

The Emergency Plan defines “Emergency Planning Zone” as …

a. The area encompassed by within a 150 foot (~50 meter) perimeter measured from the centerline of the reactor core.

b. The area encompassed by within a 150 foot (~50 meter) perimeter measured from the centerline of the ventilation stack.

c. The perimeter of the main Nuclear Radiation Center building as modified by the two small fences at the freight doors.

d. The perimeter of the main Nuclear Radiation Center building as modified by the two small fences at the freight doors, and the area over the radiation liquid waste tanks.

QUESTION B.17 [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.

QUESTION C.01 [1.0 point]
The normal rods use electric drive motors for positioning. The transient rod is moved by

a. pneumatics (air)

b. pneumatics (Nitrogen)

c. hydraulics (Water)

d. hydraulics (Oil)

QUESTION C.02 [1.0 point]
An emergency occurs on a weekend with no operators on-site. The emergency requires that the Reactor Pool Room Ventilation System be placed in the "Isolate" mode, but, the Reactor Control Console (Room 201B) is not accessible. Identify other 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.03 [2.0 points, ⅓ each]
Match the each of areas listed in column A with the correct heat transport mechanism listed in column B. Items in column B may be used once, more than once or not at all.

Column A	Column B
a. Within the fuel	1. Natural convection
b. Within the clad	2. Forced Convection
c. From the clad to the pool	3. Conduction
d. From the pool to the heat exchanger.	4. Radiation

QUESTION C.04 [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.05 [2.0 points, ½ each]
Match the purification system functions in column A with the purification component listed in column B

Column A	Column B
a. remove floating dust, bug larvae, etc.	1. Demineralizer (Ion Exchanger)
b. remove dissolved impurities	2. Skimmer
c. remove suspended solids	3. Filter (strainer)
d. maintain pH	

QUESTION C.06 [1.0 point]
Which ONE of the choices correctly identifies the radiation detector signal which if it trips will realign the ventilation system to dilute mode?

a. Continuous Air Monitor WARN alarm

b. Continuous Air Monitor HIGH alarm

c. Exhaust Gas Monitor WARN alarm

d. Exhaust Gas Monitor HIGH alarm.

QUESTION C.07 [1.0 point]
A pipe flange downstream of the primary pump fails. What design feature prevents the pump from draining the pool?

a. Closure of an automatic valve sensitive to pool level.

b. Siphon breaks (holes) located in the pump suction piping.

c. Level in pool drops below minimum required to supply suction pressure to the pump.

d. Level in pool drops below the bottom of the suction piping.

QUESTION C.08 [1.0 point]
Which **ONE** of the following parameters is **NOT** measured in the Primary Cooling Loop?

a. Temperature

b. Pressure

c. Conductivity

d. pH

QUESTION C.09 [2.0 points, ¼ each] **The Linear Channel #2 and the Rabbit terminus have been removed. Candidates were instructed to ignore answers involving these during administration of the examination.**
Using the figure provided, identify each of the following items.

a. A	1. Linear Channel #1
b. B	~~2. Linear Channel #2~~
c. C	3. Log-N Channel
d. D	4. Neutron Source
e. E	5. Pulse Gamma Channel
f. F	~~6. Rabbit Tube~~
g. G	7. Reflector
h. H	8. Rotator Tube

QUESTION C.10 [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. Exhaust Gas Monitor

c. Continuous Air Monitor

d. Bridge Area Monitor

QUESTION C.11 [2.0 points, ½ each]
Identify each of the listed scrams as having input into the logic element, the slow scram relay or both.

a. Beam Room Scram Chain

b. Compensated Ion Chamber High Voltage Failure

c. Safety Channel #2

d. Seismic Event

QUESTION C.12 [1.0 point]
The facility is shutdown for the weekend. Which ONE of the following Area Radiation Monitors will NOT cause an Evacuation alarm on an alarm signal?

a. Beam Room North

b. Bridge

c. R.C. Laboratory

d. Sample

QUESTION C.13 [1.0 point]
The ARIES system supplies emergency power to which **ONE** of the following?

a. Continuous Air Monitor

b. Dilute Fan

c. Pool Level Alarm

d. Primary Coolant Pump

QUESTION C.14 [1.0 point]
Following a reactor power calibration if necessary power reading on the Nuclear Instruments is adjusted by

a. adjusting the physical position (up or down) of the detector.

b. adjusting the high voltage signal to the detector.

c. adjusting the gain of the preamplifier circuit.

d. adjusting the screw on the meter face.

QUESTION C.15 [2.0 points, 0.4 each]
You've been asked to retrieve a sample. There is some concern that the experimenter made a math error and the sample may have a stronger radiation field than anticipated. Which ONE of the following detectors would you use as you retrieve the sample?

a. Geiger-Müller

b. GeLi

c. Scintillation

d. Ion Chamber

QUESTION C.16 [1.0 point]
Which ONE of the following methods is used to compensate for gamma radiation in a Compensated Ion Chamber?

a. Pulses smaller than a preset height (voltage) are stopped by a pulse-height discriminator circuit from entering the instrument channel's amplifier.

b. The chamber contains concentric tubes one of which detects both neutrons and gammas the other only gammas, are wired electronically to subtract the gamma signal, leaving only the signal due to neutrons.

c. The signal travels through a Resistance-Capacitance (RC) circuit, converting the signal to a power change per time period effectively deleting the signal due to gammas.

d. A compensating voltage equal to a predetermined "source gamma level" is fed into the pre-amplifier electronically removing source gammas from the signal. Fission gammas are proportional to reactor power and therefore not compensated for.

A.01 a, 7; b, 2; c, 1; d, 5
REF: Standard NRC Question

A.02 c
REF: $P = P_0 e^{t/T}$ —> ln(2) = time ÷ 100 seconds –> time = ln (2) x 100 sec. 0.693 x 100 ≈ 0.7 x 100 ≈ 70 sec.

A.03 a, 2; b, 1; c, 4; d, 3
REF:

A.04 c
REF: DOE Fundamentals Handbook, Nuclear Physics and Reactor Theory, Volume

A.05 d
REF: SDM = 2.5\$ = 0.0175 ΔK/K, $K_{eff} = 1/(1.0175) = 0.9828$ $1 - K_{eff2} = (1 - K_{eff1}) \rightarrow CR_1/CR_2 \rightarrow K_{eff2} = 1 - [(1 - K_{eff1})CR_1/CR_2]$
$K_{eff2} = 1 - [(1 - 0.9828) \times ½] = 1 - [0.0172 \times 0.5] = 1 - 0.0086 = 0.9914$ $\rho = (0.9828 - 0.9914)/(0.9828 \times 0.9914) = 0.0 = \$1.26$

A.06 a, α; b, n; c, p; d, β
REF: Chart of the Nuclides

A.07 a
REF: Standard NRC Question

A.08 a
REF: 0.1 × 3.79 = 0.379 0.9 × 0.23 = 0.207 0.1 × 7.9 = 0.79 0.9 × 1.49 = 1.34

A.09 a
REF:

A.10 a
REF:

A.11 b
REF:

A.12 c
REF:

A.13 b
REF:

A.14 c
REF: $P = P_0 e^{-t/T}$, Reactor period stabilizes at - 80 seconds. Time (t) = 180 seconds (three minutes).
$P = 1000 e^{-180/80} = 1000 (e^{-9/4}) = 1000 (0.1054) = 105.4$

A.15 c
REF: Reed Reactor Facility Training Manual September 2004, § 9.2 Reactivity

A.16 b
REF: (See attached sketch, ~ 11 fuel elements)

A.17 a
REF: Reactor Training Manual - Cross Section.

B.01 a, 20; b, 1; c, 1; d, 10
REF: 10CFR20.100x

B.02 a, 4; b, 2; c, 3; d, 1
REF: Standard NRC question

B.03 d
REF: Basic Radiological Controls knowledge: “Half-Thickness and Tenth-Thickness". $2^{10} = 1024$

B.04 a, 4; b, 2; c, 1; d, 3
REF: Standard NRC Health Physics Question

B.05 a, Air; b, Water; c, Fission
REF: Standard NRC question.

B.06 d
REF: Standard Health Physics Definition.

B.07 c
REF: WSU TS 3.0

B.08 c
REF: $I_t = I_0 e^{-\lambda t}$ 390 mR/hr ÷ 1000 mR/hr = $e^{-\lambda 1hr}$ ln(0.39) = -λ * 1 hr. λ = 0.9416 hour-1
SOLVING for additional time: $I_f = I_t e^{-\lambda t}$ 100mR/hr = 390 mR/hr e-0.9416 (time) ln (0.25) = -0.9163 * time time = 1.4454

B.09 a
REF: 10 CFR 20.1003 *Definitions*

B.10 b
REF: WSU EPlan

B.11 d
REF: WSU TS 3.12

B.12 c
REF: WSU TS 3.3

B.13 c
REF: Technical Specifications § 1.0 *Definitions*

B.14 b
REF: SOP #4, A

B.15 b
REF:

B.16 c
REF: Emergency Plan § 6.0.

B.17 d
REF: BASIC Radiological Concept (Betas don't make it through piping.)

C.01 a
REF: Find reference

C.02 c
REF: SAR, Section 9.1, also NRC examination administered 12/2006

C.03 a, 3; b, 3; c, 1; d, 2
REF: Standard NRC TRIGA cooling question.

C.04 c
REF: SAR, Section 4.2.2, also NRC exam administered 12/2006.

C.05 a, 2; b, 1; c, 3; d, 1
REF: SAR § 4.10, figure 4.10-1.

C.06 b
REF: SOP 19 § C.2.d.2.a.2. p. 5

C.07 b
REF: TRIGA MK I Reactor Mechanical Maint. & Operating Manual, § 5.11.10, p. 85

C.08 d
REF: SAR § 4,9.

C.09 a, 5; ~~b, 2~~; c, 3; d, 1; e, 7; f, 8; g, 4; ~~h, 6~~
REF: SAR figure 4-10

C.10 b
REF: Ar^{41} is a gas.

C.11 a, relay; b, both; c, both; d, relay
REF:

C.12 d
REF: SOP 16 *Standard Procedure for Checkout and Calibration of Area Radiation Monitors*, Note following step B.3.e

C.13 c
REF: SOP 36, ARIES supplies 24 vdc. Pumps, air handlers and fans are too large to run on this power supply.

C.14 a
REF: NRC Examination Question bank, also SOP 13, p. 5

C.15 d
REF: Standard NRC question, also NRC Examination Question Bank

C.16 b
REF: Standard NRC question.