May 13, 2002

Dr. Gerald E. Tripard, Director
Nuclear Radiation Center
Washington State University
Pullman, WA 99164-1300

SUBJECT: INITIAL EXAMINATION REPORT NO. 50-027/OL-02-01

Dear Dr. Tripard:

During the week of April 01, 2002, the NRC administered examinations to an employee of your facility who had applied for a license to operate your Washington State University Reactor. The examination was conducted in accordance with NUREG-1478, "Non-Power Reactor Operator Licensing Examiner Standards," Revision 1.

In accordance with 10 CFR 2.790 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 document system (ADAMS). ADAMS is accessible from the NRC Web site at (the Public Electronic Reading Room) http://www.nrc.gov/NRC/ADAMS/indesx.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/

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

Docket No. 50-027

Enclosures: 1. Initial Examination Report No. 50-027/OL-02-01
2. Examination and answer key

cc w/enclosures:
Please see next page

cc:

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

Stephanie Sharp
Reactor Supervisor, Nuclear Radiation Center
Washington State University
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DISTRIBUTION:
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ADAMS ACCESSION #: ML021080729 **TEMPLATE #: NRR-074**

OFFICE	**RORP:CE**		**IEHB:LA**		**RORP:SC**	
NAME	**PIsaac**		**EBarnhill**		**PMadden**	
DATE	**05/ 09 /2002**		**04/ 24 /2002**		**05/ 09 /2002**	

C = COVER **E = COVER & ENCLOSURE** **N = NO COPY**
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U. S. NUCLEAR REGULATORY COMMISSION
OPERATOR LICENSING INITIAL EXAMINATION REPORT

REPORT NO.:	50-027/OL-02-01
FACILITY DOCKET NO.:	50-027
FACILITY LICENSE NO.:	R-76
FACILITY:	Washington State University
EXAMINATION DATES:	04/02 - 03/2002
EXAMINER:	Patrick Isaac, Chief Examiner

SUBMITTED BY: ***/RA/***   04/09/2002
Patrick Isaac, Chief Examiner   Date

SUMMARY:

During the week of April 01, 2002, NRC administered examinations, consisting of a written examination and an operating test, to one Reactor Operator (RO) applicant. The applicant 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**	**N/A**	**1/0**
Operating Tests	**1/0**	**N/A**	**1/0**
Overall	**1/0**	**N/A**	**1/0**

3. Exit Meeting:

Personnel attending:

Stephanie Sharp, 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.

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

FACILITY: WASHINGTON STATE UNIVERSITY

REACTOR TYPE: TRIGA

DATE ADMINISTERED: 04/02/2002

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
20.00	___.___	________	________	A. REACTOR THEORY, THERMODYNAMICS AND FACILITY OPERATING CHARACTERISTICS
20.00	___.___	________	________	B. NORMAL AND EMERGENCY OPERATING PROCEDURES AND RADIOLOGICAL CONTROLS
20.00	___.___	________	________	C. PLANT AND RADIATION MONITORING SYSTEMS
60.00		________ FINAL GRADE	________%	TOTALS

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

CANDIDATE'S SIGNATURE

ANSWER SHEET

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 ___

020 a b c d ___

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

ANSWER SHEET

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 1 ___ 2 ___ 3 ___ 4 ___

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 ___

(***** 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 ___

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. Before you turn in your examination, consecutively number each answer sheet, including any additional pages inserted when writing your answers on the examination question page.

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

10. Partial credit will NOT be given.

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

12. When you are done and have turned in your examination, leave the examin-ation area as defined by the examiner. If you are found in this area while the examination is still in progress, your license may be denied

or
revoked.

EQUATION SHEET

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

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

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

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

$SUR = 26.06/\tau$

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

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

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

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

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

$\rho = \Delta Keff/Keff$

$\bar{\beta} = 0.0077$

$DR_1 D_1^2 = DR_2 D_2^2$

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

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

$SCR = S/(1-Keff)$

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

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

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

$SDM = (1-Keff)/Keff$

$Pwr = W_f \dot{m}$

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

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

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

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

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

DR ≡ , Ci ≡ Curies, E ≡ Mev, R ≡ feet

1 Curie = 3.7×10^{10} dps

1 kg = 2.21 lbm

1 hp = 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)

Section A: Reactor Theory. Thermo. & Fac. Operating Characteristics

QUESTION (A.1) [1.0]

A mixed beta-gamma point source measures 200 mrem/hr at one foot and 0.1 mrem/hr at 20 feet. The beta emission has an energy of 1.0 MeV. What is the fraction of betas in the source?

a. 10%

b. 20%

c. 80%

d. 90%

QUESTION (A.2) [1.0]

An element decays at a rate of 20% per day. Determine its half-life.

a. 3 hr.

b. 75 hr.

c. 108 hr.

d. 158 hr.

QUESTION (A.3) [1.0]

The reactor has scrammed following an extended period of operation at full power. Which one of the following accounts for generation of a majority of the heat one (1) hour after the scram?

a. Spontaneous fissions

b. Delayed neutron fissions

c. Alpha fission product decay

d. Beta fission product decay

QUESTION (A.4) [1.0]

In a subcritical Rx, Keff is increased from 0.861 to 0.946. Which one of the following is the amount of reactivity that was added to the core?

a. 0.090 delta-K/K

b. 0.220 delta-K/K

c. 0.104 delta-K/K

d. 0.125 delta-K/K

QUESTION (A.5) [1.0]

Given the following conditions:

-- The reactor is operating at a power level of 790 watts
-- The regulating control rod is withdrawn
-- The rod pull results in a stable, 45 second period

SELECT the expected reactor power 100 seconds after the rod motion.

a. 2.63 MW

b. 7290 watts

c. 1756 watts

d. 1238 watts

QUESTION (A.6) [1.0]

A reactor startup is in progress by withdrawing a control rod and then waiting until count rate stabilizes. The reactor is not critical. Assume that the control rod is being withdrawn in equal amounts each time and each control rod withdrawal adds equivalent amounts of reactivity.

Compare two consecutive control rod withdrawals.

a. Time for power to stabilize will be equal for both withdrawals and the power increase will be the same for both withdrawals.

b. The power increase will be the same for both withdrawals but the time for power to stabilize will be less for the second withdrawal.

c. The power increase will be the same for both withdrawals but time for power to stabilize will be longer for the second withdrawal.

d. The power increase will be larger for the second withdrawal and the time for power to stabilize will be longer for the second withdrawal.

QUESTION (A.7) [1.0]

Which one of the following is the PRINCIPAL reason for operating with thermal neutrons instead of fast neutrons?

a. Reactors operating primarily on fast neutrons are inherently unstable and cannot be easily controlled at low power.

b. The fission cross section of the fuel is much higher for thermal neutrons than for fast neutrons.

c. Doppler and moderator temperature coefficients become positive as neutrons energy increases.

d. Increased neutron efficient since thermal neutrons are less likely to leak out of the core than fast neutrons.

QUESTION (A.8) [1.0]

Assume that reactor power is 50% and equilibrium Xenon is attained. Reactor power is then increased to 100%. Which one of the following correctly describes the new equilibrium Xenon value?

a. The 100% equilibrium xenon is half the 50% value

b. The 100% equilibrium xenon is equal to the 50% value.

c. The 100% equilibrium xenon is higher than the 50% value but not twice as high.

d. The 100% equilibrium xenon is twice as high as the 50% value.

QUESTION (A.9) [1.0]

Which of the following six factor formula terms are affected most by temperature?

a. Thermal utilization and resonance escape probability

b. Fast fission factor and resonance escape probability

c. Fast fission factor and reproduction factor

d. Reproduction factor and thermal utilization

QUESTION (A.10) [1.0]

Which one of the following describes how doubling the time a target nuclide is irradiated affects the activity level.

a. Less than doubles the activity.

b. More than doubles the activity.

c. Exactly doubles the activity.

d. Increases the activity by a factor of e.

QUESTION (A.11) [1.0]

If reactor power is increasing by a decade every minute, it has a period of:

a. 13 sec

b. 26 sec

c. 52 sec

d. 65 sec

QUESTION (A.12) [1.0]

Which one of the following is the primary reason a neutron source is installed in the core?

a. To allow for testing and irradiation experiments when the reactor is shutdown.

b. To supply the neutrons required to start the chain reaction for subsequent reactor startups.

c. To provide a neutron level high enough to be monitored for a controlled reactor startup.

d. To increase the excess reactivity of the reactor which reduces the frequency for refueling.

QUESTION (A.13) [1.0]

If Keff equals 1.0, how much reactivity must be added to make the reactor prompt critical?

a. The beta fraction.

b. The amount to make Keff equal to 1.1.

c. The amount to make the reactor period infinite.

d. The amount needed to increase the mean neutron lifetime to 0.080 seconds.

QUESTION (A.14) [1.0]

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.15) [1.0]

The reactor is subcritical with a Keff of 0.95 and a source range count rate of 15 counts per second. Control rods are withdrawn until the source range count rate equals 45 counts per second.

Which of the following is the Keff of the core after the control rod withdrawal?

a. 0.953

b. 0.970

c. 0.983

d. 0.995

QUESTION (A.16) [1.0]

The regulating blade was withdrawn two (2) inches. The steady reactor period following blade withdrawal is observed to be sixty (60) seconds.

Which one of the following is the differential blade worth?

a. 9.1 x 10-4 delta k/k per inch

b. 5.0 x 10-3 delta k/k per inch

c. 1.2 x 10-4 delta k/k per inch

d. 5.4 x 10-4 delta k/k per inch

QUESTION (A.17) [1.0]

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

- -- Peak power from the previous pulse: 900 MW
- -- Reactivity added from the previous pulse: $1.75
- -- Reactivity to be added on this pulse: $2.00

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

a. 1029 MW

b. 1175 MW

c. 1200 MW

d. 1600 MW

QUESTION (A.18) [1.0]

Following a scram, the value of the stable reactor period is:

a. approximately 50 seconds, because the rate of negative reactivity insertion rapidly approaches zero.

b. approximately -10 seconds, as determined by the rate of decay of the shortest lived delayed neutron precursors.

c. approximately -80 seconds, as determined by the rate of decay of the longest lived delayed neutron precursors.

d. infinity, since neutron production has been terminated.

QUESTION (A.19) [1.0]

During a reactor startup, as the reactor approaches criticality, the value of 1/M:

a. decreases toward zero

b. decreases toward one

c. increases toward infinity

d. increases toward one

QUESTION (A.20) [1.0]

Which one of the following is the definition of Shutdown Margin?

a. The overall condition where the reactor is shutdown, the console key switch is off, and no work in progress involving fuel or experiments.

b. The reactor can be made subcritical by at least $0.25 in a cold xenon-free condition, with the most reactive rod full out, and all samples in their most reactive positions.

c. The condition where all control rods are fully inserted or reactivity condition equivalent to one where all control rods are fully inserted.

d. The minimum shutdown reactivity necessary to ensure that the reactor can be made subcritical by means of the control and safety systems, from any operating conditions and will remain subcritical without further operator action.

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

<u>Section B: Normal/Emerg. Procedures & Rad Con.</u>

QUESTION (B.1) [1.0]

Consider two point sources, each having the same curie strength. Source A's gammas have an energy of 1 MEV whereas Source B's gamma have an energy of 2 MEV. You obtain a reading from the same Geiger counter 10 feet from each source. Concerning the two readings, which one of the following statements is correct?

a. The reading from Source B is four times that of Source A.

b. The reading from Source B is twice that of Source A.

c. Both readings are the same.

d. The reading from Source B is half that of Source A.

QUESTION (B.2) [2.0]

Match the requirements for maintaining an active operator license in column A with the correct time period from column B.

	Column A		**Column B**
1.	Renewal of license	a.	1 year
2.	Medical Examination	b.	2 years
3.	Requalification Written examination	c.	4 years
4.	Requalification Operating Test	d.	6 years

QUESTION (B.3) [1.0]

Which one of the following does NOT require NRC approval for changes?

a. Technical Specifications

b. Requalification plan

c. Emergency Implementation Procedures

d. Emergency Plan

QUESTION (B.4) [1.0]

The governor requests radiation workers to clean up an accident at WPPSS Nuclear facility. While helping out you receive a dose of 6 Rem. 10 CFR 20 requires that this dose be tracked as a Planned special exposure. Who is responsible for maintaining a permanent record of this dose?

a. Federal Emergency Management Agency (FEMA).

b. WSU Research Reactor.

c. Nuclear Regulatory Commission.

d. State of Washington (an agreement state).

QUESTION (B.5) [1.0]

Total Effective Dose Equivalent (TEDE) is defined as the sum of the deep dose equivalent and the committed effective dose equivalent. The deep dose equivalent is related to the …

a. dose to organs or tissues.

b. external exposure to the skin or an extremity.

c. external exposure to the lens to the eyes.

d. external whole-body exposure

QUESTION (B.6) [1.0]

Since he started employment at the WSU reactor a radiation worker has accumulated a dose of 3.27 R. So far this year, the worker has received a dose of 1.25 R. How long can he remain in an area with a gamma dose rate of 75 mR/hr without exceeding the 10CFR20 TEDE limit? (Assume zero committed dose.)

a. 6 hours

b. 23 hours

c. 50 hours

d. 66 hours

QUESTION (B.7) [1.0]

A radioactive source generates a dose of 100 mr/hr at a distance of 10 feet. With two inches of lead shielding the reading drops to 50 mr/hr at a distance of 10 feet. If you were to add **ANOTHER** four inches of the same type of shielding, the reading at 10 feet would drop to …

a. 25 mr/hr

b. 12½ mr/hr

c. 6¼ mr/hr

d. 3⅛ mr/hr

QUESTION (B.8) [2.0]

Identify each of the actions listed below as either a **Channel Check**, **Channel Test**, or **Channel Calibration.**

a. Verifying overlap between Nuclear Instrumentation meters.

b. Replacing an RTD with a precision resistance decade box, to verify proper channel output for a given resistance.

c. Performing a calorimetric (heat balance) calculation on the primary system, then adjusting Nuclear Instrumentation to agree.

d. During shutdown you verify that the period meter reads -80 seconds.

QUESTION (B.9) [1.0]

Limiting Safety System Settings (LSSS) are …

a. limits on important process variables necessary to protect the integrity of the cladding which guard against the uncontrolled release of radioactivity.

b. setpoints for automatic protective devices related to those variables having significant safety functions.

c. settings for ANSI 15.8 suggested reactor scrams and/or alarms which form the protective system for the reactor or provide information which requires manual protective action to be initiated.

d. the lowest functional capability or performance levels of equipment required for safe operation of the reactor.

QUESTION: (B.10) [1.0]

Which of the following will make the calculated Shutdown Margin MORE CONSERVATIVE (Larger)?

a. The reactor is at pool ambient temperature.

b. Reactor is shutdown with Control rod (shim) #2 fully withdrawn.

c. Reactor power is at 50% and Xenon concentration at equilibrium.

d. The highest worth non-secured experiment is in its most reactive state.

QUESTION: (B.11) [1.0]

The reactor is shutdown and preparations are being made to place an experiment in the reactor pool. SELECT the conditions REQUIRING the use of a specific written procedure for this evolution.

a. Dose rate from the experiment exceeds 10 mrem/hr on contact.

b. The Reactor Pool Room overhead crane will be used to position the apparatus.

c. The experiment apparatus is reading 175 mrem/hr at 1 meter

d. Swipe tests reveal that the experiment is contaminated.

QUESTION: (B.12) [1.0]

A radioactive spill has occurred at the facility. Radioactive contamination and above normal radiation levels in the area have been confirmed. At what radiation level is the Facility Emergency Organization required to be mobilized?

a. 10 mrem/hr

b. 20 mrem/hr

c. 50 mrem/hr

d. 100 mrem/hr

QUESTION: (B.13)   [1.0]

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

Reactor operation at less than four (4) inches from the thermal column will increase:

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.14)   [1.0]

Which one of the following statements describes the reason for the Technical Specifications limit on primary coolant conductivity?

a. maintain the coolant in a slightly basic condition.

b. restrict the concentration of coolant dissolved oxygen.

c. place the coolant in a slightly acidic condition.

d. restrict the concentrations of coolant dissolved materials.

QUESTION: (B.15)   [1.0]

Which one of the following LIMITATIONS is placed on the irradiation of an explosive material in the reactor?

a. The total amount of explosive material to be irradiated cannot exceed 50 mg.

b. The reactor may not be "Pulsed" while explosive material is present.

c. Reactor power may not exceed 50% (0.5 MW) with 25 mg of material in the reactor.

d. Less than 25 mg of nitroglycerin may be irradiated, provided the container is able to withstand a material detonation without failure.

QUESTION: (B.16) [1.0]

You are the Licensed Reactor Operator in the Control Room when you observes a Red light on the E.G.M. ratemeter, a Yellow light on the Console Alarm Board and Annunciator sounding.

Which of the following are your REQUIRED actions?

a. Scram the reactor, remove the console key and evacuate the building as quickly as possible.

b. Pick up the Emergency Kit from the front office and assemble on the NRC front sidewalk.

c. Immediately proceed with Building Evacuation Procedure, B.1 and notify the Senior Operator on duty.

d. Isolate the ventilation system and notify the Senior Operator on duty.

QUESTION: (B.17) [1.0]

Which of the following, if exceeded, REQUIRES an immediate reactor scram, a building evacuation AND declaration of an Alert?

a. The reactor was pulsed with a reactivity insertion of $2.90.

b. Steady state fuel temperatures are 475 degrees C.

c. Steady state power level is 1.2 MW.

d. Calculated shutdown margin is $.40.

QUESTION: (B.18) [1.0]

SELECT the conditions under which the door to the Control Room may be left UNLOCKED.
(NOTE: Consider each choice separately.)

a. The reactor is defueled and the console key is removed and is the possession of a licensed staff member.

b. At least one person capable of following written instructions is in the Control Room.

c. The Director of the Nuclear Radiation Center is in the Control Room.

d. One member of the Washington State University Campus Police is in the Control Room.

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

Section C: Plant & Rad. Monitoring Systems

QUESTION: (C.1)   [1.0]

SELECT the type of neutron startup source installed in the reactor prior to startup.

a. Plutonium-beryllium

b. Polonium-beryllium

c. Antimony-beryllium

d. Americium-beryllium

QUESTION: (C.2)   [1.0]

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. Upon sensing the low air pressure, a solenoid valve deenergizes to relieve the pressure in the cylinder so that the rod drops to its lower limit by gravity.

c. The rod will maintain its present position and can only be pulsed twice before running out of air.

d. The rod can no longer be pulsed but will remain at its current position

QUESTION: (C.3)   [1.0]

A reactor power calibration is in progress. The below listed data was recorded:

- Linear Channel 98%
- Safety Channel #1 91%
- Safety Channel #2 97%
- Calculated Power 94%

Which of the following is an ACCEPTABLE SEQUENCE for neutron chamber adjustments for the above conditions?

Position the neutron chambers as follows:

a. Raise CIC #2, lower the fission chamber, raise CIC #1.

b. Lower CIC #1, lower CIC #2, raise the fission chamber.

c. Lower CIC #1, lower the fission chamber, lower CIC #2.

d. Raise the fission chamber, raise CIC #1, raise CIC #2.

QUESTION: (C.4) [1.0]

SELECT the specific reason why the WSU FLIP fuel has a much LONGER core lifetime than the standard TRIGA fuel.

a. The standard TRIGA fuel has a smaller fuel meat diameter and length.

b. The FLIP fuel contains a slightly different fuel-moderator material.

c. The standard TRIGA fuel contains Erbium.

d. The FLIP fuel has an installed burnable poison.

QUESTION: (C.5) [1.0]

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 Transient Rod pneumatic piston.

b. The initial withdrawal position of the Transient Rod cylinder.

c. The reactor power level prior to initiating the Transient Rod pulse.

d. The timer setting that vents the pneumatic piston after the Transient Rod pulse.

QUESTION: (C.6) [1.0]

The reactor is operating at 1 KW. Electrical power is lost to the Diffuser pump. All other facility systems are operating as designed.

Which of the following is the reason why radiation dose rates on the bridge will INCREASE for these conditions?

a. The Nitrogen-16 production rate will increase.

b. The pool water temperature will increase.

c. The Nitrogen-16 transport time will decrease.

d. The production of Ar-41 will increase.

QUESTION: (C.7) [1.0]

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 neutron flux

b. Low pool water level

c. Fire alarm

d. High ARM alarm

QUESTION: (C.8) [1.0]

Which of the following Reactor Safety Channels is not required to be operable in both the Pulse and Steady State (SS) modes? (Required in only one mode)

a. Fuel Temperature

b. High Voltage Monitor

c. Transient Rod Control

d. Pool Level

QUESTION: (C.9) [1.0]

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.10) [1.0]

Which of the following is the method by which gamma-ray compensation is accomplished in the nuclear instrumentation compensated ion chambers.

a. varying the pressure of the detector Argon charge gas in conjunction with a low boron concentration coating the inside walls of the outer chamber.

b. the comparison of the currents generated in two concentric chambers in the detector, one sensitive only to gammas and one sensitive to neutrons and gammas.

c. a pulse height discriminator that eliminates (or discriminates) the pulses from the low energy gammas and allows only the higher energy neutron signals through.

d. varying the amount and concentration of the boron trifluoride gas in the compensated ion chamber thus reducing the detector's sensitivity to gamma induced ionizations.

QUESTION: (C.11) [1.0]

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.12) [1.0]

The reactor is operating at 1 MW. 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. The pool cooling primary cooling supply and return lines will automatically isolate on lowering level.

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. The pool cooling secondary pump will automatically divert secondary water to fill the pool.

QUESTION: (C.13) [1.0]

SELECT the facility system that is monitored for possible releases of Argon-41.

a. Pool Room (Reactor) Ventilation System

b. Continuous Air Monitoring System

c. Liquid Waste Collection System

d. Primary Pool Cooling System

QUESTION: (C.14) [1.0]

Sampling and analyzing for Cobalt-60:

a. provides early indication of any reactor fuel failures.

b. ensures physical integrity of any sources stored in the pool.

c. provides confirmation of pool cooling system secondary to primary leakage.

d. monitors the performance of the demineralizer (mixed bed ion exchanger).

QUESTION: (C.15) [1.0]

Which one of the following automatic reactor scrams is designed to PREVENT the reactor from exceeding a safety limit?

a. Transient rod preset timer scram

b. High-voltage monitor scram

c. Short reactor period scram

d. Reactor power level high scram

QUESTION: (C.16) [1.0]

Which of the following parameters provides the FIRST and PRIMARY indication that a small fuel failure (cladding failure) has occurred?

a. Pool water conductivity is increasing.

b. The Argon-41 monitor activity is increasing.

c. Continuous Air Monitoring System count rate is increasing.

d. The Nitrogen-16 content of the pool water is increasing.

QUESTION: (C.17) [1.0]

Which of the following is the MECHANISM by which clad failure will occur if the WSU Technical Specification limit on fuel element temperatures is exceeded?

a. swelling of the fuel rod zirconium hydride.

b. hydrogen over pressurization from the dissociation of zirconium hydride.

c. phase changes in the type 304 stainless steel that reduces the clad yield strength.

d. excessive metallic "creep" in the type 304 stainless steel.

QUESTION: (C.18) [1.0]

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 Front Office.

d. The Air Handling Control Panel in the Penthouse.

QUESTION: (C.19) [1.0]

SELECT the REQUIRED operator actions upon receipt of a Low Pulse Air Pressure alarm AND confirmation of less than 60 psig pressure.

a. Inform the SRO on duty and take steps to regain air pressure.

b. Air scram the Transient Rod (Pulse Rod).

c. Place the Mode Switch in the "Rundown" position.

d. Manually insert the Transient Rod (Pulse Rod).

Section C: Plant & Rad. Monitoring Systems

QUESTION: (C.20) [1.0]

Which of the following describes how the reactor period signal is generated?

a. The Linear Indication Channel compensated ion chamber provides a direct rate of power change signal.

b. The Pulse Power Channel gamma chamber supplies an power signal for a power change comparison with Wide Range Channel power.

c. An input power signal from the Wide Range Channel fission chamber is used to calculate the rate of power change.

d. The two Safety Channel fission chambers supply provide independent power signals used to calculate reactor period.

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

Section A: Reactor Theory. Thermo. & Fac. Operating Characteristics

ANSWER (A.1)
c.
REFERENCE
At 20 feet, all measured radiation is from gammas.
$D_1 r_1^2 = D_2 r_2^2$
$D_1 (1)^2 = 0.1$ mr $(20)^2$
$D_1 = 40$ mrem/hr gamma
Ratio of beta to total = 1 - (40/200) = 80%

ANSWER (A.2)
b.
REFERENCE
A = Ao e-λt λ = .693/T2
ln(A/Ao) = -.693t/T2
T2 = -.693t/ln 0.8 = 75 hr

ANSWER (A.3)
d.
REFERENCE
Burn, R., Introduction to Nuclear Reactor Operations, © 1988 pg. 3-4

ANSWER (A.4)
c.
REFERENCE
Burn, R., Introduction to Nuclear Reactor Operations, © 1988, § 3.3.4, p. 3-21.

ANSWER (A.5)
b.
REFERENCE:
Reactor Operator Training Manual, Unit 5, "Introduction To Nuclear Physics", Page 168
P = 790 [e (100/45)] = 7290 watts

ANSWER (A.6)
d.
REFERENCE
Burn, R., Introduction to Nuclear Reactor Operations, © 1988, Chapt. 5, pp. 5-1 — 5-28.

ANSWER (A.7)
b.
REFERENCE
Reactor Operating Training Manual, Unit 5

ANSWER (A.8)
c.
REFERENCE
Burn, R., Introduction to Nuclear Reactor Operations, © 1988, § 8.2-8.4, pp. 8-3.

ANSWER (A.9)
a.
REFERENCE
Burn, R., Introduction to Nuclear Reactor Operations, © 1988, § 3.3, pp. 3-13 — 3-19

ANSWER (A.10)
a.
REFERENCE
Burn, R., Introduction to Nuclear Reactor Operations, © 1988, pp. 2-65

ANSWER (A.11)
b.
REFERENCE
P = Poet/T   10 = 1e60/T
ln 10 = 60/T   2.3 = 60/T
T = 60/2.3   T = 26 seconds

ANSWER (A.12)
c.
REFERENCE
Burn, R., Introduction to Nuclear Reactor Operations, © 1982, § 5.2 (b), p. 5-4.

ANSWER (A.13)
a.
REFERENCE
Burn, R., Introduction to Nuclear Reactor Operations, © 1982, § 4.2, p. 4-1.

ANSWER (A.14)
b.
REFERENCE
Reactor Operator Training Manual, Unit 6

ANSWER (A.15)
c.
REFERENCE
Reactor Operator Training Manual, Unit 5 , "Introduction To Nuclear Physics", Page 111

ANSWER (A.16)
d.
REFERENCE
Burn, R., Introduction to Nuclear Reactor Operations, © 1988, § 7.2 & 7.3, pp. 7-1 — 7-9.

$$T = \frac{\beta eff - \rho}{\lambda eff\ \rho} \Rightarrow \rho = \frac{\beta eff}{(\lambda\ \tau) + 1}$$

ρ = 0.007/((0.1 * 60) + 1) = 0.0075/7
ρ = 1.0 x 10-3 delta k/k
ρ/inch = 1.0 x 10-3 delta k/k/2 inches = 5.0 x 10-4 delta k/k per inch

ANSWER (A.17)
d.
REFERENCE
P1/(Rho1-1)squared = P2/(Rho2-1)squared
P2 = 1600 MW

ANSWER (A.18)
c.
REFERENCE
Burn, R., Introduction to Nuclear Reactor Operations, © 1982, § 4.6, p. 4-16.

ANSWER (A.19)
a.
REFERENCE
Glasstone, S. and Sesonske, A, Nuclear Reactor Engineering, Kreiger Publishing, Malabar, Florida, 1991, §§ 3.161 — 3.163, pp. 191 — 192.

ANSWER (A.20)
d.
REFERENCE
T.S. Definitions

(*** End of Section A ***)

Section B: Normal/Emerg. Procedures & Rad Con.

ANSWER   (001)
c.
REFERENCE
GM is not sensitive to energy.

ANSWER   (B.2)
1_ d; 2_ b; 3_ b; 4_ a
REFERENCE
10 CFR 55

ANSWER   (B.3)
c.
REFERENCE
10 CFR 50.54 (q); 10 CFR 50.59; 10 CFR 55.59

ANSWER   (B.4)
b.
REFERENCE
10 CFR 20

ANSWER   (B.5)
d.
REFERENCE
10 CFR 20.1201

ANSWER   (B.6)
c.
REFERENCE
10 CFR 20 Whole Body Limit = 5 R
Time = [(5 R - 1.25 R) / 0.075 R/hr] = 50 hours

ANSWER   (B.7)
b.
REFERENCE
Two inches = one-half thickness ($T_{½}$). Using 3 half-thickness will drop the dose by a factor of $(½)^3 = ⅛$.
100/8 = 12.5

ANSWER   (B.8)
a, **check**; b, **test**; c, **calibration**; d, **check**
REFERENCE
T.S. 1.4

ANSWER   (B.9)
b.
REFERENCE
Tech. Specs Definitions

ANSWER (B10)
c.
REFERENCE
T.S. 3.2

ANSWER (011)
c.
REFERENCE
Standard Operating Procedure #34, "Transfer of Non-Fuel Devices and Experiment Apparatus into ..., Page 3

ANSWER (012)
b.
REFERENCE
Emergency Plan & Implementing Procedures, "Facility Contamination", Section 1

ANSWER (013)
d.
REFERENCE
WSU Technical Specification 3.12, Pages 16 & 17

ANSWER (014)
d.
REFERENCE
WSU Technical Specification 3.13, Page 17

ANSWER (015)
d.
REFERENCE
WSU Technical Specification 3.10, Page 14

ANSWER (016)
d.
REFERENCE
standard Operating Procedure #19, "Action In Event Of Alarm", Page 5

ANSWER (017)
a.
REFERENCE
Emergency Plan & Implementing Procedures, "Exceeding A Safety Limit", Sections 1 & 2

ANSWER (018)
c.
REFERENCE
Administrative Procedures, Section 4, "Access Control At The Nuclear Radiation Center", Page 2
Standard Operating Procedure #4, "Startup, Operation And Shutdown Of The Reactor, Page 1

Section C: Plant & Rad. Monitoring Systems

ANSWER: 001 (1.00)
c.
REFERENCE
Reactor Operator Training Manual, Unit 11, Appendix Page 2

ANSWER: 002 (1.00)
a.
REFERENCE
Safety Analysis Report, Section 4.0, "Reactor Description", Pages 4-19 - 4-22

ANSWER: 003 (1.00)
a.
REFERENCE:
Standard Operating Procedure #13, "Performing Reactor Power Calibration", Page 5

ANSWER: 004 (1.00)
d.
REFERENCE:
Reactor Operator Training Manual, Unit 11, Pages 4 & 5

ANSWER: 005 (1.00)
b.
REFERENCE:
Standard Operating Procedure #4, "Startup, Operation And Shutdown Of The Reactor", Page 7

ANSWER: 006 (1.00)
c.
REFERENCE:
Safety Analysis Report, Section 4.0, "Reactor Description", Page 4-35

ANSWER: 007 (1.00)
d.
REFERENCE:
SOP #19 Para. B.5, pg. 3

ANSWER: 008 (1.00)
c.
REFERENCE:
Safety Analysis Report, Section 4.0, Table 4.8-1

ANSWER: 009 (1.00)
d.
REFERENCE:
Safety Analysis Report, Section 3.0, "Facility Structure", Page 3-10
Standard Operating Procedure #26, "Continuous Air System Check And Calibration", Page 2

ANSWER: 010 (1.00)
b.
REFERENCE:
Reactor Operator Training Manual, Unit 8, Pages 28 - 30

ANSWER: 011 (1.00)
d.
REFERENCE:
WSU Technical Specification 3.13, Page 17

ANSWER: 012 (1.00)
b.
REFERENCE:
Safety Analysis Report, Section 4.0, "Reactor Description", Page 4-30

ANSWER: 013 (1.00)
a.
REFERENCE:
Safety Analysis Report, Section 3.0, "Facility Structure", Page 3-7

ANSWER: 014 (1.00)
b.
REFERENCE:
Standard Operating Procedure #24, "Pool Water Analysis", Page 1

ANSWER: 015 (1.00)
d.
REFERENCE:
WSU Technical Specification 3.6.3 Bases, Pages 11 & 12

ANSWER: 016 (1.00)
c.
REFERENCE:
Reactor Operator Training Manual, Unit 6, Reactor Operator Training Notes, Pages 1 & 2
Emergency Plan and Implementing Procedures, "Fuel Element Failure"

ANSWER: 017 (1.00)
b.
REFERENCE:
WSU Technical Specification 2.1, Bases, Page 6

ANSWER: 018 (1.00)
c.
REFERENCE:
Standard Operating Procedure #5, "Performing Preventive Maint...Equipment", Pages 12 -14

ANSWER: 019 (1.00)
b.
REFERENCE:
Standard Operating Procedure #19, "Action In Event Of An Alarm", Page 6

ANSWER: 020 (1.00)
c.
REFERENCE:
Safety Analysis Report, Section 4.0, "Reactor Description", Page 4-29, Figure 4.8-5

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