June 20, 2003

Mr. Stephen G. Frantz, Director
Reed Reactor Facility
3203 SE Woodstock Blvd.
Portland, OR 97202

SUBJECT: INITIAL EXAMINATION REPORT NO. 50-288/OL-03-01, REED COLLEGE

Dear Mr. Frantz:

During the week of May 5, 2003, the NRC administered operator licensing examinations at your Reed College 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 or via Internet e-mail at pxi@nrc.gov.

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. 50-288

Enclosures:
1. Initial Examination Report No. 50-288/OL-03-01
2. Facility Comments and NRC Resolution
3. Examination and answer key

cc w/enclosures:
Please see next page

cc:

Mayor of the City of Portland
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Portland, OR 97204

Reed College
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Dean of Faculty
3203 S.E. Woodstock Boulevard
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Test, Research, and Training
Reactor Newsletter
University of Florida
202 Nuclear Sciences Center
Gainesville, FL 32611

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<u>DISTRIBUTION</u>: w/ encl.:

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DHughes	Facility File (EBarnhill) (O6-D17)	

ADAMS PACKAGE ACCESSION NO.: ML030500532
ADAMS REPORT ACCESSION NO.: ML031620293 **TEMPLATE #:NRR-074**

OFFICE	RORP:CE		IEHB:LA	E	RORP:SC	
NAME	PIsaac:rdr		EBarnhill		PMadden	
DATE	06/ 12 /2003		06/ 13 /2003		06/ 19 /2003	

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

REPORT NO.:	50-288/OL-03-01
FACILITY DOCKET NO.:	50-288
FACILITY LICENSE NO.:	R-112
FACILITY:	Reed College
EXAMINATION DATES:	05/05/2003 - 05/08/2003
EXAMINER:	Patrick Isaac, Chief Examiner

SUBMITTED BY: ***/RA/*** 06/09/2003
Patrick Isaac, Chief Examiner Date

SUMMARY:

During the week of May 5, 2003, NRC administered Operator Licensing examinations to 13 Reactor Operator (RO) and 5 Senior Reactor Operator Upgrade (SROU) candidates. One RO candidate failed Section A and Section C of the written examinations. One SROU candidate failed the operating tests. All other candidates passed the examinations.

ENCLOSURE 1

REPORT DETAILS

1. Examiners:

   Patrick Isaac, Chief Examiner
   Paul Doyle

2. Results:

	RO PASS/FAIL	SRO PASS/FAIL	TOTAL PASS/FAIL
Written	**12/1**	**N/A**	**12/1**
Operating Tests	**13/0**	**4/1**	**17/1**
Overall	**12/1**	**4/1**	**16/2**

3. Exit Meeting:

   Personnel attending:

   Stephen G. Frantz, Director, Reed Reactor Facility
   Eric Weis, SRO, Reed Reactor Facility
   Rachel Barnett, SRO, Reed Reactor Facility
   Paul Doyle, NRC
   Patrick Isaac, NRC

   The facility commented on a well constructed and fair examination. Mr. Frantz suggested some changes to the written examination answer key. These suggestions and the NRC's resolution to them are addressed in Enclosure 2. There were no generic concerns raised by the examiners.

FACILITY COMMENTS AND NRC RESOLUTION

Question B-15:
Consider two point sources, each having the ***SAME*** curie strength. Source A's gammas have an energy of 1.0 MeV, while Source B's gammas have an energy of 2.0 MeV. Using a **Geiger-Müller** detector the reading from source B will be … *(Ignore detector efficiency)*

a. four times that of source A.

b. twice that of source A.

c. the same.

d. half that of source A.

Facility Comment B-15:
The answer should be "c". A GM tube reading depends on activity, not gamma energy. This must be a typo in the answer key since the reference is also incorrect.

NRC Resolution B-15:
Comment accepted. The answer key will be modified to accept "c" as correct.

Question C-18:
Which of the following instruments is used to detect High range Beta-Gamma radiation during an emergency condition?

a. Eberline Model E-140

b. Model RO-2

c. CD V - 700 model 6B

d. CD V - 715 model 1B

Facility Comment C-18:
The answer should be "b". We use an Eberline RO-2 ion chamber for high radiation fields. We no longer have any of the old CDV instruments at the facility.

NRC Resolution C-18:
Comment accepted. The answer key will be modified to accept "b" as correct.

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

FACILITY: REED COLLEGE

REACTOR TYPE: TRIGA

DATE ADMINISTERED: 2003/05/05

CANDIDATE: ____________________________

INSTRUCTIONS TO CANDIDATE:
Answers are to be written on the answer sheet provided. Attach all answer sheets to the examination. Point values are indicated in parentheses for each question. A 70% in each category 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	**33.3**	______	____	**A.**	**REACTOR THEORY, THERMODYNAMICS AND FACILITY OPERATING CHARACTERISTICS**
20.00	**33.3**	______	____	**B.**	**NORMAL AND EMERGENCY OPERATING PROCEDURES AND RADIOLOGICAL CONTROLS**
20.00	**33.3**	______	____	**C.**	**FACILITY AND RADIATION MONITORING SYSTEMS**
60.00		______ **FINAL GRADE**	____%		**TOTALS**

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

____
Candidate's Signature

ENCLOSURE 3

QUESTION A.1 [1.0 point]
Core excess reactivity changes with …

a. fuel element burnup

b. control rod height

c. neutron energy level

d. reactor power level

QUESTION A.2 [1.0 point]
You enter the control room and note that all nuclear instrumentation show a steady neutron level, and no rods are in motion. Which ONE of the following conditions CANNOT be true?

a. The reactor is critical.

b. The reactor is subcritical.

c. The reactor is supercritical.

d. The neutron source has been removed from the core.

QUESTION A.3 [1.0 point]
The delayed neutron precursor (β) for U^{235} is 0.0065. However, when calculating reactor parameters you use β_{eff} with a value of ~0.0070. Why is β_{eff} larger than β?

a. Delayed neutrons are born at higher energies than prompt neutrons resulting in a greater worth for the neutrons.

b. Delayed neutrons are born at lower energies than prompt neutrons resulting in less leakage during slowdown to thermal energies.

c. The fuel also contains U^{238} which has a relatively large β for fast fission.

d. U^{238} in the core becomes Pu^{239} (by neutron absorption), which has a higher β for fission.

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 increases 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]
Which of the following atoms will cause a neutron to lose the most energy during an elastic scattering reaction?

a. O^{16}

b. C^{12}

c. U^{235}

d. H^{1}

QUESTION A.6 [1.0 point]
Which ONE of the following is the MAJOR source of energy released during fission? Kinetic Energy of the…

a. prompt gamma rays.

b. capture gammas.

c. Beta particles.

d. fission fragments.

QUESTION A.7 [1.0 point]
Which ONE of the following describes the **MAJOR** contributor to the production and depletion of Xenon respectively in a **STEADY-STATE OPERATING** reactor?

	Production	Depletion
a.	Radioactive decay of Iodine	Radioactive Decay
b.	Radioactive decay of Iodine	Neutron Absorption
c.	Directly from fission	Radioactive Decay
d.	Directly from fission	Neutron Absorption

QUESTION A.8 [1.0 point]
Which ONE of the following is an example of neutron decay?

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.9 [1.0 point]
Which ONE of the following is the reason for the -80 second period following a reactor scram?

a. The ability of U^{235} to fission source neutrons.

b. The half-life to the longest-lived group of delayed neutron precursors.

c. The amount of negative reactivity added on a scram is greater than the shutdown margin.

d. The Doppler effect, which adds positive reactivity due to the temperature decrease following a scram.

QUESTION A.10 [1.0 point]
Which ONE of the following explains the response of a SUBCRITICAL reactor to equal insertions of positive reactivity as the reactor approaches criticality?

a. Each insertion causes a **SMALLER** increase in the neutron flux resulting in a **LONGER** time to stabilize.

b. Each insertion causes a **LARGER** increase in the neutron flux resulting in a **LONGER** time to stabilize.

c. Each insertion causes a **SMALLER** increase in the neutron flux resulting in a **SHORTER** time to stabilize.

d. Each insertion causes a **LARGER** increase in the neutron flux resulting in a **SHORTER** time to stabilize.

QUESTION A.11 [1.0 point]
K_{eff} for the reactor is 0.85. If you place an experiment worth +17.6% into the core, what is the new K_{eff} ?

a. 0.995

b. 0.9995

c. 1.005

d. 1.05

QUESTION A.12 [1.0 point]
Which ONE of the following is the reason for an installed neutron source within the core? A startup without an installed neutron source …

a. is impossible as there would be no neutrons available to start up the reactor.

b. would be very slow due to the long time to build up neutron population from so low a level.

c. could result in a very short period due to the reactor going critical before neutron population built up high enough to be read on nuclear instrumentation.

d. can be compensated for by adjusting the compensating voltage on the source range detector.

QUESTION A.13 [1.0 point]
Several processes occur that may increase or decrease the available number of neutrons. SELECT from the following the six-factor formula term that describes an INCREASE in the number of neutrons during the cycle.

a. Thermal utilization factor.

b. Resonance escape probability.

c. Thermal non-leakage probability.

d. Reproduction factor.

QUESTION A.14 [1.0 point]
The term "prompt jump" refers to:

a. the instantaneous change in power due to raising a control rod.

b. a reactor which has attained criticality on prompt neutrons alone.

c. a reactor which is critical using both prompt and delayed neutrons.

d. a negative reactivity insertion which is less than β_{eff}.

QUESTION A.15 [1.0 point]
By definition, an exactly critical reactor can be made prompt critical by adding positive reactivity equal to …

a. the shutdown margin

b. the K_{excess} margin

c. the β_{eff} value

d. 1.0 %ΔK/K.

QUESTION A.16 [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.17 [1.0 point]
Reactor power doubles in 42 seconds. Based on the period associated with this transient, how long will it take for reactor power to increase by a factor of 10?

a. 80 seconds

b. 110 seconds

c. 140 seconds

d. 170 seconds

QUESTION A.18 [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.19 [1.0 point]
Regulating rod worth for a reactor is 0.001 ΔK/K/inch. Moderator temperature **INCREASES** by 9°F, and the regulating rod moves 4½ inches inward to compensate. The moderator temperature coefficient α_{Tmod} is …

a. $+5 \times 10^{-4}$ ΔK/K/°F

b. -5×10^{-4} ΔK/K/°F

c. $+2 \times 10^{-5}$ ΔK/K/°F

d. -2×10^{-5} ΔK/K/°F

QUESTION A.20 [1.0 point]
K_{eff} is K_{∞} times …

a. the fast fission factor (ε)

b. the total non-leakage probability ($\mathcal{L}_f \times \mathcal{L}_{th}$)

c. the reproduction factor (η)

d. the resonance escape probability (p)

QUESTION B.1 [1.0 point]
After the reactor is at power from an initial start-up, Core-excess reactivity is calculated to complete SOP 02, Start-up and Core Excess Check. The calculation indicates the core excess reactivity is .021 delta k/k. Which one of the following is the correct action for this excess reactivity?

If the core excess reactivity value:

a. is less than the allowable maximum, operation may continue.

b. is greater than recent past values but less than maximum, the reactor must be shutdown and the NRC informed prior to the next reactor startup.

c. is greater than recent past values but less than maximum, the reactor must be shutdown, even though the reason has been determined.

d. is above the allowable maximum, the reactor must be shutdown.

QUESTION B.2 [1.0 point]
Which ONE of the following conditions is a violation of Technical Specifications, Rx Pool?

d. Conductivity of the pool water is 4 mhos per centimeter averaged over one month.

b. Radioactivity in the pool water is 0.2 micro Ci/ml.

c. Pool water ph is 5.7

d. Bulk temperature of the coolant is 45 degrees C during reactor operation.

QUESTION B.3 [10 points]
Prior to performing the Startup Checklist, how far back is the reactor operator required to review the Main Log?

a. The last 24 hours of reactor operation.

b. 48 hours of reactor operation or to the last time that operator operated the reactor.

c. One week.

d. 30 days or to the last time that operator operated the reactor.

QUESTION B.4 [1.0 point]
In accordance with Technical Specifications, which ONE of the following statements is TRUE?

a. Each fuel experiment shall be controlled such that the total inventory of Iodine isotopes 131 thru 135 in the experiment is no greater than 1.5 curies.

d. The reactivity worth of any individual in-core experiment shall not exceed $2.00.

c. Experiments containing materials corrosive to Rx components shall not be irradiated in the Rx.

d. Explosive experiments shall be doubly encapsulated.

QUESTION B.5 [1.0 point
A change to EIP, Attachment C, Contents of Emergency Grab-Bag, is required. Which one of the following is required for the procedure change to be implemented?

a. Implement immediately with Reactor Supervisor concurrence with notification to the Director..

b. Implement immediately with Director's concurrence.

c. Implement after Director's approval with Reactor Safety Committee approval within 14 days.

d. Implement only after Reactor Safety Committee and/or the Radiation Safety Committee approval.

QUESTION B.6 [1.0 point]
During a long (8 hr) reactor run, the operator notices that the GSM reading has been drifting slowly upward. What action is the operator required to perform when the GSM goes into alarm?

a. Notify Oregon Dept. of Energy

b. Call Police Dept. (911 on Red phone)

c. Immediately secure the main facility circuit breaker

d. Evacuate the reactor bay

QUESTION B.7 [1.0 point]
Two inches of shielding reduce the gamma exposure in a beam of radiation from 400 mR/hr to 100 mR/hr. If you add an **additional** **four** inches of shielding what will be the new radiation level? (Assume all reading are the same distance from the source.)

a. 6.25 mR/hr

b. 12.5 mR/hr

c. 25 mr/hr

d. 100 mr/hr

QUESTION B.8 [2.0 points, ½ point each]
10 CFR 55 contains requirements associated with your operator or senior operator license. Match each of the requirements listed in column A with it's appropriate time period in column B. (Note: Periods from column B may be used more than once or not at all.)

	Column A (Requirements)	**Column B (Years)**
a.	License Expires	1
b.	Pass a Requalification Written Examination	2
c.	Pass a Requalification Operating Test	4
d.	Medical Examination Required	6

QUESTION B.9 [2.0 points, ½ each]
Identify each of the radioisotopes in column A with its PRIMARY source (irradiation of air, irradiation of water, or is a fission product).

a. $_{1}H^{3}$

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

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

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

QUESTION B.10 [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.11 [2.0 points, ½ each]
Match the Condition listed in column A with the corresponding reactivity limit in column B. (Each

	Column A	***Column B***
a.	Maximum rate of reactivity insertion of a rod	$1.00
b.	Total Reactivity worth of all experiments	0.12% ΔK/K
c.	Maximum worth of an ***Unsecured Experiment***	$2.00
d.	Maximum Excess reactivity above the reference core condition (normal)	2.25% ΔK/K

QUESTION B.12 [1.0 point, ¼ each]
Identify the correct number (2, 7, 8, 10, 11, 24, 32, 52 or 65) which correctly defines the maximum period between testing intervals per each of the Technical Specifications definitions.

a. Weekly: ___ days

b. Bimonthly: ___ weeks

c. Semi-annual: ___ weeks

d. Annually: ___ weeks

QUESTION B.13 [1.0 point]
Reed's Technical Specifications and operating procedures require the reactor to be shutdown if the reactor pool temperature exceeds a specified limit. Which one of the following is the LOWEST temperature that EXCEEDS the Tech. Spec. limit?

a. 50 degrees F

b. 45 degrees C

c. 50 degrees C

d. 120 degrees F

QUESTION B.14 [1.0 point]
A radiation survey instrument was used to measure an irradiated experiment. The results were 0.1 mrem/hr, read 10 minutes following removal from the core. If the half life of the sample is 1 minute. What was the dose rate, at the time the sample was initially removed from the core?

a. 10 rem/hr

b. 1 rem/hr

c. 100mrem/hr

d. 10 mrem/hr

QUESTION B.15 [1.0 point]
Consider two point sources, each having the ***<u>SAME</u>*** curie strength. Source A's gammas have an energy of 1.0 MeV, while Source B's gammas have an energy of 2.0 MeV. Using a **Geiger-Müller** detector the reading from source B will be … *(Ignore detector efficiency)*

a. four times that of source A.

b. twice that of source A.

c. the same.

d. half that of source A.

QUESTION B.16 [1.0 point]
Per the definition in the Emergency Plan, Protective Action Guide(s) is (are) …

a. The person or persons appointed by the Emergency Coordinator to ensure that all personnel have evacuated the facility or a specific part of the facility.

b. a condition or conditions which call(s) for immediate action, beyond the scope of normal operating procedures, to avoid an accident or to mitigate the consequences of one.

c. Projected radiological dose or dose commitment values to individuals that warrant protective action following a release of radioactive material.

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

QUESTION B.17 [1.0 point]
A fire in the reactor facility is out of control. Which one of the following must be contacted to implement an emergency evacuation of the Psychology Building?

a. On-duty Senior Reactor Operator

b. Health Physicist

c. Portland Police Bureau

d. Campus Security

(*** End of Section B ***)

QUESTION C.1 [1.0 point]
Which ONE of the following scrams is NOT required by Technical Specifications?

a. Linear channel

b. % power channel

c. Manual

d. Log channel

QUESTION C.2 [1.0 point]
How is water or condensation removed from the rotary specimen rack?

a. The pool is periodically drained to allow the condensation to evaporate.

b. Water absorbing material is placed in a perforated specimen tube, which is inserted in the rack.

c. An electric heater is placed in an insulated specimen tube, which is inserted in the rack.

d. An inert gas is inserted in the rack to blow out the condensation.

QUESTION C.3 [1.0 point]
The pool water level must be maintained at a specified level for proper skimmer operation. Why is this pool level necessary?

a. Above this pool level, the reactor water system pumps will lose suction and fail.

b. Below this level, air entry could interfere with proper operation of the rabbit tube.

c. Above this level, the water pressure could damage the purification system filters.

d. Below this level, air entry could damage the purification system demineralizers.

QUESTION C.4 [1.0 point]
The neutron absorber in Reed's reactor control rods is:

a. Aluminum oxide

b. Zirconium hydride

c. Graphite powder

d. Boron carbide

QUESTION   C.5 [1.0 point]
Which ONE of the following nuclear channels provides the operator with a continuous record of neutron flux from approximately one watt to full power?

a. Period channel

b. Log power channel

c. Count rate channel

d. Linear power channel

QUESTION   C.6 [1.0 point]
Which ONE is NOT an input to the Regulating Rod Servo?

a. Linear power channel

b. % demand potentiometer

c. Rod raising interlock

d. Period channel

QUESTION   C.7 [1.0 point]
Which ONE of the following radiation monitoring systems will NOT cause a ventilation confinement actuation?

a. Particulate stack monitor

b. RAM

c. GSM

d. CAM

QUESTION   C.8 [1.0 point]
Limit switches mounted on each drive assembly provide switching for console lights.

Which one of the statements is FALSE?

a. The DOWN light indicates that the control rod and rod drive are at their lower limits.

b. The UP light indicates that the control rod and rod drive are at their upper limits.

c. When the CONT/ON pushbuttons are depressed, the ON lights are extinguished.

d. The CONT side light of the CONT/ON switch goes off less than one second after a scram occurs.

QUESTION C.9 [1.0 point]
What will be the effect of a high differential pressure across the filter on the reactor water pump and the demineralizer flows?

a. Increase reactor water pump flow and increase demineralizer flow.

b. Increase reactor water pump flow and decrease demineralizer flow.

c. decrease reactor water pump flow and increase demineralizer flow.

d. decrease reactor water pump flow and decrease demineralizer flow.

QUESTION C.10 [1.0 point]
Which ONE of the following statements correctly describes the pneumatic transfer system path and operating pressure?

a. The pneumatic transfer system exhausts to the reactor room and maintains the transfer system at a positive pressure.

b. The pneumatic transfer system exhausts to the building exhaust and maintains the transfer system at a positive pressure.

c. The pneumatic transfer system exhausts to the reactor room and maintains the transfer system at a negative pressure.

d. The pneumatic transfer system exhausts to the building exhaust and maintains the transfer system at a negative pressure.

QUESTION C.11 [1.0 point]
Which ONE of the following does not provide any protective interlocks or actions?

a. Linear Power Channel

b. Log Power (Log-N Channel)

c. Percent Power Channel

d. Count Rate Channel

QUESTION C.12 [1.0 point]
Which ONE of the following statements correctly describes the purpose of the PULL ROD in the control rod drive assembly?

a. Provides rod full out position indication.

b. Provides a means for manually adjusting rod position by pulling rod out.

c. Provides rod bottom indication.

d. Automatically engages the control rod on a pull signal.

QUESTION C.13 [1.0 point]
Which ONE of the following statements correctly describes the purpose of the potentiometer in the control rod drive assembly.

a. Provides rod position indication when the electromagnet engages the connecting rod armature.

b. Provides a variable voltage to the rod drive motor for regulating control rod speed.

c. Provides potential voltage as required for resetting the electromagnet current.

d. Provides the potential voltage to relatch the connecting rod.

QUESTION C.14 [1.0 point]
Which ONE of the following is the flow through the primary loop and the cleanup loop?

a. 110 gpm total flow with 10 gpm through the cleanup loop

b. 120 gpm total flow with 20 gpm through the cleanup loop

c. 110 gpm total flow with 20 gpm through the cleanup loop

d. 120 gpm total flow with 10 gpm through the cleanup loop

QUESTION C.15 [1.0 point]
Which ONE of the following ranges of nuclear instrumentation utilizes an uncompensated ion chamber as the neutron detection device?

a. Count Rate channel

b. Log N channel

c. Linear Power channel

d. % Power channel

QUESTION C.16 [1.0 point]
Which ONE of the following statements describes the drive speeds of the Shim rod, Regulating rod and Safety rod?

a. The Shim rod drives at 24 inches per minute, the Regulating and Safety rods drive at 19 inches per minute.

b. The Shim and Regulating rods drive at 24 inches per minute, the Safety rod drives at 19 inches per minute.

c. The Safety rod drives at 24 inches per minute, the Regulating and Shim rods drive at 19 inches per minute.

d. The Regulating rod drives at 24 inches per minute, the Safety and Shim rods drive at 19 inches per minute.

QUESTION C.17 [1.0 point]
Which ONE of the following describes the action of the rod control system to drive the magnet draw tube down after a dropped rod?

a. Deenergizing the rod magnet initiates the rod down motion of the draw tube.

b. Actuation of the MAGNET DOWN limit switch initiates the rod down motion of the draw tube.

c. Actuation of the ROD DOWN limit switch initiates the rod down motion if the rod drive is withdrawn.

d. Resetting the scram signal initiates the rod down motion of the draw tube.

QUESTION C.18 [1.0 point]
Which of the following instruments is used to detect High range Beta-Gamma radiation during an emergency condition?

a. Eberline Model E-140

b. Model RO-2

c. CD V - 700 model 6B

d. CD V - 715 model 1B

QUESTION C.19 [1.0 point]
In what region of the Pulse Size vs. Applied Voltage characteristic curve does the fission chamber operate?

a. Geiger Muller

b. Limited Proportionality

c. Proportional

d. Ionization

QUESTION C.20 [1.0 point]
Which ONE of the following will cause a HIGH conductivity reading at the nlet of the demineralizer?

a. Failure of cooling water heat exchanger

b. Pool water temperature low

c. Reactor water system pressure greater than secondary water pressure

D. High reactor water pump flow

A.1 a
REF: Burn, R., *Introduction of Nuclear Reactor Operations*, © 1988, §

A.2 c
REF: Burn, R., *Introduction of Nuclear Reactor Operations*, © 1988, §

A.3 b
REF: Burn, R., *Introduction of Nuclear Reactor Operations*, © 1988, §

A.4 a
REF: Burn, R., *Introduction of Nuclear Reactor Operations*, © 1988, §

A.5 d
REF: Burn, R., *Introduction of Nuclear Reactor Operations*, © 1988, §

A.6 d
REF: Burn, R., *Introduction of Nuclear Reactor Operations*, © 1988, §

A.7 b
REF: Burn, R., *Introduction of Nuclear Reactor Operations*, © 1988, §

A.8 b
REF: Burn, R., *Introduction of Nuclear Reactor Operations*, © 1988, §

A.9 b
REF: Burn, R., *Introduction of Nuclear Reactor Operations*, © 1988, §

A.10 b
REF: Burn, R., *Introduction of Nuclear Reactor Operations*, © 1988, §

A.11 b
REF: Burn, R., *Introduction of Nuclear Reactor Operations*, © 1988, §

A.12 c
REF: Burn, R., *Introduction of Nuclear Reactor Operations*, © 1988, §

A.13 d
REF: Burn, R., *Introduction of Nuclear Reactor Operations*, © 1988, §

A.14 a
REF: Burn, R., *Introduction of Nuclear Reactor Operations*, © 1988, §

A.15 c
REF: Burn, R., *Introduction of Nuclear Reactor Operations*, © 1988, §

A.16 c
REF: Burn, R., *Introduction of Nuclear Reactor Operations*, © 1988, §

A.17 c
$P = P_0 e^{t/\tau}$ 1st find **τ**. **τ** = time/(ln(2)) = 42/0.693 = 60.6 sec. Time = 60.6 × ln(10) = 139.5 sec
REF: Burn, R., *Introduction of Nuclear Reactor Operations*, © 1988, §

A.18 a

0.1 × 3.79 = .379 0.9 × 0.23 = 0.207 0.1 × 7.9 = 0.79 0.9 × 1.49 = 1.34

REF: Burn, R., *Introduction of Nuclear Reactor Operations*, © 1988, §

A.19 a

0.001 ΔK/K/~~inch~~ × 4.5 ~~inch~~ ÷ 9°F = 0.001 ÷ 2 = 0.0005 = 5×10^{-4} ΔK/K/°F

REF: Burn, R., *Introduction of Nuclear Reactor Operations*, © 1988, §

A.20 b

REF: Burn, R., *Introduction of Nuclear Reactor Operations*, © 1988, §

B.1 a
REF: SOP-02

B.2 a
REF: RRF Tech Spec

B.3 d
REF: SOP-01

B.4 a
REF: RRF Tech Specs

B.5 d
REF: Technical Specification Definitions

B.6 d
REF: Emergency Implementation Procedures.2.

B.7 a
REF: Nuclear Power Plant Health Physics and Radiation Protection, Research Reactor Version©1988, § 1.2.3 "Half-Thickness and Tenth-Thickness" $(½)^6 = {}^1/_{64} = {}^{400}/_{64}$ = 50/8 = 25/4 = 6.26

B.8 a, 6; b, 2; c, 1; d, 2
REF: 10CFR55

B.9 a, water; b, air; c, water; d, fission product
REF: Typical NRC Question (Chart of the Nuclides

B.10 d
REF: Standard Health Physics Definition.

B.11 a, 0.12% ΔK/K; b, $2.00; c, $1.00; d, 2.25% ΔK/K
REF: Tech. Specs.

B.12 a, 10; b, 11; c, 32; d, 65
REF: Tech. Specs.

B.13 c
REF: Technical Specifications,

B.14 c
REF: Ten half-lives implies that dose was reduced by (½)10 = 1/1024 ≈ 1/1000. Initially, the reading would be about 1000 times larger 0.1 mrem × 1000 = 100 mrem.

B.15 c
REF: Admin Procedures Section VII.

B.16 d
REF: SAR 7.2.2(d) p. 7-7.

B.17 d
REF: Emergency Implementing Plan

C.1 d
REF: Tech Specs

C.2 b
REF: GA Triga Maintenance and Operating Manual

C.3 d
REF: GA Triga Maintenance and Operating Manual

C. 4 d
REF: GA Triga Maintenance and Operating Manual

C.5 b
REF: Triga Mechanical Maintenance and Operating Manual (Appendix B)

C.6 c
REF: GA TRIGA Mech. Maintenance Manual

C.7 b
REF: Emergency Plan

C.8 b
REF: GA TRIGA Electrical Maintenance MAnual

C.9 d
REF: GA TRIGA Maintenance and Operating Manual.

C.10 d
REF: RRF Description and SAR (pg 5-7)

C.11 b
REF: GA TRIGA Mechanical Maintenance and Operating Manual

C.12 c
REF: RRF SAR (pg 5-8 thru 5-12)

C.13 a
REF: RRF SAR (pg 5-6 through 5-11)

C.14 b
REF: GA TRIGA Mech. Maint. and Operating Manual

C.15 d
REF: GA TRIGA Inst. Maint. Manual

C.16 d
REF: GA TRIGA Mech. Maint. & Operating Manual

C.17 c
REF: GA TRIGA Mech. Maint. & Operating Manual

C.18 b
REF: RRF introduction to Radiation and Rad. Inst. Manuals

C.19 c
REF: RRF Introduction to Radioactivity (pg 12-1-25 & 2-31)

C.20 a
REF: GA TRIGA Maintenance and Operating Manual

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 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.

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 ___

(***** 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.

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

EQUATION SHEET

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

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

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

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

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

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

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

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

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

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

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

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

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

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

$$\rho = \frac{\Delta K_{eff}}{k_{eff}}$$

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

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

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

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

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

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

DR — mRem, Ci — curies,
E — Mev, R — feet

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

1 Curie = 3.7 x 1010 dis/sec 1 kg = 2.21 lbm

1 Horsepower = 2.54 x 103 BTU/hr 1 Mw = 3.41 x 106 BTU/hr

1 BTU = 778 ft-lbf °F = 9/5 °C + 32

1 gal (H_2O) ≈ 8 lbm $\quad$ °C = 5/9 (°F - 32)