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

REPORT NO.: 50-288/OL-96-01

FACILITY DOCKET NO.: 50-288

FACILITY LICENSE NO.: R-112

FACILITY: Reed College

EXAMINATION DATES: January 22 - 25, 1996

EXAMINER: Paul Doyle, Chief Examiner

SUBMITTED BY: Paul Doyle, Chief Examiner   1/26/96 Date

SUMMARY:

The NRC administered Operator Licensing examinations to 2 Reactor Operator and 3 Senior Reactor Operator Upgrade candidates. One of the Reactor Operator candidates failed Section B of the written examination only. All candidates passed the operating portion of their respective examinations.

REPORT DETAILS

1. Examiners:
   Paul Doyle, Chief Examiner

2. Results:

	RO (Pass/Fail)	SRO (Pass/Fail)	Total (Pass/Fail)
NRC Grading:	1/1	3/0	4/1

3. Exit Meeting:
   Paul Doyle, NRC, Examiner
   Stephen Frantz, Reed College, Facility Director
   Josh Filner, Reed College, Deputy Facility Director

   The examiner thanked the facility for their support in coordinating the examinations and reported that the examinations did not expose any generic weaknesses in the candidates' knowledge. The facility presented the examiner with written comments on the NRC written examination.

ENCLOSURE 1

FACILITY COMMENTS AND NRC RESOLUTIONS TO COMMENTS

ENCLOSURE 2

Comments on the NRC written exam at Reed College on 1/22/96

A.17 The answer key is incorrect. The correct answer is c. increase by 8°C

Reactivity due to shim = 0.1% ΔK/K/in * 10 in = 0.01 ΔK/K
Temperature must add - 0.01 ΔK/K + - 0.00125 ΔK/K/°C = +8°C

Ref: Reed Reactor Facility Training Manual, Chapter 10.

B.1 The answer key is incorrect for a and b. The correct answer is **1** for both.

The fuel and source are in the lazy susan and are therefore not **core** configuration changes. They should be in **black ink** since they are experiments in the lazy susan.

Ref: Reed Reactor Facility SOP 10.

B.4 The answer key is incorrect. The correct answer is **a.** minor contamination

Minor contamination is defined in SOP 22 as less than 100 times background.
Background is typically between 10 and 16 cpm.
Thus 90 cpm above background is less than 100 times background and is **minor** contamination.

Ref: Reed Reactor Facility SOP 22.

B.12 Suggest adding the words *primary* or *major* to the question so that option a, nitrogen-16, is not sellected.

C.9 Suggest accepting either options **b** or **d**.

Both statements are true and we teach both. The pipe ends about two feet below the surface of the water, and there is a siphon breaker in the pipe.

Ref: Reed Reactor Facility Mechanical Maintenance Manual. Actual piping layout.

C.10 Suggest accepting either options **a** or **c**.

Both statements are true and we teach both. Too high a flow could result in an unacceptable ion exchange rate, result in resin separation, or chanelling.

Ref: Reed Reactor Facility Mechanical Maintenance Manual.

C.12 The answer key is incorrect. The correct answer is d. absorbing material

Ref: Reed Reactor Facility Mechanical Maintenance Manual.

Stephen G Frantz
DIRECTOR RRF 1/24/96

NRC RESOLUTION TO FACILITY COMMENTS

All comments accepted. Answer key has been modified as required.

United States Nuclear Regulatory Commission

Operator Licensing Examination

Enclosure 3

QUESTION (A.1) [1.0]
Which one of the following conditions describes a reactor that is EXACTLY critical?

a. $K_{eff} = 0; \rho = 0$

b. $K_{eff} = 0; \rho = 1$

c. $K_{eff} = 1; \rho = 0$

d. $K_{eff} = 1; \rho = 1$

QUESTION (A.2) [1.0]
A few minutes following a scram reactor power will decrease at the same rate regardless of reactor power history. Which one of the following is the reason for this stable negative period? The rate of power change is dependent on...

a. mean lifetime of longest lived delayed neutron precursor.

b. constant decay rate of prompt neutrons.

c. mean lifetime of the shortest lived delayed neutron precursor.

d. constant decay rate of prompt gamma emitters.

QUESTION (A.3) [1.0]
For the same constant reactor period, which one of the following transients requires the **LONGEST** time to occur? A power increase of...

a. 5% or rated power — going from 1% to 6% of rated power.

b. 10% or rated power — going from 10% to 20% of rated power.

c. 15% of rated power — going from 20% to 35% of rated power.

d. 20% of rated power — going from 40% to 60% of rated power.

QUESTION (A.4) [1.0]
Which one of the following correctly describes the differences between prompt and delayed neutrons.

a. Prompt neutrons account for less than 1% of the neutron population, while delayed neutrons account for 99% of the neutron population.

b. Prompt neutrons are released during the fast fission process, while delayed neutrons are released during the delayed neutron process.

c. Prompt neutrons are released during the fission process, while delayed neutrons are released during the decay process.

d. Prompt neutrons are the dominating factor in determining the reactor period while delayed neutrons have little effect on reactor period.

QUESTION (A.5) [1.0]
Which one of the following is the number for the average number of neutrons produced by a thermal fission of U^{235}?

a. 2.00

b. 2.07

c. 2.43

d. 2.87

QUESTION (A.6) [1.0]
Which one of the following correctly describes a **THERMAL** neutron?

a. A neutron possessing thermal rather than kinetic energy.

b. The primary source of thermal energy increase in the reactor coolant during reactor operation.

c. A neutron that was produced a significant time (on the order of seconds) after it's initiating fission occurred.

d. A neutron which experiences no net change in energy after several collisions with atoms of it's surroundings.

QUESTION (A.7) [1.0]
Which one of the following correctly describes the characteristics of a good moderator?

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

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

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

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

QUESTION (A.8) [1.0]
Which one of the following is the stable reactor period which will result in a power rise from 0.02% rated reactor power to 100% rated reactor power in 186 seconds?

a. 10 seconds

b. 22 seconds

c. 29 seconds

d. 116 seconds

QUESTION (A.9) [1.0]
Given: The reactor is exactly critical.
How much reactivity must be added to make the reactor prompt critical? An amount equal to...

a. the β_{eff} fraction.

b. that required to make K_{eff} equal to 1.100.

c. that required to make the reactor period infinite.

d. that required to increase neutron lifetime to 0.8 seconds.

QUESTION (A.10) [1.0]
Which one of the following factors will **NOT** affect the control rod position at criticality?

a. Installed experiment location and type.

b. Installed neutron source position.

c. Time following shutdown.

d. Moderator temperature.

QUESTION (A.11) [1.0]
Which one of the four-factor formula factors is most strongly affected by control rod movement?

a. Fast Fission Factor (ϵ)

b. Thermal Utilization Factor (f)

c. Neutron Reproduction Factor(η)

d. Resonance Escape Probability (p)

QUESTION (A.12) [1.0]
The reactor is at 50% power. Which one of the following reactivity coefficients will be the **FIRST** to turn reactor power following a rod withdrawal? (Assume no scram.)

a. Fuel-Moderator Temperature

b. Water-Moderator Temperature

c. Void

d. Pressure

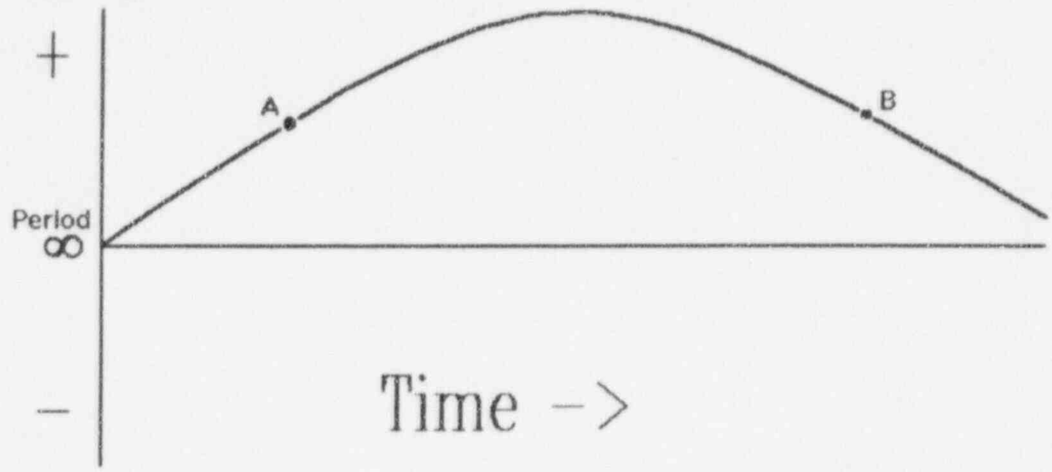
QUESTION (A.13) [1.0]
Shown below is a trace of **REACTOR PERIOD** as a function of time. Between points A and B **REACTOR POWER** is:

a. continually increasing.

b. continually decreasing.

c. increasing, then decreasing.

d. constant.



QUESTION (A.14) [1.0]
The reactor has been shutdown for two weeks. You start up the reactor raise power to maximum allowed and place the regulating rod in automatic mode. Which one of the following describes the expected response of the regulating rod for the next half hour? (Assume no insertion or removal of experiments, and constant pool temperature.)

a. Drive in.

b. Drive out.

c. Remain constant.

d. Drive out then back in.

QUESTION (A.15) [1.0]
Which one of the following is the major source of energy released due to thermal fission of a U^{235} atom?

a. Kinetic energy of the fission fragments.

b. Kinetic energy of the fission neutrons

c. Prompt gamma rays

d. Fission Product decay.

QUESTION (A.16) [1.0]
Which one of the following statements correctly describes why the fuel element moderator contributes to a "prompt" negative temperature coefficient?

a. Samarium buildup causes the insertion of negative reactivity at higher fuel temperatures.

b. The neutron energy distribution shifts to a higher level at higher fuel temperatures.

c. The neutron energy distribution shift to a lower level at higher temperatures.

d. Zirconium-Hydride causes the escape probability to decrease.

QUESTION (A.17) [1.0]
Assume the fuel temperature coefficient (α_T) is -1.25×10^{-3} $\Delta K/K/°C$, and the average worth of the shim rod is 0.1%$\Delta K/K/in$. If the reactor is manual mode and the shim rod is shimmed out 10 inches, for reactor power to stabilize temperature must have ...

a. increased by 80°C

b. decreased by 80°C

c. increased by 8°C

d. decreased by 8°C

QUESTION (A.18) [1.0]
At the beginning of a reactor startup K_{eff} is 0.90 with a count rate of 30 cps. After withdrawing a rod the count rate stabilizes at 60 cps. What is the new K_{eff}?

a. 0.91

b. 0.925

c. 0.95

d. 0.975

QUESTION (A.19) [1.0]
Which one of the following defines a "dollar" worth of reactivity?

a. $\beta_{eff} \approx 0.007\ \Delta K/K$

b. $\beta \approx 0.0065\ \Delta K/K$

c. $K_{eff} = 1.100$

d. $\rho = 0.111\ \Delta K/K$

QUESTION (A.20) [1.0]
Which one of the following describes the reactor behavior as you approach the point where the reactor is critical? Each Equal insertion of positive reactivity results in a larger/smaller change in equilibrium count rate and a longer/shorter time to stabilize.

a. larger, longer

b. larger, shorter

c. smaller, longer

d. smaller, shorter

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

QUESTION (B.1) [2.0, (0.5 each)]
Match each of the main log entries below with the correct ink colors... (NOTE: Choices may be more than once or not at all.

a. 09:30 Fueled Experiment inserted into Lazy Susan. (Signature: *Reactor Operator*)

b. 09:45 A Pu-Be Neutron source experiment inserted into Lazy Susan. (Signature: *Reactor Operator*)

c. 10:00 Control Console loss of power resulting in a reactor scram, cause unknown, all rods verified on bottom, all rod drives stuck out. (Signature: *Reactor Operator*)

d. 10:15 Faulty breaker in back of Control Console replaced, reactor console reenergized, permission granted to restart reactor. (Signature: *Facility Director*)

1. Written in black ink.
2. Written in black ink, underlined in red ink.
3. Written in red ink.
4. Written in black ink, underlined in green ink.
5. Written in green ink.

QUESTION (B.2) [1.0]
Standard Operating Procedure 03 *Reactor Operations*, places a limit on maximum power to preclude exceeding the license limit due to a power fluctuation. What is this limit?

a. 200 Kwatts

b. 225 Kwatts

c. 240 Kwatts

d. 287.5 Kwatts

QUESTION (B.3) [1.0]
Which ONE of the following conditions on the Startup Checklist would **NOT** preclude reactor startup?

a. Linear Channel Scram is 112%.

b. Source Interlock is not operational.

c. The Period channel scram is 2 seconds.

d. Control Rod Position Indicator Servo Voltage is 2000 mV.

QUESTION (B.4) [1.0]
During the Prestartup checklist a swipe of the area around the removal tube for the lazy susan reads 90 counts above background. This is considered...

a. Minor contamination

b. Intermediate contamination

c. High contamination

d. Major contamination

QUESTION (B.5) [1.0]
During performance of a power calibration (SOP 44) indicated power differed from calculated power by 15 Kwatts. Which one of the following actions is required for the Linear Power and Percent Power channels?

a. Adjust the detector high voltage on the detectors.

b. Adjust the compensating voltages on the detectors.

c. Adjust the detector heights.

d. No adjustment necessary.

QUESTION (B.6) [1.0]
During the weekly checks of the primary coolant system, you obtain a conductivity reading of 3.0 μmho/cm. The primary system had been operating for 15 minutes prior to taking the reading. Which ONE of the following actions should you perform next?

a. Allow the primary system to operate for another 30 minutes, then take another reading.

b. Allow the primary system to operate for another 60 minutes, then take another reading.

c. Inform the SRO, make preparations to replace the primary filters.

d. Inform the SRO, make preparations to backflush the demineralizers.

QUESTION (B.7) [1.0]
Which ONE of the following is the absolute **MAXIMUM STEADY-STATE** power level allowed by **TECHNICAL SPECIFICATIONS**?

a. 240 Kilowatts

b. 250 Kilowatts

c. 287.5 Kilowatts

d. 300 Kilowatts

QUESTION (B.8) [1.0]
Which ONE of the following is **NOT** a part of the Technical Specifications definition of a *Shutdown* 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 fuel handling or maintenance of the control rod mechanisms.

c. The minimum shutdown margin with the most reactive or the operable control elements withdrawn shall be $1.10

d. Sufficient control rods are inserted so as to assure the reactor is subcritical by a margin greater than 0.7 $\Delta K/K$, cold Xenon free.

QUESTION (B.9) [1.0]
During removal of an experiment from the reactor there is a small explosion which cuts the neck of the person removing the experiment. You note that bright red blood is spurting from the neck. Which ONE of the following would be your **PRIMARY** concern?

a. decontamination of the neck area.

b. Stabilization of the injury.

c. Counseling the wounded experimenter.

d. Estimation of the internal dose.

QUESTION (B.10) [1.0]
Two Senior Reactor Operators (SROs) and one unlicensed trainee are the only people on-site during reactor operations. One SRO becomes ill and leaves the site. What action must be taken by the remaining SRO.

a. The reactor must be shutdown.

b. Operations may continue unrestricted.

c. Operations may continue ONLY if the remaining SRO remains in the control room.

d. Operations may continue ONLY if the remaining SRO remains within the Reactor Laboratory area.

QUESTION (B.11) [1.0]
An experiment removed from the reactor initially reads 1 R/hr at 3 feet with no shielding. Fifteen (15) minutes after removal, the experiment reads 750 mR/hr at 3 feet, with no shielding. How long after initial removal would it take for the radiation level to decrease to 10 mR/hr at 1 foot?

a. 4 hours

b. 5 hours

c. 6 hours

d. 12 hours

QUESTION (B.12) [1.0]
Which ONE of the following is the most significant radioactive gas produced by the irradiation of air? Stem modified per facility comment for clarity.

a. $Nitrogen^{16}$

b. $Xenon^{135}$

c. $Argon^{41}$

d. $Hydrogen^{3}$ (Tritium)

QUESTION (B.13) [1.0]
While working in the reactor compartment a radiation worker receives 100 millirem worth of dose due to beta radiation, 25 millirem of dose due to gamma radiation and 5 millirem of dose due to slow neutron radiation. What is the workers total dose?

a. 130 millirem

b. 175 millirem

c. 205 millirem

d. 275 millirem

QUESTION (B.14) [1.0]
The date is November 29 1996. Your annual deep dose to date has been 900 millirem. You are working with an experiment which emits a gamma dose rate of 300 millirem/hour. Approximately how long may you work in this area without **exceeding** a 10 CFR 20 limit. (Assume you are 19 years old.)

a. 1 hours

b. 7 hours

c. 13 hours

d. 24 hours

QUESTION (B.15) [1.0]
While walking past the outside of the reactor facility on a Sunday, you faintly hear an alarm bell ringing from within. You call the facility director and he asks you to check the alarm for him while he is driving in. Which type of meter would you use and why prior to opening the door to the facility.

a. Geiger Müeller, to check for radiation dose.

b. Geiger Müeller, to check for radioactive contamination.

c. Ion Chamber, to check for radiation dose.

d. Ion Chamber, to check for radioactive contamination.

QUESTION (B.16) [2.0, 0.4 each]
Match the tag on the Lazy Susan status board in column A with the correct sample description from column B.

COLUMN A	**COLUMN B**
a. White with a "1".	1. Aluminum TRIGA tube
b. White with a "2".	2. Position not to be used without Director's permission.
c. Yellow	3. Position not to be used at all.
d. Orange	4. Shutdown Irradiation
e. Blue	5. Double loaded plastic TRIGA tube
	6. Single loaded plastic TRIGA tube

QUESTION (B.17) [1.0]
Which one of the following is the maximum inventory of Iodine $^{131-135}$ isotopes which may be generated by a fueled experiment?

a. 1.5 curies

b. 0.5 curies

c. 15 millicuries

d. 5 millicuries

QUESTION (B.18) [1.0]
If the Radiation Area Monitor (RAM) were to fail and you knew it could be fixed within 2 hours, does Tecnical Specifications allow reactor operations to continue, and if so, what is (are) the minimum requirements?

a. NO

b. YES, if replaced by a portable gamma-sensitive ion chamber.

c. YES, if replaced by a temporary gamma-sensitive monitor with alarm.

d. YES, as long as the GSM is in service.

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

QUESTION (C.1) [1.0]
What is the purpose of the orifice in the Primary Cooling System?

a. To restrict coolant flow to 20 gpm through the demineralizers.

b. To prevent excessive coolant flow back into the core.

c. To restrict coolant flow to 100 gpm bypassing the demineralizers.

d. To prevent excessive backpressure on the heat exchanger.

QUESTION (C.2) [1.0]
During operations at high (150 Kwatts) power, you lose compensating voltage for a compensated ion chamber. Which ONE of the following would be the resulting change in power level detected?

a. Small decrease in indicated power.

b. Small increase in indicated power.

c. Large decrease in indicated power.

d. Large increase in indicated power.

QUESTION (C.3) [2.0, 0.5 each]
Match the control rod drive mechanism part from COLUMN "A" with the correct function in COLUMN "B".

COLUMN A		COLUMN B
a. Piston	1.	Provide rod bottom indication.
b. Potentiometer	2.	Provide rod full withdrawn indication.
c. Pull Rod	3.	Provide rod position indication when the electromagnet engages the armature.
d. Push Rod	4.	Works with dash pot to slow rod near bottom of its travel.

QUESTION (C.4) [2.0, 0.5 each]
Match the Input Signal from the respective Control and Instrumentation circuits in COLUMN "A" to the correct circuits in COLUMN "B". (Items in COLUMN B may be used more than once or not at all.)

COLUMN A		**COLUMN B**	
a.	Log-N Period channel	1.	Indication Only
b.	Log Count Rate channel	2.	Indication and Scram Only
c.	Linear Power channel	3.	Indication and Reg. Rod Control Only
d.	Percent Power channel	4.	Indication, Scram and Reg. Rod Control

QUESTION (C.5) [1.0]
What automatic Control and Instrumentation System scram protects against a loss of signal from the Log-N channel?

a. Console Power Supply Failure Scram

b. Log-N period Scram

c. External Circuit

d. Ion Chamber Power Supply Failure

QUESTION (C.6) [1.0]
An unlicensed operator trainee, inadvertently shut V-11 (primary pump discharge valve) prior to starting the pump. What built-in feature prevents damage due to overheating the pump?

a. Small recirculation line from discharge side of pump to suction side of pump.

b. Overpressure relief valve in line bypassing valve V-11 (pump discharge).

c. Small hole in V-11 disc allows cooling flow even when valve is shut.

d. Bypass line with throttle valve around V-11 (pump discharge) allows cooling flow.

QUESTION (C.7) [1.0]
Which ONE of the following is NOT a design function of the purification system?

a. Reduce radiation level due to dissolved ions.

b. Reduce radiation due to gases in solution.

c. Reduce radiation due to suspended solids.

d. Reduce corrosion due to dissolved ions.

Section C Plant and Rad Monitoring Systems

QUESTION (C.8) [1.0]
The return water from the primary coolant/purification system is ejected from an angled nozzle, which causes a swirling motion in the pool. Which one of the following is the primary purpose for this design...

a. Increase the heat transfer rate due to increase convective flow.

b. Decrease the activation rate of O^{16} to N^{16} due to decrease time in the core.

c. Increase the transport time for N^{16} to reach the surface of the pool.

d. Break up O^{16} bubbles in the pool thereby decreasing the formation of N^{16}.

QUESTION (C.9) [1.0]
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.10) [1.0]
Which one of the following is the correct reason for maintaining 10 gallons per minute flow rate through each of the demineralizers?

a. Too fast a flow rate would result in an unacceptable ion exchange rate due to reduced contact time.

b. Too slow a flow rate would result in too high a temperature, resulting in resin breakdown.

c. Too fast a flow rate would result in resin separation, with a loss of resin to the pool.

d. Too slow a rate would produce 'channels' with and unacceptable reduction in efficiency.

QUESTION (C.11) [1.0]
Which one of the following is the radiation monitoring systems will cause a ventilation confinement actuation?

a. GSM

b. RAM

c. APM

d. Victoreen

QUESTION (C.12) [1.0]
How is water or condensation removed from the rotary specimen rack?

a. The pool is periodically drained, and a drain at the bottom of the Lazy susan opened.

b. The specimen rack is periodically removed and cleaned by hand.

c. An electric heater is placed in an insulated specimen tube to boil off the condensate.

d. A water absorbing material is placed in a perforated specimen tube, and inserted into the rack.

QUESTION (C.13) [1.C]
The reactor is operating at 80% power with the regulating rod at 80% withdrawn in SERVO mode, when a reactor operator trainee trips in the control room inadvertently depressing the OUT button for the regulating rod. He immediately rights himself, but the button remains stuck (in the depressed position). Which one of the following
conditions would you expect to see three minutes after the initial depressing of the button and why?

a. Reactor Scram. Due to decreasing reactor period.

b. Reactor Scram. Due to increasing reactor power.

c. Minimal effect. Feedback from the reactor period and power level meters will generate an opposite signal stopping the rod.

d. No effect. The regulating rod buttons do not effect rod position in SERVO mode.

QUESTION (C.14) [1.0]
Which one of the following is the primary reason for the Service Air system?

a. Provide motive force for the Pneumatic Sample Insertion System (Rabbit).

b. Provide motive force for the bleed valve in the secondary system.

c. Provide a method for blowing out stuck TRIGA tubes from the lazy susan.

d. Provide motive force for the Ventilation system dampers.

QUESTION (C.15) [1.0]
Which one of the following Radiation Protection Systems is used to routinely monitor the Ar^{41} release to the environment?

a. RAM

b. CAM

c. APM

d. GSM

QUESTION (C.16) [1.0]
What material is used in the core reflector as the reflector material?

a. Aluminum

b. Virgin Polyethylene

c. Borated Polyethylene

d. Graphite

QUESTION (C.17) [1.0]
Which component(s) in the purification system is primarily responsible for maintenance of the pool water pH?

a. The filters.

b. The demineralizer.

c. The skimmer.

d. Chemical additions via the Resin Supply tank.

QUESTION (C.18) [1.0]
How is mechanical shock to the control rods minimized on a reactor scram?

a. A piston moving through the barrel assembly undergoes dashpot action over the last 2 inches of movement.

b. The rod moving through the rod guide tube undergoes dashpot action over the last 2 inches of movement.

c. A piston moving through the barrel assembly encounters a small spring which absorbs the energy over the last 2 inches of movement.

d. The rod moving through the rod guide tube encounters a small spring which absorbs the energy over the last 2 inches of movement.

(*** End of Section C ***)
(*** End of Examination ***)

ANSWER (A.1)
c
REFERENCE (A.1)
P. Terdal, ed, *Reed ℞ Facility Training Manual*, Reed Institute 1994 § 8.2, p. 8-2, and § 9.2 p. 9-1.

ANSWER (A.2)
a
REFERENCE (A.2)
P. Terdal, ed, *Reed ℞ Facility Training Manual*, Reed Institute 1994 §§ 9.5 & 9.6, pp. 9-5 — 9-8.

ANSWER (A.3)
a
REFERENCE (A.3)
P. Terdal, ed, *Reed ℞ Facility Training Manual*, Reed Institute 1994 § 10.1, p. 10-2.
$P = P_0 e^{t/T}$, given T is a constant $t \propto \ln(P/P_0)$

ANSWER (A.4)
c
REFERENCE (A.4)
P. Terdal, ed, *Reed ℞ Facility Training Manual*, Reed Institute 1994 § 9.5, p. 9-5.

ANSWER (A.5)
c
REFERENCE (A.5)
P. Terdal, ed, *Reed ℞ Facility Training Manual*, Reed Institute 1994 § 7.2, p. 7-4.

ANSWER (A.6)
d
REFERENCE (A.6)
P. Terdal, ed, *Reed ℞ Facility Training Manual*, Reed Institute 1994 § 7.3.1, p. 7-6.

ANSWER (A.7)
a
REFERENCE (A.7)
P. Terdal, ed, *Reed ℞ Facility Training Manual*, Reed Institute 1994 § 8.3.2, p. 8-4.

ANSWER (A.8)
b
REFERENCE (A.8)
P. Terdal, ed, *Reed ℞ Facility Training Manual*, Reed Institute 1994 § 10.1, p. 10-2.
$P = P_0\ e^{t/T}$ $\ln(P/P_0) = t/T$ $\ln(5000) = 186/T$ $T = 186s/\ln(5000) = 186/8.517 =$ 21.8 sec.

ANSWER (A.9)
a
REFERENCE (A.9)
P. Terdal, ed, *Reed Rx Facility Training Manual*, Reed Institute 1994
§ 9.8, p. 9-12.

ANSWER (A.10)
b
REFERENCE (A.10)
P. Terdal, ed, *Reed Rx Facility Training Manual*, Reed Institute 1994 §§ 11.xx

ANSWER (A.11)
b
REFERENCE (A.11)
P. Terdal, ed, *Reed Rx Facility Training Manual*, Reed Institute 1994 § 8.3,
p. 8-3 — 8-7.

ANSWER (A.12)
a
REFERENCE (A.12)
P. Terdal, ed, *Reed Rx Facility Training Manual*, Reed Institute 1994 § 10.5.1,
p. 10-15.

ANSWER (A.13)
a
REFERENCE (A.13)
P. Terdal, ed, *Reed Rx Facility Training Manual*, Reed Institute 1994
§ 10.1, p. 10-2.
Since Rx period is positive throughout, Power must be increasing throughout.

ANSWER (A.14)
b
REFERENCE (A.14)
P. Terdal, ed, *Reed Rx Facility Training Manual*, Reed Institute 1994
§ 10.4.2, p. 10-11 — 10-13.

ANSWER (A.15)
a
REFERENCE (A.15)
P. Terdal, ed, *Reed Rx Facility Training Manual*, Reed Institute 1994
§ 10.1, p. 10-1.

ANSWER (A.16)
b
REFERENCE (A.16)
NRC examination bank

ANSWER (A.17)
~~a~~ c Answer changed per facility comment.
Reactivity due to shim = 0.1%ΔK/K/inch * 10 inch = 0.01 ΔK/K
Temperature must add - 0.01 ΔK/K. -0.01 ΔK/K ÷ -0.00125 ΔK/K/°C = +80°C
REFERENCE (A.17)
P. Terdal, ed, *Reed R̷ Facility Training Manual*, Reed Institute 1994 § 10.x, p. 10-x.

ANSWER (A.18)
c
REFERENCE (A.18)
Formula sheet. $(CR_2 \div CR_1) = (1 - K_{eff1}) \div (1 - K_{eff2})$
$60/30 = (1 - 0.9) \div (1 - X) \rightarrow 2 = 0.1 \div (1 - X)$
$1 - X = 0.1/2 = 0.05 \rightarrow \rightarrow X = 1 - 0.05 = 0.95$

ANSWER (A.19)
a
REFERENCE (A.19)
P. Terdal, ed, *Reed R̷ Facility Training Manual*, Reed Institute 1994 §

ANSWER (A.20)
a
REFERENCE (A.20)
Typical NRC examination question

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

ANSWER (B.1)
a, ~~3~~ 1; b, ~~2~~ 1; c, 5; d, 5 Answer changed per facility comment.
REFERENCE (B.1)
SOP 10, § 10.7

ANSWER (B.2)
c
REFERENCE (B.2)
SOP-3 § 3.5.4

ANSWER (B.3)
c
REFERENCE (B.3)
SOP 01, Startup Checklist, Appendix A.

ANSWER (B.4)
b a Answer changed per facility comment.
REFERENCE (B.4)
SOP 22, § 22.7.1, Decontamination

ANSWER (B.5)
c
REFERENCE (B.5)
SOP 44, Power Calibration.

ANSWER (B.6)
~~b~~
REFERENCE (B.6)
SOP 70, Weekly Checks.

ANSWER (B.7)
c
REFERENCE (B.7)
Technical Specifications § A.2 *Steady State Mode*

ANSWER (B.8)
c
REFERENCE (B.8)
Technical Specifications § A *Definitions*

ANSWER (B.9)
b
REFERENCE (B.9)
NRC examination administered March 25, 1992.

ANSWER (B.10)
c
REFERENCE (B.10)
Administrative procedures § III.3.1(3)

ANSWER (B.11)
c
REFERENCE (B.11)
Equation sheet.
First: $I = I_0 e^{-\lambda t}$ Solving for λ: $-\lambda(\frac{1}{4}\text{ hour}) = \ln(I/I_0) =$
$\ln(750/1000) = -0.28768$
multiply both sides by 4 hour^{-1}: $\lambda = 1.1507\ \text{hr}^{-1}$
Next figure Initial reading at 1 foot. $I_0/d^2 = I/d_0^2$
$I = I_0\, d_0^2/d^2 = 9 * 1000 = 9000$ mR/hr
Finally solve for final time $-\lambda t = \ln(10/9000) \rightarrow t = -[(-6.8024) / 1.1507] =$
$5.911 \approx 6$ hours

ANSWER (B.12)
c
REFERENCE (B.12)
SAR § 7.5 *Production of Radioactive Gases by the Reactor*

ANSWER (B.13)
a
REFERENCE (B.13)
millirem (gamma) = millirem (beta) = millirem (neutron)

ANSWER (B.14)
c
REFERENCE (B.14)
10 CFR 20.1201 Occupational dose limits for adults
Limit = 5.0 Rem/year. 5 - 0.9 = 4.1 allowable.
Time = (4.1 Rem) ÷ 0.3 Rem/hour = 41/3 = 13.66 Hours

ANSWER (B.15)
c
REFERENCE (B.15)
P. Terdal, ed, *Reed Reactor Facility Training Manual*, Reed Institute 1994
§ 6.4 Ionization Chambers.

ANSWER (B.16)
a, 6; b, 5; c, 1; d, 3; e, 4
REFERENCE (B.16)
SOP 52 Lazy Susan Irradiations § 52.7.1.3, p. 3

ANSWER (B.17)
a
REFERENCE (B.17)
RRF Technical Specification § J.9

ANSWER (B.18)
b
REFERENCE (B.18)
Technical Specifications § G.1

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

ANSWER (C.1)
c
REFERENCE (C.1)
NRC examination administered 5/95

ANSWER (C.2)
b
REFERENCE (C.2)
Typical NRC examination question

ANSWER (C.3)
a. 4; b. 3; c. 1; d. 2
REFERENCE (C.3)
Reed Reactor Facility SAR p. 5-10, also NRC examination administered 08/1992.

ANSWER (C.4)
a. 4; b. 1; c, 4; d, 2
REFERENCE (C.4)
SAR Figure 5-7 *Block diagram of Reactor Instrumentation for Steady State Operation*

ANSWER (C.5)
d
REFERENCE (C.5)
SAR § 5.3.4 *Safety Devices*, also Examiner Notes from Operating Test

ANSWER (C.6)
a
REFERENCE (C.6)
RRF Diagrams

ANSWER (C.7)
b
REFERENCE (C.7)
Reed Reactor TRIGA MARK I REACTOR MECHANICAL MAINTENANCE AND OPERATING MANUAL § 5.1 pg. 71.

ANSWER (C.8)
c
REFERENCE (C.8)
Examiner Notes from previous examinations

ANSWER (C.9)
b OR d Answer modified per facility comment.
REFERENCE (C.9)
TRIGA MK I Reactor Mechanical Maint. & Operating Manual, § 5.11.10, p. 85

ANSWER (C.10)
c or a Answer modified per facility comment.
REFERENCE (C.10)
RRF Triga Mk I Reactor Mechanical Maintenance and Operating Manual, § 5.11.1, pp. 81, and NRC examination administered August 1992.

ANSWER (C.11)
a
REFERENCE (C.11)
RRF Emergency Plan, also NRC examination administered August 1992.

ANSWER (C.12)
~~c~~ d Answer changed per facility comment.
REFERENCE (C.12)
RRF, TRIGA MK I Reactor Mechanical and Operating Manual, § 4.3.4, p. 41.

ANSWER (C.13)
d
REFERENCE (C.13)
SOP 3 § 3.5 Precautions 3.5.2.

ANSWER (C.14)
d
REFERENCE (C.14)
Examiner notes from previous examinations.

ANSWER (C.15)
d
REFERENCE (C.15)
SOP 05, the Shutdown Checklist

ANSWER (C.16)
d
REFERENCE (C.16)
TRIGA MK I Reactor Mechanical Maint. & Operating Manual § 3.2 *Reflector*

ANSWER (C.17)
b
REFERENCE (C.17)
TRIGA, MK I Reactor Mechanical Maint. & Operating Manual § 5.11.8

ANSWER (C.18)
a
REFERENCE (C.18)
RRF SAR § 5.2.8, p. 5-11.

(*** End of Section C ***)
(*** End of Examination ***)

A.1 c

A.2 a

A.3 a

A.4 c

A.5 c

A.6 d

A.7 a

A.8 b

A.9 a

A.10 b

A.11 b

A.12 a

A.13 a

A.14 b

A.15 a

A.16 b

A.17 ~~a~~ c Answer changed per facility comment.

A.18 c

A.19 a

A.20 a

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

Section B Normal/Emerg. Procedures & Rad Con

B.1 a, ~~3~~ 1; b, ~~2~~ 1; c, 5; d, 5 Answer changed per facility comment.

B.2 c

B.3 c

B.4 ~~b~~ a Answer changed per facility comment.

B.5 c

B.6 b

B.7 c

B.8 c

B.9 b

B.10 c

B.11 c

B.12 c

B.13 a

B.14 c

B.15 c

B.16 a, 6; b, 5; c, 1; d, 3; e, 4

B.17 a

B.18 b

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

Section C Plant and Rad Monitoring Systems

C.1 c

C.2 b

C.3 a. 4; b. 3; c. 1; d. 2

C.4 a. 4; b. 1; c, 4; d, 2

C.5 d

C.6 a

C.7 b

C.8 c

C.9 b or d Answer modified per facility comment.

C.10 c or a Answer modified per facility comment.

C.11 a

C.12 ~~c~~ d Answer changed per facility comment.

C.13 d

C.14 d

C.15 d

C.16 d

C.17 b

C.18 a

(*** End of Section C ***)
(*** End of Examination ***)