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

REPORT NO.:	50-170/OL-96-01
FACILITY DOCKET NO.:	50-170
FACILITY LICENSE NO.:	R-84
FACILITY:	Armed Forces Radiobiological Research Institute
EXAMINATION DATES:	September 16 - 17, 1996
EXAMINER:	Patrick Isaac, Chief Examiner
SUBMITTED BY:	Patrick Isaac (signature), Patrick Isaac, Chief Examiner — 10/9/96, Date

SUMMARY:

During the week of September 16, 1996, the NRC administered Operator Licensing Examinations to two Senior Reactor Operator Instant (SROI) candidates. Both candidates passed the examinations.

ENCLOSURE 1

REPORT DETAILS

1. Examiners:

   Patrick Isaac, Chief Examiner

2. Results:

	RO PASS/FAIL	SRO PASS/FAIL	TOTAL PASS/FAIL
Written	N/A	2/0	2/0
Operating Tests	N/A	2/0	2/0
Overall	N/A	2/0	2/0

3. Exit Meeting:

   Stephen Miller, AFRRI, Reactor Facility Director
   LtCol Leonard Alt, AFRRI, Senior Staff Engineer
   Patrick Isaac, NRC, Chief Examiner

   The facility examination comments were discussed as noted in Enclosure 2. There were no generic concerns raised by the Chief Examiner.

NRC RESOLUTIONS - WRITTEN EXAMINATION

QUESTION (A.11)

Which one of the following statements is FALSE?

a. The value of an isotope's neutron absorption cross section is independent of a neutron's energy.

b. A U-235 atom can be fissioned by a "fast" neutron.

c. A U-238 atom is less likely to have a "thermal" fission, than a Pu-239 atom.

d. Approximately 210 MeV is released per fission event.

Answer: d

Facility Comment:

The correct answer should be 'a'.

NRC Resolution:

Comment Accepted. The answer key for A.11 will be modified to accept 'a' as correct.

QUESTION (A.12)

Which one of the following indicates the response of zirconium hydride-uranium mixture used in the fuel to a rapid power excursion?

a. Power is rapidly turned by the increased Doppler broadening of the zirconium.

b. Power is rapidly turned by the increased Doppler broadening of the uranium.

c. Fuel temperature increase will increase the moderation length of neutrons.

d. Fuel temperature increase will increase the absorbtion cross section of the fuel.

Answer: c

Facility Comment:

Both answers 'b' and 'c' are correct.

NRC Resolution:

Comment accepted. The answer key will be modified to accept both 'b' and 'c' as correct.

QUESTION (A.15)

How much (by what factor) would power increase in one second in a prompt critical reactor?

a. 1.00×10^{2}

b. 1.00×10^{5}

c. 7.55×10^{24}

d. 6.33×10^{60}

Answer: d

Facility Comment:

The prompt neutron lifetime used in the solution is different than the one stated in the equation sheet, which yields a significantly different answer. None of the answers provided are correct, therefore, this question should be deleted from the examination.

NRC Resolution:

Comment accepted. Question A.15 will be deleted from the examination.

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

FACILITY: Armed Forces Radiobiological Research inst.

REACTOR TYPE: TRIGA

DATE ADMINISTERED: 09/16/96

REGION: I

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 brackets 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	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.	PLANT 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

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 neither received nor given assistance in completing the examination. This must be done after you compiete 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 and each answer sheet.

6. Mark your answers on the answer sheet provided. USE ONLY THE PAPER PROVIDED AND DO NOT WRITE ON THE BACK SIDE OF THE PAGE.

7. The point value for each question is indicated in [brckets] after the question.

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

9. When turning in your examination, assemble the completed examination with examination questions, examination aids and answer sheets. In addition turn in all scrap paper.

10. Ensure all information you wish to have evaluated as part of your answer is on your answer sheet. Scrap paper will be disposed of immediately following the examination.

11. To pass the examination you must achieve a grade of 70 percent or greater in each category.

12. There is a time limit of three (3) hours for completion of the examination.

13. When you have completed and turned in you examination, leave the examination area. If you are observed in this area while the examination is still in progress, your license may be denied or revoked.

EQUATION SHEET

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

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

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

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

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

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

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

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

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

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

$$\Delta\rho = \frac{K_{eff_2} - K_{eff_1}}{k_{eff_1} \times K_{eff_2}}$$

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

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

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

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

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

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

DR — Rem, E — Mev, Ci — Curies, R — feet

$$DR = \frac{0.5\,CiE(n)}{R^2}$$

DR — mRem, E — Mev, Ci — mCuries, R — meters

$$\ell^* = 7 \times 10^{-4} \; seconds$$

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

$$c_{P_{(H_2O)}} = 1.0 \; \frac{BTU}{hour \; lbm \; °F}$$

$$c_{P_{(H_2O)}} = 1.0 \; \frac{CALORIE}{second \; gram \; °C}$$

$$K_{eff} = \epsilon \, \mathfrak{L}_f \, p \, \mathfrak{L}_{th} \, f \, \eta$$

$$f = \frac{V_{fuel}\Sigma_a^{fuel}\phi_{fuel}}{V_{fuel}\Sigma_a^{fuel}\phi_{fuel} + V_{mod}\Sigma_a^{mod}\phi_{mod} + V_{poison}\Sigma_a^{poison}\phi_{poison}}$$

$$\eta_{fuel} = \frac{\Sigma_{fission}^{fuel}}{\Sigma_{abs}^{fuel}} V_{fuel}$$

1 Curie = 3.7×10^{10} dis/sec

1 kg = 2.21 lbm

1 Mw = 3.41×10^6 BTU/hr

1 gal (H_2O) ≈ 8.34 lbm

°C = 5/9 (°F - 32)1

°F = 9/5 °C + 32

°K = 273.16 + °C

°R = 471.69 + °F

1 barn = 10^{-24} cm^2

$N_A = 6.0225 \times 10^{23}$

Section A

A.1 a b c d ___

A.2 a b c d ___

A.3 a b c d ___

A.4 a b c d ___

A.5 a b c d ___

A.6 a b c d ___

A.7 a b c d ___

A.8 a b c d ___

A.9 a b c d ___

A.10 a b c d ___

A.11 a b c d ___

A.12 a b c d ___

A.13 a b c d ___

A.14 a b c d ___

A.15 a b c d ___

A.16 a b c d ___

A.17 a b c d ___

A.18 a b c d ___

A.19 a b c d ___

A.20 a b c d ___

Section B

B.1 a b c d ___

B.2 a b c d ___

B.3 a b c d ___

B.4 a b c d ___

B.5 a b c d ___

B.6 a b c d ___

B.7 a b c d ___

B.8 a b c d ___

B.9 a b c d ___

B.10 a b c d ___

B.11 a b c d ___

B.12 a b c d ___

B.13 a b c d ___

B.14 a b c d ___

B.15 a b c d ___

B.16 a b c d ___

B.17 a b c d ___

B.18 a b c d ___

B.19 a b c d ___

B.20 a b c d ___

Section C

C.1	a b c d	___
C.2	a b c d	___
C.3	a b c d	___
C.4	a b c d	___
C.5	a b c d	___
C.6	a b c d	___
C.7	a b c d	___
C.8a	1 2 3 4	___
b	1 2 3 4	___
c	1 2 3 4	___
d	1 2 3 4	___
C.9a	1 2 3 4 5 6	___
b	1 2 3 4 5 6	___
c	1 2 3 4 5 6	___
d	1 2 3 4 5 6	___
C.10	a b c d	___
C.11	a b c d	___
C.12	a b c d	___
C.13	a b c d	___
C.14	a b c d	___
C.15	a b c d	___
C.16	a b c d	___
C.17	a b c d	___
C.18	a b c d	___

QUESTION (A.1) [1.0]
With all rods in, cold, Xe free, the count rate is 1000 cpm and the reactivity is -$5.36. What final count rate would you expect to see if the safety rod was completely withdrawn?

a. 344 cpm

b. 1726 cpm

c. 2488 cpm

d. 3662 cpm

QUESTION (A.2) [1.0]
With the reactor on a constant period, which transient requires the LONGEST time to occur?

A reactor power change of:

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

b. 10% of rated power - going from 10% to 20% power of rated power

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

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

QUESTION (A.3) [1.0]
The time required to increase power from 100 watts to 250 Kwatts on a 5 second period is about:

a. 40 seconds

b. 90 seconds

c. 200 seconds

d. 360 seconds

QUESTION (A.4) [1.0]
Which ONE of the following statements is a characteristic of subcritical multiplication?

a. The number of neutrons gained per generation doubles for each succeeding generation.

b. A constant neutron population is achieved when the total number of neutrons produced in one generation is equal to the number of source neutrons in the next generation.

c. For equal reactivity additions, it takes less time for the equilibrium subcritical neutron population level to be reached as Keff approaches one.

d. Doubling the indicated count rate will reduce the margin to criticality by approximately one half.

QUESTION (A.5) [1.0]
Shortly after a reactor trip, reactor power indicates 0.5% where a stable negative SUR is attained. Reactor power will be reduced to 0.05% in approximately _______ seconds.

a. 90

b. 180

c. 270

d. 360

QUESTION (A.6) [1.0]
During a fuel loading, if the fuel elements are loaded to the core one by one starting near the source and proceeding toward the detector, which ONE of the following statements describes the effect of this loading sequence on the 1/M plot?

a. The sequence has no effect on the 1/M plot.

b. The 1/M plot will have a less angular slope, predicting criticality for a larger number of elements.

c. The 1/M plot will have a steeper slope, initially predicting criticality for a fewer number of elements.

d. The 1/M plot will approach infinity. Predicting criticality would be difficult.

QUESTION (A.7) [1.0]
Which ONE of the following describes how the effective delayed neutron fraction varies over core life?

a. Decreases due to the burnup of U^{238}

b. Increases due to the burnup of U^{238}

c. Decreases due to the buildup of Pu^{239}

d. Increases due to the buildup of Pu^{239}

QUESTION (A.8) [1.0]
An initial count rate of 100 is doubled five times during startup. Assuming an initial K_{eff}=0.950, what is the new K_{eff}?

a. 0.957

b. 0.979

c. 0.988

d. 0.998

QUESTION (A.9) [1.0]
Given a source strength of 100 neutrons per second (N/sec) and a multiplication factor of 0.8, the expected neutron count rate would be:

a. 125 N/sec

b. 250 N/sec

c. 400 N/sec

d. 500 N/sec

QUESTION (A.10) [1.0]
Which one of the following is the main source of heat in the reactor one hour after shutdown?

a. Decay of fission products

b. Fission due to delayed neutrons

c. Spontaneous fission within the core

d. Decay of radioactive structural material

QUESTION (A.11) [1.0]
Which one of the following statements is FALSE?

a. The value of an isotope's neutron absorption cross section is independent of a neutron's energy.

b. A U-235 atom can be fissioned by a "fast" neutron.

c. A U-238 atom is less likely to have a "thermal" fission, than a Pu-239 atom.

d. Approximately 210 MeV is released per fission event.

QUESTION (A.12) [1.0]
Which one of the following indicates the response of zirconium hydride-uranium mixture used in the fuel to a rapid power excursion?

a. Power is rapidly turned by the increased Doppler broadening of the zirconium.

b. Power is rapidly turned by the increased Doppler broadening of the uranium.

c. Fuel temperature increase will increase the moderation length of neutrons.

d. Fuel temperature increase will increase the absorbtion cross section of the fuel.

QUESTION (A.13) [1.0]
Which one of the following could result from an attempt to start up the reactor with NO installed neutron source?

a. The reactor could not be started up because there would be no source of neutrons to start the chain reaction.

b. It is possible that reactor power would not be indicated on the nuclear instrumentation until an incident fission reaction resulted in a very short period.

c. Subcritical multiplication would result in a stable count rate on the nuclear instrumentation even though power was increasing.

d. Startup of the reactor would require increasing the voltage on the source range detectors to establish a count rate from photoneutrons.

QUESTION (A.14) [1.0]
The purpose of the beryllium in the Am-Be neutron startup source is the following:

a. to convert the installed Am^{241} to Am^{245}

b. to moderate the neutrons produced by Am^{241}

c. to convert to neutrons the alpha emitted spontaneously by Am^{241}

d. to enhance the conversion of Am^{241} to Np^{237}

QUESTION (A.15) [1.0] **DELETED**
How much (by what factor) would power increase in one second in a prompt critical reactor?

a. 1.00×10^{2}

b. 1.00×10^{5}

c. 7.55×10^{24}

d. 6.33×10^{60}

QUESTION (A.16) [1.0]
The Fulch's Pulse Model equation is used to understand the pulsing characteristics of TRIGA type reactors. This equation shows that:

a. peak pulse power varies linearly as the square of the prompt reactivity insertion Δk_p

b. energy released varies as the square root of the prompt reactivity insertion Δk_p

c. average fuel temperature varies as the square root of the prompt reactivity insertion Δk_p

d. peak pulse power varies linearly with the prompt reactivity insertion Δk_p.

QUESTION (A.17) [1.0]
What thickness of concrete is needed to reduce the intensity of a narrow 500 KeV photon beam to one-fourth its value (in units of cm), given that the mass attenuation coefficient for concrete @ 500 keV is 0.089 cm^2/g and the density of concrete is 2.35 g/cm^3?

a. 8.135 cm

b 6.628 cm

c. 4.864 cm

d. 2.357 cm

QUESTION (A.18) [1.0]
While doing a two hour operation with the cooling system out of service, the pool temperature increases 3°C. Which one of the following most closely represents the reactor power?

a. 3 Kw

b. 45 Kw

c. 100 Kw

d. 1 Mw

QUESTION (A.19) [1.0]
The description of the experiment on the Reactor Use Request requires that power be ramped from cold critical at 15 watts to 50 kW on a five second period. The core is in position 500 and the Reg. rod is 650 units withdrawn. Neglecting any effects from heating, which one of the following will be the position of the Reg rod to obtain the five second period for this ramp?

a. 700 units

b. 750 units

c. 800 units

d. 850 units

QUESTION (A.20) [1.0]
An experiment is loaded into the B-ring of the core when the reactor is operating at 900 Kw in the manual mode. After loading the experiment, the reactor power level decreases to 740 Kw. How much reactivity was added by the experiment? Neglect reactivity effects of heating.

a. $0.32

b. $0.76

c. $1.80

d. $2.63

QUESTION (B.1) [1.0]
A non-monitored opening of the exposure room may be performed when which of the following conditions are met?

1. At least two days have passed since the last power run

2. Survey meter readings at the door are less than 1 mr/hr

3. ER cam reading is less than 200 cpm above background

4. The reactor has not been to power in that ER since the last survey

a. 4

b. 4, 3

c. 4, 3, 2

d. 4, 3, 2, 1

QUESTION (B.2) [1.0]
Which one of the following meets the definition of a Channel Check per the Technical Specifications?

a. Immersing a temperature detector in an ice bath and verifying a reading of 32° F.

b. Placing a source next to a radiation detector and observing meter movement.

c. Performing a precise determination of reactor power, then adjusting reactor power meters to correspond to correct power.

d. Comparing the NM-1000 to the NP-1000 to verify proper overlap.

QUESTION (B.3) [1.0]
Downward classification and termination of an emergency can only be authorized by the:

a. ECP Commander

b. ERT Commander

c. Naval Medical Center Fire Department Commander

d. Any military officer

QUESTION (B.4) [1.0]
According to the reactor operational procedures, which of the following steps is NOT required in the event of an AFRRI complex emergency evacuation?

a. Ensure the reactor are doors are secured upon departure.

b. SCRAM the reactor.

c. Move the core to position 500.

d. Secure any exposure facilities in use to restrict access.

QUESTION (B.5) [1.0]
The exposure rate measured one foot from a experiment is 120 mR/hr. What is the dose rate at a distance of two feet from the experiment?

a. 30 mR/hr

b. 40 mR/hr

c. 60 mR/hr

d. 120 mR/hr

QUESTION (B.6) [1.0]
A sample of 0.999 "pure" gold is irradiated in the reactor; 15 millicuries of Au-198 are produced. Considering only the principal gamma-ray (0.412 MeV), a Radiation barrier would have to be erected from the irradiated gold at a distance of approximately:

a. 3 ft

b. 7 ft

c. 14 ft

d. 25 ft

QUESTION (B.7) [1.0]
A room contains a source which, when exposed, results in a general area dose rate of 175 millirem per hour. This source is scheduled to be exposed continuously for 35 days. Select an acceptable method for controlling radiation exposure from the source within this room.

a. Post the area with words "Danger-Radiation Area".

b. Equip the room with a device to visually display the current dose rate within the room.

c. Equip the room with a motion detector that will alarm in the control room.

d. Lock the room to prevent inadvertent entry into the room.

QUESTION (B.8) [1.0]
Based on 10CFR55, which one of the following is the MINIMUM requirement that must be met to retain an "active" license?

a. Must perform license duties at least 4 hours per calendar quarter.

b. Must perform license duties at least 40 hours per calendar year.

c. Must perform license duties a minimum of 8 hours per month.

d. Must perform license duties a minimum of 5 eight-hour shifts per calendar quarter.

QUESTION (B.9) [1.0]
A system or component is defined as "operable" by Technical Specifications if:

a. a channel check has been performed.

b. a functional check has been performed.

c. it is capable of performing its intended function.

d. it has no outstanding testing requirements.

QUESTION (B.10) [1.0]
A 4 inch thickness of steel reduces gamma radiation dose rate from 60 mrem/hr to 6 mrem/hr. What is the dose rate if an additional 1 inch thickness of steel is added?

a. 0.56 mrem/hr

b. 1.50 mrem/hr

c. 2.62 mrem/hr

d. 3.37 mrem/hr

QUESTION (B.11) [1.0]
Operator "A" works a standard forty (40) hour work week. His duties require him to work in a radiation area for four (4) hours a day. The dose rate in the area is 10 mR/hour. Which one of the following is the MAXIMUM number of days operator "A" may perform his duties without exceeding 10CFR20 limits?

a. 12 days

b. 25 days

c. 31 days

d. 125 days

QUESTION (B.12) [1.0]
During an emergency evacuation, personnel should be evacuated to a distance outside the _____mR/hr level.

a. 20

b. 10

c. 5

d. 2

QUESTION (B.13) [1.0]
Who is the Search Team Marshall?

a. Senior Enlisted Advisor, ASO

b. Head, Administrative Services Officer

c. Head, Health and Safety Department

d. Reactor Facility Director

QUESTION (B.14) [1.0]
When a contaminated individual is transported to the hospital, he will be accompanied by _____

a. A reactor staff member

b. An individual from his department

c. A member of Safety & Health Department

d. A person from the ERT muster location

QUESTION (B.15) [1.0]
If a local emergency exists in the reactor room and does not require total building evacuation, but radiation levels in the control room average 10 mR/hr, the ERT location should be:

a. Front patio

b. Room 3152

c. Reactor control room

d. Hallway outside door 3106A

QUESTION (B.16) [1.0]
All fuel elements at AFRRI must be measured annually or:

a. After 100 pulses > $2.00

b. After 500 pulses > $2.00

c. After 500 reactor operations

d. After 100 MW total power generated

QUESTION (B.17) [1.0]
Which of the following radiation detectors are used to meet the Technical Specification requirements for core measuring channels?

a. 1 fission chamber, and three uncompensated gamma-ion chambers.

b. 1 fission chamber, three compensated gamma-ion chambers, and a Cerenkov detector.

c. 1 fission chamber, two boron-lined uncompensated ion chambers, and either an uncompensated gamma-ion chamber or a Cerenkov detector.

d. 1 fission chamber, two compensated gamma-ion chambers, 1 uncompensated gamma-ion chamber, and a Cerenkov detector.

QUESTION (B.18) [1.0]
During steady state operations greater than 200 KW, which one of the following alarms will be set to full scale?

a. R2 & R5

b. R2 & R3

c. R1 & R3

d. R1 & R5

QUESTION (B.19) [1.0]
Which ONE of the following is the reactor power limit if the purification system inlet water temperature exceeds 60°C.?

a. 1000 watts

b. 5000 watts

c. 10000 watts

d. 50000 watts

QUESTION (B.20) [1.0]
Which ONE of the following scrams **IS REQUIRED** by Reactor Technical Specifications?

a. Percent Power, High Flux in the Pulse Mode

b. Steady State Timer

c. Manual Scram Bar

d. Loss of AC Voltage

QUESTION (C.1) [1.0]
Which RAMs are connected to a back-up power supply?

a. All reactor RAMs

b. R-1 only

c. R-5 only

d. R-1 and R-5

QUESTION (C.2) [1.0]
When the console is first turned on with the lead shield doors closed, a warning horn will sound in:

a. The exposure room nearest the core

b. The exposure farthest from the core

c. Both exposure rooms

d. Neither exposure room

QUESTION (C.3) [1.0]
Hot radioactive waste drains at AFRRI are color coded:

a. Blue

b. Black

c. Red

d. Yellow

QUESTION (C.4) [1.0]
Criticality dosimeters (mounted on red wooden plaques) measure neutron exposures above ____ and gamma exposures above _____.

a. 1 Rad, 50 Rad

b. 10 Rad, 50 Rad

c. 10 Rad, 100 Rad

d. 100 mR, 500 mR

QUESTION (C.5) [1.0]
The samarium wafer in the fuel rods is used to:

a. Mechanically isolate the graphite from the fuel to prevent carbon from changing the physical properties of the fuel lattice.

b. Minimize reactivity changes resulting from fission-product buildup and fuel burnup.

c. Increase the rigidity of the fuel elements.

d. Reduce thermal stress on the fuel clad during pulsing operations.

QUESTION (C.6) [1.0]
In case of a large water loss from the pool, the connection in the primary water system for an emergency fill line is located in:

a. Room 3152 near still

b. Room 2158 near primary pump

c. Reactor room near pool

d. room 3430 near heat exchanger

QUESTION (C.7) [1.0]
The maximum setting for the pulse timer is:

a. 1 second

b. 3 seconds

c. 10 seconds

d. 15 seconds

QUESTION (C.8) [2.0]
Match each of the following radiation detectors found within the facility with its respective detector type.

a.	Continuous Air Monitor (CAM)	1.	BF-3 Neutron Detector
b.	Stack Gas Monitor (SGM)	2.	Geiger-Mueller Detector
c.	Remote Area Monitors (RAM)	3.	Scintillation Detector
d.	Criticality Monitoring System(R-5)	4.	Ion Chamber

QUESTION (C.9) [2.0]
Match the pressure to the system

a.	Primary discharge pressure	1.	12 psi
b.	Shield door bearing air	2.	80 psi
c.	Normal air compressor tank	3.	27.5 psi
d.	Transient rod air	4.	9 psi
		5.	21.5 psi
		6.	100 psi

QUESTION (C.10) [1.0]
Which one of the following statements is FALSE?

a. During times of maintenance, the Primary water system can bypass the heat exchanger through valves.

b. In the event the reactor still breaks down, makeup water can be added to the tank by using the millipore system.

c. A 66 gallons lost will cause the pool level to decrease by one inch.

d. In the event of a leak downstream of the Primary pump, excessive drainage of the pool is prevented by siphon breaks.

QUESTION (C.11) [1.0]
A minimum loss of ___ inches of water from the reactor pool will activate the lobby audio alarm.

a. 2

b. 4

c. 6

d. 19.5

QUESTION (C.12) [1.0]
The prefilter and roughing filters are changed when the differential pressure across them has increased to approximately ____ inches of water.

a. 1.00

b. 2.00

c. 3.00

d. 7.00

QUESTION (C.13) [1.0]
Which ONE of the following describes the operation of the interlock system for the lead shielding doors?

a. The limit switches on the reduction gears provide only indication and are not part of the interlock system.

b. The control rod magnets cannot be energized unless the shielding doors are fully open.

c. The shield doors must be full open to move the core support carriage to the mid-pool region.

d. Fuel support carriage stops 6 inches prior to reaching the fully closed doors.

QUESTION (C.14) [1.0]
Which ONE of the following fission products are most likely to be released from the POOL following a fuel element failure?

a. Heavy Metals and argon

b. Low Z materials and uranium

c. Noble gases and Iodine

d. Transuranium elements and zirconium

QUESTION (C.15) [1.0]
Which one of the following set of devices is tested when the TRIGA control system is in the PRESTART mode?

a. - Fuel temperature scram circuits
- NM1000 scram circuits
- Interlock preventing control rod withdrawal with low neutron level

b. - DAC Watchdog timer
- NPP High Voltage Scram
- NM1000 power level calibration

c. - Interlock preventing simultaneous withdrawal of two control rods
- Fuel temperature scram circuits
- NPP1000 High % power scram

d. - NM1000 scram circuits
- Key Switch in the OFF position
- DAC Watchdog timer

QUESTION (C.16) [1.0]
Which one of the conditions will NOT prevent rod withdrawal?

a. While conducting a reactor startup, the reactor operator notices a loss of high voltage to the high flux safety channel one.

b. The reactor operator selects pulse mode and attempts to withdraw the shim rod.

c. Rods are being pulled for a reactor startup. Source count is 0.1 cps.

d. The demin inlet temperature is 40°C.

QUESTION (C.17) [1.0]
Which one of the following is measured by sensors in the "water box" at the entrance of the water purification loop?

a. Water pH

b. Water gamma radioactivity

c. Water pressure

d. Water turbidity

QUESTION (C.18) [1.0]
The Stack Gas Monitor detects:

a. O-19

b. Ar-41

c. N-16

d. Xe-135

ANSWER (A.1)
b
REFERENCE (A.1)
As stated on the rod worth curves, the Safety rod is worth \$2.205
Therefore the reactor is shutdown by \$5.36 - \$2.205 = \$3.155 after safety rod withdrawal.
$CR_1 (1 - keff)_1 = CR_2 (1 - keff)_2$ $CR_2 = CR_1 (1 - keff)_1 / (1 - keff)_2$
Keff= 1/1-ρ where ρ=\$ x β
$Keff_1$= 1/1-(5.36 x 0.007) = 1.0390
$Keff_2$= 1/1-(3.155 x 0.007)= 1.0226
$CR_2 = CR_1 \left(\frac{1 - 1.0390}{1 - 1.0226}\right)$
= 1726 cpm

ANSWER (A.2)
a
REFERENCE (A.2)
$P = P_o e^{(t/\tau)} \Rightarrow t \sim \ln(P/P^o)$
ln 6 > ln 2 > ln (35/20) > ln (3/2)

ANSWER (A.3)
a
REFERENCE (A.3)
$P_f = P_o e^{(t/\tau)} \Rightarrow t = \tau (\ln P_f/P_o) \Rightarrow t = 5$ sec (ln 250000 w/100 w) ≈ 40 sec

ANSWER (A.4)
d
REFERENCE (A.4)

ANSWER (A.5)
b
REFERENCE (A.5)
Glasstone, S. and Sesonske, A, *Nuclear Reactor Engineering,* Kreiger Publishing, Malabar, Florida, 1991, § 5.47, p. 246.
Lamarsh, J.R., *Introduction to Nuclear Engineering,* Addison-Wesley Publishing, Reading, Massachusetts, 1983. § 7.1, p. 289.
$P_f=P_o 10^{SUR(t)} \rightarrow t=\log(P_f/P_o)/SUR$ where SUR= -1/3 dpm

ANSWER (A.6)
b
REFERENCE (A.6)
Glasstone, S. and Sesonske, A, *Nuclear Reactor Engineering,* Kreiger Publishing, Malabar, Florida, 1991, §§ 3.161 — 3,163, pp. 190 & 191.

ANSWER (A.7)
c
REFERENCE (A.7)
Glasstone, S. and Sesonske, A, *Nuclear Reactor Engineering*, Kreiger Publishing, Malabar, Florida, 1991, § 2.183, p. 107.

ANSWER (A.8)
d
REFERENCE (A.8)
Glasstone, S. and Sesonske, A, *Nuclear Reactor Engineering*, Kreiger Publishing, Malabar, Florida, 1991, § 3.161 — 3.163, pp. 190 — 191.
$CR_1/CR_2 = (1 - K_{eff2})/(1 - K$
$1/32\ (1 - 0.95) = 1 - K_{eff2}$
$1 - 0.05/32 = K_{eff2}$
$K_{eff2} = 0.9984$

ANSWER (A.9)
d
REFERENCE (A.9)
Glasstone, S. and Sesonske, A, *Nuclear Reactor Engineering*, Kreiger Publishing, Malabar, Florida, 1991, § 3.161 — 3.163, pp. 190 — 191.
$C.R. = S/(1 - K_{eff}) \rightarrow C.R. = 100/(1 - 0.8) = 100/0.2 = 500$

ANSWER (A.10)
a
REFERENCE (A.10)
Glasstone, S. and Sesonske, A, *Nuclear Reactor Engineering*, Kreiger Publishing, Malabar, Florida, 1991, § 6.28, p. 337.

ANSWER (A.11)
a
*REFERENCE
"Nuclear Reactor Engineering" Army Manual - pgs. 11-23
AFRII Question Bank Cat. A

ANSWER (A.12)
b, c
REFERENCE (A.12)
Training Manual Ch. 6, Reactor Physics, Sect. 6.2.2, pg. 6-11

ANSWER (A.13)
b
REFERENCE (A.13)
Glasstone, S. and Sesonske, A, *Nuclear Reactor Engineering*, Kreiger Publishing, Malabar, Florida, 1991, §§ 2.70 — 2.74, pp. 65 -- 66.

ANSWER (A.14)
c
REFERENCE (A.14)
Glasstone, S. and Sesonske, A, *Nuclear Reactor Engineering,* Kreiger Publishing, Malabar, Florida, 1991, §§ 2.70 — 2.74, pp. 65 -- 66.

ANSWER (A.15) **DELETED**
d
REFERENCE (A.15)
Glasstone, S. and Sesonske, A, *Nuclear Reactor Engineering,* Kreiger Publishing, Malabar, Florida, 1991, § 5.51, p. 248.

$\tau = \ell^*/\rho$ $\quad \ell^* = 5 \times 10^{-5}$ seconds $\quad \rho \approx .007$
$\tau = 5 \times 10^{-5}/0.007 = 0.00714$ sec
$P_f/P_0 = e^{t/\tau}$ $\rightarrow P_f/P_0 = e^{1/0.00714} = 6.33 \times 10^{60}$

ANSWER (A.16)
a
REFERENCE (A.16)
Reference Package for the TRIGA Mark-F, Reference Equations.

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

ANSWER (A.17)
b
REFERENCE (A.17)
AFRRI Question Bank Cat. A
$I = I_0 e^{-\mu x}$ $\quad I/I_0 = 0.25 = e^{-(0.089)(2.35)\chi}$
$0.25 = e{-}0.2091\chi$ $\quad \ln(0.25) = \ln(e^{-0.2091\chi})$
$-1.386 = -0.2091\chi$ $\quad \chi = 6.628$ cm

ANSWER (A.18)
c
REFERENCE (A.18)
Reference Package for the AFRRI TRIGA Mark-F.
Tank constant = 1.48 °C/100 KWH

ANSWER (A.19)
c
REFERENCE (A.19)
AFRRI Reference Package, Fundamentals of Nuclear Reactor Engineering p. 64-72.

ANSWER (A.20)
a
REFERENCE (A.20)
Power Coefficient of Reactivity curve

ANSWER (B.1)
c
REFERENCE (B.1)
Operational Procedure 1, Tab A

ANSWER (B.2)
d
REFERENCE (B.2)
AFRRI Technical Specifications Definitions pg. 1

ANSWER (B.3)
a
REFERENCE (B.3)
Emergency Plan, Section 7.0, pg. 7-1

ANSWER (B.4)
c
REFERENCE (B.4)
Operational Procedure 6

ANSWER (B.5)
a
REFERENCE (B.5)
$I_1D_1^2 = I_2D_2^2$
(120 mR/hr)(1 ft)^2 / (2 ft)^2 = 30 mR/hr

ANSWER (B.6)
a
REFERENCE (B.6)
D = 6CEN/R^2 R^2 = 6(15 x 10^{-3} Ci)(0.412 MeV)/0.005 R^2 = 7.4
R = 2.7

ANSWER (B.7)
d
REFERENCE (B.7)
10CFR20.1601(a)(3)

ANSWER (B.8)
a
REFERENCE (B.8)
10CFR55.53(e)

ANSWER (B.9)
c
REFERENCE (B.9)
AFRRI T.S., pg. 2, Definition 1.15

ANSWER (B.10)
d
REFERENCE (B.10)

4 inch = 1/10 (6/60) shielding value layer.
1 inch = $10 \times 10^{-0.25}$ = .56 shielding value layer or: I/Io = e(-ux)
Shielded dose = 6 mrem/hr x .56 = 3.37 mrem/hr

ANSWER (B.11)
d
REFERENCE (B.11)
10CFR20.1201(a)(1)
$5000 \text{ mr} \times \frac{1 \text{ hr}}{10 \text{ mr}} \times \frac{\text{day}}{4 \text{ hr}} = 125 \text{ days}$

ANSWER (B.12)
d
REFERENCE (B.12)
AFRRI Emergency Response Guidebook, pg. 17
AFRRI Question Bank Cat. C

ANSWER (B.13)
a
REFERENCE (B.13)
AFRRI Emergency Plan pg. 3-5, Section 3.1.1

ANSWER (B.14)
c
REFERENCE (B.14)
AFRRI Emergency Plan, Section 6.4.3

ANSWER (B.15)
c
REFERENCE (B.15)
Emergency Plan, Section 6.2

ANSWER (B.16)
b
REFERENCE (B.16)
T.S. 4.2.5

ANSWER (B.17)
c
REFERENCE (B.17)
AFRRI Question Bank Cat. B
AFRRI Manual 82-1, Chapter 5, Sect. A

ANSWER (B.18)
d
REFERENCE (B.18)
Operational Procedure 8, Tab E

ANSWER (B.19)
b
REFERENCE (B.19)
AFRRI TRIGA MARK-F Technical Specifications Section 3.3.a, pg 12

ANSWER (B.20)
c
REFERENCE (B.20)
AFRRI supplied question qa55, also Reactor Tech. Specs.

ANSWER (C.1)
a
REFERENCE (C.1)
AFRRI Question Bank Cat. B

ANSWER (C.2)
a
REFERENCE (C.2)
AFRRI Question Bank Cat. B

ANSWER (C.3)
c
REFERENCE (C.3)
SAR, Fig. 3-7

ANSWER (C.4)
a
REFERENCE (C.4)
SAR, pg. 3-33, Section 3.6.5

ANSWER (C.5)
b
REFERENCE (C.5)
SAR, pg. 12

ANSWER (C.6)
b
REFERENCE (C.6)
SAR Section 3.3.1, Figures 3-2 and 3-6

ANSWER (C.7)
d
REFERENCE (C.7)
T.S.3.2.2

ANSWER (C.8)
a. 2 b. 3 c. 3 d. 3
REFERENCE (C.8)
Operations Manual Ch. 6

ANSWER (C.9)
a. 5 b. 4 c. 6 d. 2
REFERENCE (C.9)
Oper. Proc. 8 Tab B

ANSWER (C.10)
a
REFERENCE (C.10)
As-built drawings for Reactor Area, M-1, SAR Sect. 3.3.3

ANSWER (C.11)
c
REFERENCE (C.11)
SAR Sect. 3.3.6

ANSWER (C.12)
a
REFERENCE (C.12)
TRIGA Tracker - Maintenance - M041

ANSWER (C.13)
c
REFERENCE (C.13)
AFRRI TRIGA MARK-F Safety Analysis Report Section 4.3, pg 4-5

ANSWER (C.14)
c
REFERENCE (C.14)
AFRRI TRIGA MARK-F Safety Analysis Report Section 6.3.2.2, pg 6-19

ANSWER (C.15)
b
REFERENCE (C.15)
GA Control Console Operator's Manual pg. 2-5

ANSWER (C.16)
d
REFERENCE (C.16)
Operations Manual ch. 5

ANSWER (C.17)
b
REFERENCE (C.17)
SAR 3.3.3

ANSWER (C.18)
b
REFERENCE (C.18)
SAR Section 3.6.3