

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

REPORT NO.: 50-151/OL-94-01
FACILITY DOCKET NO.: 50-151
FACILITY LICENSE NO.: R-115
FACILITY: University of Illinois
EXAMINATION DATES: October 25-26, 1994
EXAMINER: Patrick Isaac, Chief Examiner
SUBMITTED BY: Patrick Isaac 11/15/94
Patrick Isaac, Chief Examiner Date
APPROVED BY: David J. Lange 11/22/94
David J. Lange, Chief Date
Program Development and NPR Exam Section
Operator Licensing Branch
Division of Reactor Controls
and Human Factors
Office of Nuclear Reactor Regulation

SUMMARY:

On October 25, 1994 the NRC administered written examination and operating tests to three Senior Reactor Operator Instant (SROI) candidates. One candidate failed one section of the written examination. All other applicants passed all portions of the examination.

ENCLOSURE 1

REPORT DETAILS

1. Examiners:

Patrick Isaac, Chief Examiner

2. Results:

	<u>RO</u> <u>(Pass/Fail)</u>	<u>SRO</u> <u>(Pass/Fail)</u>	<u>Total</u> <u>(Pass/Fail)</u>
NRC Grading:	N/A	2/1	2/1

3. Written Examination:

The written examination was administered on October 25, 1994 to three SROI candidates. A copy of the master "as given" examination with answer key was given to the licensee's training staff for their formal review.

During the review of the written examination the facility's training staff identified to the NRC examiner a discrepancy in the facility's SAR which renders question C-17 invalid. The candidates were asked to disregard question C-17. The facility's training staff also requested that the following changes be made to the examination answer key:

- Question B-11 - Accept both answers "a" and "d" as correct.
- Question C-10 - Change the correct answer to "a".

The Chief Examiner agreed with the staff comments and the examination answer key will be corrected to reflect the above requested changes.

One candidate failed Section B of the written examination. The other two candidates passed all three sections of this examination.

4. Operating Tests:

Operating tests were administered on October 26, 1994 to three SROI candidates. A facility licensed SRO was present for and supervised all reactor operations. There were no generic deficiencies identified by the examiner.

All candidates passed the operating tests.

5. Exit Meeting:

An exit meeting was held on October 26, 1994. The Chief Examiner informed the facility's representatives that the results of the examinations would be forwarded to them following the grading of the examinations and NRC management review.

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

FACILITY: Univ. of Illinois
 REACTOR TYPE: TEST
 DATE ADMINISTERED: 1994/10/24
 REGION: II
 CANDIDATE: _____

INSTRUCTIONS TO CANDIDATE:

Answers are to be written on the answer sheet provided. Attach the answer sheets to the examination. Points for each question are indicated in paren-theses for each question. A 70% overall is required to pass the examination. Examinations will be picked up three (3) hours after the examination starts.

<u>CATEGORY VALUE</u>	<u>% OF TOTAL</u>	<u>CANDIDATE'S SCORE</u>	<u>% OF CATEGORY VALUE</u>	<u>CATEGORY</u>
<u>20.00</u>	<u>33.90</u>	_____	_____	A. REACTOR THEORY, THERMODYNAMICS AND FACILITY OPERATING CHARACTERISTICS
<u>20.00</u>	<u>33.90</u>	_____	_____	B. NORMAL AND EMERGENCY OPERATING PROCEDURES AND RADIOLOGICAL CONTROLS
<u>19.00</u>	<u>32.20</u>	_____	_____	C. PLANT AND RADIATION MONITORING SYSTEMS
<u>59.00</u>		_____	_____ %	TOTALS
		<u>FINAL GRADE</u>		

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

CANDIDATE'S SIGNATURE

ENCLOSURE 2

NRC RULES AND GUIDELINES FOR LICENSE EXAMINATIONS

During the administration of this examination the following rules apply:

1. Cheating on the examination means an automatic denial of your application and could result in more severe penalties.
2. After the examination has been completed, you must sign the statement on the cover sheet indicating that the work is your own and you have not received or given assistance in completing the examination. This must be done after you complete the examination.
3. Restroom trips are to be limited and only one candidate at a time may leave. You must avoid all contacts with anyone outside the examination room to avoid even the appearance or possibility of cheating.
4. Use black ink or dark pencil only to facilitate legible reproductions.
5. Print your name in the blank provided in the upper right-hand corner of the examination cover sheet.
6. Fill in the date on the cover sheet of the examination (if necessary).
7. Print your name in the upper right-hand corner of the first page of each section of your answer sheets.
8. Before you turn in your examination, consecutively number each answer sheet, including any additional pages inserted when writing your answers on the examination question page.
9. The point value for each question is indicated in parentheses after the question.
10. Partial credit will NOT be given.
11. If the intent of a question is unclear, ask questions of the examiner only.
12. When you are done and have turned in your examination, leave the examination area as defined by the examiner. If you are found in this area while the examination is still in progress, your license may be denied or revoked.

EQUATION SHEET

$$Q = m c_p \Delta T$$

$$Q = m \Delta h$$

$$Q = UA \Delta T$$

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

$$SUR = 26.06/\tau$$

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

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

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

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

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

$$\rho = \Delta Keff/Keff$$

$$\bar{B} = 0.0073$$

$$DR_1 D_1^2 = DR_2 D_2^2$$

$$DR = \frac{6CiE(n)}{R^2} \quad DR = \quad , Ci = \text{Curies}, E = \text{Mev}, R = \text{feet}$$

$$RR = I * N * f$$

$$SCR = S/(1-Keff)$$

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

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

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

$$SDM = (1-Keff)/Keff$$

$$Pwr = W_f m$$

$$\ell^* = 1 \times 10^{-4} \text{ seconds}$$

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

$$\rho = \bar{B}/[(\lambda_{eff} * \tau)] + 1$$

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

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

$$1 \text{ Curie} = 3.7 \times 10^{10} \text{ dps}$$

$$1 \text{ hp} = 2.54 \times 10^3 \text{ BTU/hr}$$

$$1 \text{ BTU} = 778 \text{ ft-lbf}$$

$$1 \text{ gal H}_2\text{O} \approx 8 \text{ lbm}$$

$$Cp (\text{H}_2\text{O}) = 0.146$$

$$1 \text{ kg} = 2.21 \text{ lbm}$$

$$1 \text{ Mw} = 3.41 \times 10^6 \text{ BTU/hr}$$

$$^\circ\text{F} = 9/5^\circ\text{C} + 32$$

$$^\circ\text{C} = 5/9 (^\circ\text{F} - 32)$$

$$Cp (\text{D}_2\text{O}) = 0.162$$

A. RX THEORY, THERMO & FAC OP CHARS

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 b ___

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

B. NORMAL/EMERG PROCEDURES & RAD CON

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 B *****)

C. PLANT AND RAD MONITORING SYSTEMS

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

QUESTION: 001 (1.00)

The fundamental design parameter which permits a TRIGA reactor system to operate safely during either steady-state or pulsing conditions is the large prompt negative temperature coefficient of reactivity. The largest contributor to this design parameter is:

- a. doppler effects
- b. core neutron spectrum-hardening
- c. core leakage
- d. formation of core voids

QUESTION: 002 (1.00)

A $1/M$ plot is being done on a subcritical reactor that is 90% fueled with irradiated fuel elements.

Which one of the following would be the expected response in neutron flux should the source be removed from the reactor?

- a. Decrease to zero since no fissions are occurring.
- b. Decrease to the level of spontaneous fissions.
- c. Decrease the exact amount equal to the strength of the source.
- d. Decrease to a level equal to spontaneous fission plus fissions cause by spontaneous neutrons.

(***** CATEGORY A CONTINUED ON NEXT PAGE *****)

QUESTION: 003 (1.00)

Which one of the following would be the effect on measured control rod worth from a FAILURE to remove the source while completing control rod calibrations by the Positive Period Method?

- a. Less than actual rod worth due to decrease in beta fraction.
- b. Greater than actual rod worth due to increase in beta fraction.
- c. Less than actual rod worth due to longer reactor period.
- d. Greater than actual rod worth due to shorter reactor period.

QUESTION: 004 (1.00)

Which one of the following explains why the fuel temperature coefficient is negative?

- a. Hydrogen atoms in the fuel vibrate more at the higher temperatures which increases the probability of absorption of neutrons in the zirconium.
- b. Hydrogen atoms in the fuel vibrate more at higher temperatures which results in less moderation of neutrons and a harder neutron flux.
- c. Hydrogen atoms in the fuel vibrate less at the higher temperatures which increases the probability of absorption of neutrons in the zirconium.
- d. Hydrogen atoms in the fuel vibrate less at higher temperatures which results in less moderation of neutrons and a harder neutron flux.

(***** CATEGORY A CONTINUED ON NEXT PAGE *****)

QUESTION: 005 (1.00)

Which one of the following is the PRIMARY source of Xenon formation in the reactor?

- a. Gamma decay of Promethium 149
- b. Beta decay of Iodine 135
- c. Directly from fission of Uranium 235
- d. Neutron absorption in Cesium 135

QUESTION: 006 (1.00)

Which one of the following defines the term Beta effective?

- a. Number of delayed neutrons causing fissions divided by the number of prompt neutrons causing fissions.
- b. Number of delayed neutrons divided by the number of prompt neutrons.
- c. Number of delayed neutrons divided by the total number of neutrons.
- d. Number of delayed neutrons causing fission divided by the total number of neutrons causing fissions.

QUESTION: 007 (1.00)

Which one of the following factors affects the size of the delayed neutron fraction in the reactor?

- a. Power level
- b. Temperature of the fuel
- c. Type of fuel
- d. Fuel to moderator ratio

(***** CATEGORY A CONTINUED ON NEXT PAGE *****)

QUESTION: 008 (1.00)

The TRIGA reactor uses Radium-Beryllium and Antimony-Beryllium external neutron sources.

Which one of the following are the respective characteristics required for these neutron sources to produce the neutron emitting reaction?

- a. Gamma AND Beta emitters
- b. Beta AND Proton emitters
- c. Proton AND Alpha emitters
- d. Alpha AND Gamma emitters

QUESTION: 009 (1.00)

Which one of the following is equivalent to one (1) dollar of reactivity for the Triga Reactor?

- a. The Delayed Neutron Fraction (β_{eff}).
- b. The Prompt Neutron Fraction (β_{act}).
- c. The reactor period equivalent to a doubling time of one hundred (100) seconds.
- d. The half life of the shortest delayed neutron precursor.

QUESTION: 010 (1.00)

The Triga Reactor is subcritical with a known K_{eff} of 0.96. Which one of the following is the amount of reactivity that must be added to achieve exact criticality?

- a. \$0.0417
- b. \$0.571
- c. \$4.17
- d. \$5.71

(***** CATEGORY A CONTINUED ON NEXT PAGE *****)

QUESTION: 011 (1.00)

The Triga reactor is exactly critical. Which one of the following governs the reactor period following a positive reactivity insertion of a value greater than the delayed neutron fraction (β_{eff})?

- a. Thermal diffusion length
- b. Prompt neutron lifetime
- c. Shortest delayed neutron precursor
- d. Mean diffusion time

QUESTION: 012 (1.00)

The following condition exist:

1. Cobalt 60 ($Co60$) has undergone a nuclear reaction.
2. The new product is Nickel 60 ($Ni60$).
3. $Co60$ has an atomic weight of 60 and an atomic number of 27.
4. $Ni60$ has an atomic weight of 60 and an atomic number of 28.

Which one of the following reactions has occurred?

- a. $Co60$ beta plus decay to $Ni60$
- b. $Co60$ alpha decay to $Ni60$
- c. $Co60$ gamma decay to $Ni60$
- d. $Co60$ beta minus decay to $Ni60$

(***** CATEGORY A CONTINUED ON NEXT PAGE *****)

QUESTION: 013 (1.00)

In an operating TRIGA reactor, the effect of the xenon poison is different from that due to samarium because:

- a. While both poisons decay with their respective half lives after shutdown, the samarium poison decays with a shorter half life.
- b. The magnitude of the xenon poison effect is usually much smaller than that for samarium.
- c. The xenon poison will begin to decay twelve to 14 hours after reactor shutdown, whereas samarium poison will peak and its effects will remain indefinitely after shutdown.
- d. While both poisons decay after shutdown, xenon decays 12 times faster than samarium.

QUESTION: 014 (1.00)

Which one of the following is the primary method by which neutrons are moderated in light water?

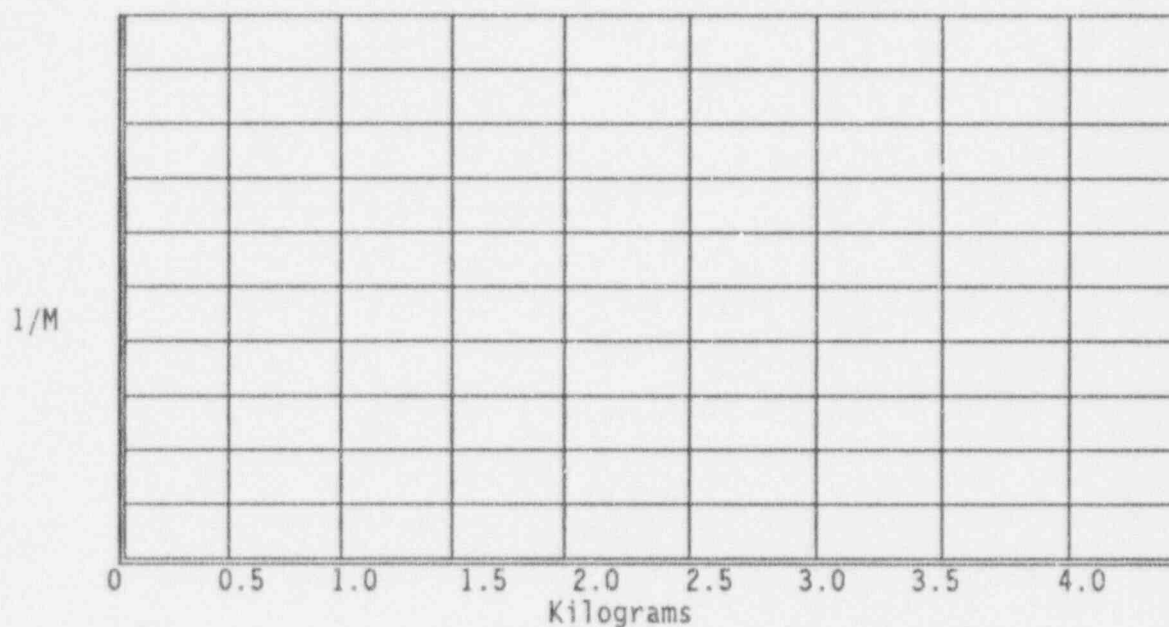
- a. Radiative capture
- b. Inelastic scattering
- c. Elastic scattering
- d. Charge particle reaction

(***** CATEGORY A CONTINUED ON NEXT PAGE *****)

QUESTION: 015 (1.00)

Experimenters are attempting to determine the critical mass of a new fuel material. Initial count rate is 100 counts/sec. As more fuel was added the following fuel to count rate data was taken:

Fuel	Count Rate
0.50 kg	500 c/sec
0.75 kg	1000 c/sec
1.00 kg	2400 c/sec
1.25 kg	5900 c/sec
1.50 kg	14000 c/sec

1/M PLOT

Which one (1) of the following is the amount of fuel needed for a critical mass?

- a. 1.5 kg
- b. 1.7 kg
- c. 2.1 kg
- d. 2.4 kg

(***** CATEGORY A CONTINUED ON NEXT PAGE *****)

QUESTION: 016 (1.00)

At 0800 hours the reactor power was 15 watts and a steady positive reactor period was established. At 0845 hours the reactor power had increased to 1000 kw.

Which one of the following is the reactor period for this power ascension (Assume NO temperature effects)?

- a. 243 sec
- b. 324 sec
- c. 642 sec
- d. 857 sec

QUESTION: 017 (1.00)

The reactor is not permitted to be pulsed from power levels above 250kw. The reason for this requirement is:

- a. The additional fast neutron flux from the pulse could dangerously embrittle fuel cladding.
- b. The additional heat from the pulse could cause pool temperature limits to exceed operating specifications.
- c. The additional thermal neutron flux from the pulse could dangerously embrittle fuel cladding.
- d. The additional heat from the pulse could cause fuel temperature limits to be exceeded.

(***** CATEGORY A CONTINUED ON NEXT PAGE *****)

QUESTION: 018 (1.00)

The reactor is at 1 MW when it is scrammed by the sudden insertion of 16.24 percent in reactivity. Which one of the following is the resulting power level from the prompt drop.

- a. 500 kw
- b. 390 kw
- c. 50 kw
- d. 39 watts

QUESTION: 019 (1.00)

Which one of the following control rods has the HIGHEST worth?

- a. Fast transient rod
- b. Regulating rod
- c. Safety rod in "B" hexagonal
- d. Safety rod in "E" hexagonal

QUESTION: 020 (1.00)

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

- a. Spontaneous fissions
- b. Delayed neutron fissions
- c. Alpha fission product decay
- d. Beta fission product decay

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

QUESTION: 001 (1.00)

The Continuous Air Particulate Monitor (CAM) has alarmed and the exhaust air has failed to divert through the Charcoal Filters.

Which one of the following actions is necessary to divert the exhaust air flow?

- a. Isolate the air supply to the dampers.
- b. Open the circuit breaker for the Exhaust System.
- c. Trip the exhaust fan.
- d. Trip a redundant monitor on the Tracerlab 5-Channel Geiger Tube System.

QUESTION: 002 (1.00)

The reactor is operating at 250 kW.

Which one of the following statements related to access to the reactor top is correct?

- a. Visitors are NOT allowed at the reactor top if reactor power is 250 kW.
- b. At 250 kW the maximum time permitted is 5 minutes.
- c. At 250 kW the maximum time permitted is 20 minutes
- d. At 250 kW the maximum time permitted is 30 minutes

QUESTION: 003 (1.00)

The reactor is operating at 1.2 MW. An operator must enter the reactor well. Which one of the following is the MINIMUM required radiation monitoring requirements for this entry?

- a. Film badge ONLY
- b. Film badge AND self-reading personnel monitoring device
- c. Film badge AND alarming dosimeter
- d. Film Badge AND Health Physics personnel monitoring

QUESTION: 004 (1.00)

Which one of the following will be cause to shutdown the UIUC TRIGA reactor which is operating at 250 kw for training?

- a. Two non secured experiments, each worth \$1.35, are suspended in the reactor tank 1 foot above the core.
- b. The ventilation exhaust blower is taken out of service for 3 hours to lubricate the filter diversion valve.
- c. The total of the absolute values of the reactivity worth of all experiments in the reactor is \$3.25
- d. A fuel temperature detector is bypassed for 15 minutes to perform a channel check.

QUESTION: 005 (1.00)

Which one of the following limits is imposed on the use of the Sample Handling Tool?

- a. Never insert into the Lazy Susan when reactor power is greater than 3 kW.
- b. Never insert into the Central Thimble when neutron flux is greater than 3×10^3 neutrons per cm squared-sec.
- c. Never withdraw from the Lazy Susan until the sample has decayed for ten (10) minutes.
- d. Never withdraw from the Central Thimble until dose rate are less than 100 mRem at one (1) foot.

QUESTION: 006 (1.00)

The reactor is operating at 1 MW when fuel damage is noted. Dose rates in the Reactor Building are such that an evacuation is necessary.

Which one of the following individuals by title is responsible for initiating the building evacuation per The University Of Illinois "Radiation Emergency Plan"?

- a. Licensed Reactor Operator
- b. Reactor Health Physicist
- c. Reactor Laboratory Director
- d. Reactor Supervisor

QUESTION: 007 (1.00)

Which one of the following pieces of portable radiation monitoring equipment is capable of surveying dose rates as high as 100 R/hr?

- a. Geiger-Mueller detector
- b. Ion Chamber
- c. Snoopy Survey Meter
- d. Digital Dosimeter

QUESTION: 008 (1.00)

Which one of the following areas is restricted to all individuals with the exception of Reactor Staff personnel?

- a. Mechanical Equipment Room
- b. High Level Radioactive Storage area
- c. Fuel Storage area
- d. The Vault

QUESTION: 009 (1.00)

Which one of the following describes how a film badge detects and measures neutron radiation?

- a. Silver atoms in the film are activated by neutron absorption.
- b. Heavy isotopes of hydrogen are formed in the film due to neutron absorption.
- c. The density of the film badge is changed due to neutron absorption.
- d. Elastic collisions between neutrons and hydrogen nuclei in the film badge wrapper leave tracks in the film.

QUESTION: 010 (1.00)

Which one of the following is the Basis for requiring a MINIMUM of three (3) gpm Emergency Cooling System flow?

- a. Sufficient to remove the decay heat generated by fission product decay without causing fuel damage.
- b. Sufficient to remove the decay heat generated by fissions from delayed neutron precursors without causing fuel damage.
- c. Sufficient to restore pool level following an accident during which a beam port was sheared.
- d. Sufficient to restore pool level following an accident during which a Primary Cooling line was sheared.

QUESTION: 011 (1.00)

The following conditions exist:

1. A sample has been sent through the Pneumatic Transfer (RABBIT) System MANUALLY.
2. The sample is now ready for discharge from the core.
3. The IN TRANSIT TO light is NOT lit.

Which one of the following is the FIRST action required in order to retrieve the activated sample?

- a. Reset the amplifier in Room 222.
- b. Reset Breaker No. 2 on the electrical distribution panel in Room 222.
- c. Place the Timer Return switch to the OFF position.
- d. Place the Manual Carrier Control switch to the RETURN position.

QUESTION: 012 (1.00)

Which one of the following of the reactor scram inputs is NOT active when in the SQUARE WAVE mode?

- a. Peak Reactor Power
- b. Watchdog
- c. Fuel Element Temperature
- d. Reactor period

QUESTION: 013 (1.00)

You have been assigned to decrease the dose rate being emitted by a point source. The dose rate is due to 1.5 Mev gamma. What thickness of lead will be required to decrease the dose rate by a factor of 10?

Given: Mass attenuation coefficient for lead @ 1.5 Mev = $0.051 \text{ cm}^2/\text{gram}$ and the density of lead is 11.4 gram/cm^3 .

- a. 0.2 cm
- b. 2 cm
- c. 4 cm
- d. 8 cm

QUESTION: 014 (1.00)

Which one of the following statements correctly describes the operations of the Bypass Switch associated with the Secondary Cooling System?

- a. When placed in the BYPASS No. 1 position secondary flow bypasses the #1 cooling tower.
- b. When placed in the BYPASS No. 2 position secondary flow partially bypasses the heat exchanger.
- c. When placed in the BYPASS BOTH position temperature and level interlocks are defeated when starting the Secondary pump.
- d. When placed in the BYPASS OFF position the Primary pump may be started without the Secondary pump operating.

QUESTION: 015 (1.00)

An operator is working in an area where the dose rate is 50 mRem/hr. Which one of the following is the expected MINIMUM Radiation Posting for the area?

- a. RADIATION AREA
- b. HIGH RADIATION AREA
- c. VERY HIGH RADIATION AREA
- d. RESTRICTED AREA

QUESTION: 016 (1.00)

Which one of the following is the basis for the Technical Specification Safety Limit associated with Low Hydride Fuel Elements?

- a. Ensures phase change in the zirconium hydride which can cause distortion of the fuel element does not occur.
- b. Ensures phase change in the zirconium hydride which results in melting at the centerline of the fuel element does not occur.
- c. Ensures fission product gas pressure is below that which can cause cladding failure.
- d. Ensures hydrogen gas pressure is below that which can cause cladding failure.

QUESTION: 017 (1.00)

Which one of the following is a violation of Technical Specifications with regard to conducting a SUBCRITICAL experiment?

- a. The effective multiplication factor (keff) for a new Triga fuel element configuration is 0.97.
- b. A safety control rod with scram capability based on neutron flux level is used for a new Triga fuel element configuration with an expected keff of 0.90.
- c. The reactor is used for the initial source of neutrons for a natural uranium fuel configuration.
- d. The Inverse Multiplication Method is used to predict the critical mass of a new natural uranium fuel configuration.

QUESTION: 018 (1.00)

Which one of the following is the PRIMARY reason for maintaining Primary Cooling water conductivity below 4 micromho/cm?

- a. Prevents chloride stress corrosion in the stainless steel fuel cladding.
- b. Prevents dissolution of oxide layer on the stainless steel fuel cladding.
- c. Limits radiation levels associated with N-16 activity in the Primary Cooling water.
- d. Limits radiation levels associated with activation of impurities in the Primary Cooling water.

QUESTION: 019 (1.00)

Which one of the following defines the MINIMUM condition for REACTOR SHUTDOWN per Technical Specifications 1.0, "Definitions"?

- a. The control key is in the OFF position.
- b. All safety rods are fully inserted in the core.
- c. Shutdown Margin is \$1.00 with two (2) control rods fully withdrawn from the core.
- d. Neutron count rate is less than two (2) cps as indicated on the Source Range detector.

QUESTION: 020 (1.00)

The following conditions exist:

1. On Saturday, October 22, 1994 the reactor was started and the shutdown reactivity for the cold, xenon-free condition was measured to be \$0.75.
2. The reactor operated for forty eight (48) hours with a burnup of \$0.04.
3. The reactor was then shutdown and an unsecured experiment worth +\$0.30 reactivity was added to the core.
4. At 0900 hours on October 24 the shutdown reactivity was calculated.
5. At 0900 hours Xenon worth was \$1.00.

Which one of the following is the shutdown reactivity at 0900 hours?

- a. \$0.49
- b. \$0.79
- c. \$1.49
- d. \$1.79

QUESTION: 001 (1.00)

Which one of the following is the reason the Fast Transient Rod (FTR) contains double length of poison?

- a. Allows the rod to reach a constant velocity prior to leaving the core so positive reactivity addition is at a constant rate.
- b. The extra length allows for a more even flux shape when the rod is ejected.
- c. Allows the rod to reach a constant velocity when falling back into the core so negative reactivity addition is at a constant rate.
- d. The extra length allows for more negative reactivity addition when the rod falls back into the core.

QUESTION: 002 (1.00)

Which one of the following is the reason a polyethylene vial may NOT be irradiated in the Central Thimble at high power levels without special approvals?

- a. Large thermal neutron flux can cause excessive neutron activation.
- b. Excessive Gas pressure can cause the vials to explode.
- c. Excessive heat buildup can cause the vials to deform or melt.
- d. Fast neutron activation can cause the vials to become brittle.

QUESTION: 003 (1.00)

Which one of the following Pneumatic Transfer System conditions is indicated SPECIFICALLY by the CARRIER IN REACTOR light being illuminated in the Reactor Lab Control Room?

- a. The blower has been activated from Room 222.
- b. The Permission switch has been turned on.
- c. A sample has traversed past the photoelectric cell under the reactor ledge.
- d. A vacuum has been drawn in the sample chamber in the reactor core.

QUESTION: 004 (1.00)

Which one of the following is the reason Primary Purification flow in the purification loop is restricted to 1-2 gpm?

- a. Prevents streaming in the resin bed.
- b. Prevents resin carryover into the reactor pool.
- c. Extends the lifetime of the resin bed.
- d. Allows for greater reaction time in the resin bed.

QUESTION: 005 (1.00)

Which one of the following is the PRIMARY reason for the heater downstream of the Auxiliary Cooling Heat Exchanger and why is it set to maintain flow temperature at 35-40 degrees C?

- a. Heats Secondary water during times of low power operation so discharges to Boneyard Creek are maintained at a constant temperature.
- b. Heats Primary water during times of low power levels so tank water temperature is maintained at a constant temperature for reactivity measurements.
- c. Heats Secondary water to prevent shrinkage of tank welds which cause seepage of water into the tunnel and thermal column track.
- d. Heats Primary water to prevent shrinkage of tank welds which cause seepage of water into the tunnel and thermal column track.

QUESTION: 006 (1.00)

Which one of the following is the reason the Secondary Cooling System is always started prior to initiating Forced Convection Primary Cooling?

- a. To prevent thermal shock to the Primary piping.
- b. To prevent possible Primary to Secondary leakage.
- c. To allow controlled heatup of Primary piping.
- d. To allow for controlled heatup of Secondary Cooling Towers.

QUESTION: 007 (1.00)

The reactor is operating at 1.5 MW with the cooling towers in service. Which one of the following will result from OPENING the access doors to the cooling towers?

- a. A Secondary pump low flow trip that will result in a Primary flow trip which will scram the reactor.
- b. Loss of Secondary Coolant pressure which could result in primary to secondary leakage.
- c. Air entrainment in Secondary Coolant water which will result in oxidation of Secondary Coolant piping.
- d. Loss of vacuum in the cooling tower will result in loss of basin level.

QUESTION: 008 (1.00)

The following plant conditions exist:

1. The reactor is operating at 1 MW steady-state.
2. The North beam port is in use.

Which one of the following groups of radiation monitors satisfy MINIMUM requirements for continued operation per Technical Specifications 3.4, "Reactor Instrumentation"?

	Reactor Tank Monitor	Air Particulate Monitor	East-Wall ARM	Beam Port Monitor
a.	Yes	Yes	No	No
b.	No	No	Yes	Yes
c.	Yes	No	Yes	No
d.	Yes	Yes	Yes	Yes

QUESTION: 009 (1.00)

Which one of the following conditions will NOT allow the reactor control system to enter the Square Wave Ready State?

- a. Reactor power is less than 1 Kw
- b. Regulating rod "Down" light is illuminated
- c. Reactor period is 30 seconds
- d. The Square Wave Mode button is pushed in prior to positioning the ATR receiver

QUESTION: 010 (1.00)

Which one of the following conditions will AUTOMATICALLY close the Reactor Isolation valves?

- a. Reactor tank water level is fifteen (15) feet above the core.
- b. Primary flow is 2200 gpm.
- c. Control air pressure is 45 psi.
- d. Secondary flow is 1200 gpm.

(***** CATEGORY C CONTINUED ON NEXT PAGE *****)

QUESTION: 011 (1.00)

Which one of the following limits the amount of reactivity which is inserted by the Transient Rod?

- a. Solenoid valve adjustment
- b. Air pressure
- c. Cylinder position
- d. Initial rod position

QUESTION: 012 (1.00)

The reactor is operating at 0.75 MW.

Which one of the following signals will cause a reactor scram?

- a. Primary flow is 200 gpm.
- b. Secondary flow is 200 gpm.
- c. Core exit temperature is 135 degrees F.
- d. Secondary heat exchanger outlet temperature is 95 degrees F.

QUESTION: 013 (1.00)

Which one of the following statements describes how Primary temperature is controlled?

- a. Primary flow to the heat exchanger is throttled.
- b. Secondary flow to the heat exchanger is throttled.
- c. Secondary flow is diverted around the cooling towers.
- d. Primary flow is diverted around the heat exchanger.

QUESTION: 014 (1.00)

The reactor is operating in the Pulse Mode.

Which one of the following is an interlock in the Rod Control System that is applicable to this mode?

- a. No rod movement other than the transient rod is possible.
- b. No rod movement is possible above 250 kilowatts.
- c. The movement of either transient rod is prohibited when any other control rod is fully withdrawn.
- d. The movement of both transient rods is physically prohibited.

QUESTION: 015 (1.00)

Which one of the following does NOT discharge directly to the 500 gallon Liquid Waste Retention Tank?

- a. Clean-up sink
- b. Lab floor drains
- c. Main floor restroom sink
- d. Trench drain

QUESTION: 016 (1.00)

Which one of the following is the purpose of the Primary Coolant Delay Tanks?

- a. To assist in controlling pressure surges associated with closing isolation valves while at full flow conditions.
- b. To delay primary flow to allow for decay of N-16 activity prior to reaching the heat exchanger room.
- c. To provide sufficient backpressure for Primary pump operation to prevent cavitation during closure of isolation valves.
- d. To delay primary flow to allow for decay of fission product activity in the event of a fuel cladding leak prior to reaching the heat exchanger room.

QUESTION: 017 (1.00) *DELETED*

Which one of the following would result from loss of power to the DN Drive Windings to an individual control rod?

- a. Inability to move the control rod in INWARD direction.
- b. Outward rod movement at 24 inches per minute.
- c. Inward rod movement at 24 inches per minute.
- d. A reactor scram.

QUESTION: 018 (1.00)

Which one of the following provides the signal for the Reactor Period Scram Signal?

- a. Fission Chamber to the NP-1000 Safety Channel
- b. Ion Chamber to the NP-1000 Safety Channel
- c. Fission Chamber to the NM-1000 Wide Range Channel
- d. Ion Chamber to the NM-1000 Wide Range Channel

QUESTION: 019 (1.00)

Which one of the following conditions is indicated by the CRT rod display indicating MAGENTA while the Magnet box indicates BLACK?

- a. Control rod is at its lower limit and the magnet power circuit is energized.
- b. Control rod is at its lower limit and the magnet power circuit is de-energized.
- c. Control rod is at its upper limit and the magnet power circuit is energized.
- d. Control rod is at its upper limit and the magnet power circuit is de-energized.

QUESTION: 020 (1.00)

Which one of the following is indicated by the fuel temperature thermocouple?

- a. Fuel centerline temperature
- b. Zirconium rod temperature
- c. Fuel element cladding temperature
- d. Fuel element surface temperature

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

ANSWER: 001 (1.00)

b.

REFERENCE:

UIUC TRIGA Trng. Manual pg. 1-45
General Atomics Trng. Manual Sect. 6.3.3

ANSWER: 002 (1.00)

d.

REFERENCE:

1. Nuclear Reactor Laboratory, Experiment 2, page 1-62.

ANSWER: 003 (1.00)

d.

REFERENCE:

1. Nuclear Reactor Laboratory, Experiment 3, page 1-64.

ANSWER: 004 (1.00)

b.

REFERENCE:

1. Nuclear Reactor Laboratory, Experiment NE 451, page 1-69.

ANSWER: 005 (1.00)

b.

REFERENCE:

1. Reactor Theory, "Poisons".

ANSWER: 006 (1.00)

d.

REFERENCE:

1. "Training Notes", page 2.

ANSWER: 007 (1.00)

c.

REFERENCE:

1. "Training Notes", page 2.

ANSWER: 008 (1.00)

d.

REFERENCE:

1. "Training Notes", 2.A.IV, "Neutron Sources", page 4.

ANSWER: 009 (1.00)

a.

REFERENCE:

1. "Training Notes", 2.B.I.a., "Reactivity", page 7.

(***** CATEGORY A CONTINUED ON NEXT PAGE *****)

ANSWER: 010 (1.00)

d.

REFERENCE:

1. "Training Notes", 2.B.II., "Critical", page 7-8.
2. $\Delta k = (k_2 - k_1) / (k_2 * k_1)$
 $\Delta k = (1 - 0.96) / (1 * 0.96)$
 $\Delta k = 0.04 / 0.96 = 0.0417$
 $\Delta k = 0.0417 / 0.0073 = \5.71

ANSWER: 011 (1.00)

b.

REFERENCE:

1. "Training Notes", 2.B.III., "Supercritical", page 8.

ANSWER: 012 (1.00)

d.

REFERENCE:

1. "Introduction To Nuclear Engineering", Larmarsh, page 21.

ANSWER: 013 (1.00)

c.

REFERENCE:

UIUC Trng Materials pg. 1-32

ANSWER: 014 (1.00)

c.

REFERENCE:

1. "Introduction To Nuclear Engineering", Lamarsh, page 60.

ANSWER: 015 (1.00)

b.

REFERENCE:

1. "Introduction To Nuclear Engineering", Lamarsh, 2nd Edition, page 102.

ANSWER: 016 (1.00)

a.

REFERENCE:

1. "Introduction To Nuclear Engineering", Lamarsh, 2nd Edition, page 284.
2. $P(2) = P(1) * e^{(t/T)}$
 $1 \times 10E6 = 15 * e^{(2700/T)}$
 $2700/T = \ln(1 \times 10E6/15)$
 $T = 2700/11.107 = 243.08$

ANSWER: 017 (1.00)

d.

REFERENCE:

T.S. 3.1 Bases

ANSWER: 018 (1.00)

c.

REFERENCE:

1. "Introduction To Nuclear Engineering", Lamarsh, 2nd Edition, page 289.
2. $P2 = \text{betabar} * (1 - \text{roe}) * P1 / (\text{betabar} - \text{roe})$
 $P2 = 0.0073 * (1 + 0.1624) * 1000 / (0.0073 + 0.1624)$
= 50 kw

ANSWER: 019 (1.00)

b.

REFERENCE:

1. "Training Notes", 2.D.I., "Shutdown Margin And Excess Reactivity", page 11.

ANSWER: 020 (1.00)

d.

REFERENCE:

1. "Introduction To Nuclear Engineering", Lamarsh, 2nd Edition, page 350.

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

ANSWER: 001 (1.00)

b.

REFERENCE:

1. "Training Notes University Of Illinois Advanced Triga", Section 3.F., page 20.

ANSWER: 002 (1.00)

a.

REFERENCE:

1. "Rules And Regulations For The Operation Of The Nuclear Reactor", I.G.3., "Building Security".

ANSWER: 003 (1.00)

b.

REFERENCE:

1. "Rules And Regulations For The Operation Of The Nuclear Reactor", I.I., "Building Security".

ANSWER: 004 (1.00)

a.

REFERENCE:

Tech. Specs. 3.1.b

ANSWER: 005 (1.00)

a.

REFERENCE:

1. "Rules And Regulations For The Operation Of The Nuclear Reactor", VI., "Rules For Radioisotope Production".

ANSWER: 006 (1.00)

a.

REFERENCE:

1. "Radiation Emergency Plan", 4.4, "Radioactive Spill, High Offgas Activity, Or Fuel Damage", page 11 of 20.

ANSWER: 007 (1.00)

b.

REFERENCE:

1. "Radiation Emergency Plan", 6.2, "Radiation Monitoring Equipment", page 14 of 20.

ANSWER: 008 (1.00)

c.

REFERENCE:

1. "UIUC Nuclear Reactor Laboratory Physical Security Plan", page 5 of 12.

(***** CATEGORY B CONTINUED ON NEXT PAGE *****)

ANSWER: 009 (1.00)

d.

REFERENCE:

1. "Reactor Experiments", Health Physics - Nuclear Reactor, page 1-84.

ANSWER: 010 (1.00)

a.

REFERENCE:

1. Technical Specification 3.4, "Emergency Removal Of Decay Heat", page 30.
2. SAR, Section IV.C.3.c, "Emergency Spray Cooling", pages IV-50 to IV-59.

ANSWER: 011 (1.00)

a. / d.

REFERENCE:

1. "Use of the MRL Pneumatic Transfer (RABBIT) System", page 2.

ANSWER: 012 (1.00)

d.

REFERENCE:

1. "UIUC Operation and Maintenance Manual, Appendix A", page 5-3.

ANSWER: 013 (1.00)

c.

REFERENCE:

$$\mu = (0.051 \text{ cm}^2/\text{g}) \times 11.4 \text{ g/cm}^3 = 0.5814 \text{ cm}^{-1}$$

$$I = I_0 e^{-\mu x} \implies \ln(0.1) = -(0.5814) x$$

$$x = 2.3026/0.5814 = 3.9672 \approx 4$$

ANSWER: 014 (1.00)

c.

REFERENCE:

1. NRLOP-2, "Secondary Cooling System", page 1 of 4.

ANSWER: 015 (1.00)

a.

REFERENCE:

1. 10CFR20.1003

ANSWER: 016 (1.00)

a.

REFERENCE:

1. Technical Specification 2.1, "Safety Limit - Fuel Element Temperature", page 4.

ANSWER: 017 (1.00)

b.

REFERENCE:

1. Technical Specification 3.9, "Subcritical Experiments Using the Reactor Thermal Column or Bulk Shielding Facility", page 19.

ANSWER: 018 (1.00)

d.

REFERENCE:

1. SAR VJ.F, "Water Purification Loop", page VI-21.

ANSWER: 019 (1.00)

c.

REFERENCE:

1. Technical Specifications 1.0, "Definitions", page 1.

ANSWER: 020 (1.00)

c.

REFERENCE:

1. Technical Specifications 3.1, "Reactivity", page 8.

ANSWER: 001 (1.00)

a.

REFERENCE:

1. "Training Notes University Of Illinois Advanced Triga", Section 3.A.III, page 14.

ANSWER: 002 (1.00)

c.

REFERENCE:

1. "Training Notes University Of Illinois Advanced Triga", Section 3.B.I, page 14.

ANSWER: 003 (1.00)

c.

REFERENCE:

1. "Training Notes University Of Illinois Advanced Triga", Section 3.B.III, page 16.

ANSWER: 004 (1.00)

a.

REFERENCE:

1. "Training Notes University Of Illinois Advanced Triga", Section 3.C.I, page 17.

ANSWER: 005 (1.00)

d.

REFERENCE:

1. "Training Notes University Of Illinois Advanced Triga", Section 3.C.I, page 17.

ANSWER: 006 (1.00)

b.

REFERENCE:

1. "Training Notes University Of Illinois Advanced Triga", Section 3.C.II, page 18.

ANSWER: 007 (1.00)

a.

REFERENCE:

1. "Training Notes University Of Illinois Advanced Triga", Section 3.C.II, page 19.

ANSWER: 008 (1.00)

d.

REFERENCE:

1. XI.E.3., "Additional Radiation Monitoring Requirements", page XI-25.

(***** CATEGORY C CONTINUED ON NEXT PAGE *****)

ANSWER: 009 (1.00)

b.

REFERENCE:

UIUC Digital Console Operators Manual sect. 5 pg. 5-3

ANSWER: 010 (1.00)

a.

REFERENCE:

1. VII.B.7, "Fail Safe Due To Electrical Power Or Air Pressure Loss", page VII-24.

ANSWER: 011 (1.00)

c.

REFERENCE:

1. VII.B.3.b., "Control Rod Drives", page VII-17.

ANSWER: 012 (1.00)

c.

REFERENCE:

1. VII.B.5.d., "Coolant Temperatures", page VII-25

(***** CATEGORY C CONTINUED ON NEXT PAGE *****)

ANSWER: 013 (1.00)

c.

REFERENCE:

1. VII.B.9., "Heat Removal Control System", page VII-26.

ANSWER: 014 (1.00)

a.

REFERENCE:

1. VII.B.10., "Interlocks and Scrams", page VII-27.

ANSWER: 015 (1.00)

c.

REFERENCE:

1. XI.B.2., "Liquid Waste System Design and Evaluation", page XI-3.

ANSWER: 016 (1.00)

b.

REFERENCE:

1. SAR IV.A., "Design Basis", page IV-2.

(***** CATEGORY C CONTINUED ON NEXT PAGE *****)

ANSWER: 017 (1.00) **DELETED**

b.

REFERENCE:

1. SAR Amendment, "Question 6.", page 11.

ANSWER: 018 (1.00)

c.

REFERENCE:

1. UIUC Operation And Maintenance Manual Appendix D, "NM-1000 Functional Block Diagram".

ANSWER: 019 (1.00)

d.

REFERENCE:

1. UIUC Operation And Maintenance Manual Appendix D, page 1-29.

ANSWER: 020 (1.00)

a.

REFERENCE:

1. SAR III.C.2., "Core Assembly", page III-13.

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

A N S W E R K E Y

M U L T I P L E C H O I C E

- 001 o
- 002 d
- 003 d
- 004 b
- 005 b
- 006 d
- 007 c
- 008 d
- 009 a
- 010 d
- 011 b
- 012 d
- 013 c
- 014 c
- 015 b
- 016 a
- 017 d
- 018 c
- 019 b
- 020 d

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

A N S W E R K E Y

M U L T I P L E C H O I C E

- 001 b
- 002 a
- 003 b
- 004 a
- 005 a
- 006 a
- 007 b
- 008 c
- 009 d
- 010 a
- 011 a , d
- 012 d
- 013 c
- 014 c
- 015 a
- 016 a
- 017 b
- 018 d
- 019 c
- 020 c

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

ANSWER KEY

MULTIPLE CHOICE

001 a

002 c

003 c

004 a

005 d

006 b

007 a

008 d

009 b

010 a

011 c

012 c

013 c

014 a

015 c

016 b

017 b *DELETED*

018 c

019 d

020 a

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