September 15, 2010

Dr. Tatjana Jevremovic, Director
University of Utah Nuclear Research Reactor
50 South Central Drive
University of Utah
Salt Lake City, UT 84112

SUBJECT: INITIAL EXAMINATION REPORT NO. 50-407/OL-10-01, UNIVERSITY OF UTAH NUCLEAR TRIGA REACTOR

Dear Dr. Jevremovic:

During the week of August 9, 2010, the Nuclear Regulatory Commission (NRC) administered operator licensing examinations at your University of Utah TRIGA reactor. The examinations were conducted according to NUREG-1478, "Operator Licensing Examiner Standards for Research and Test Reactors," Revision 2. Examination questions and preliminary findings were discussed with those members of your staff identified in the enclosed report.

The NRC is very concerned with the written examination results for this examination. Both candidates failed with low scores as listed below:

Category	Candidate 1 Score	Candidate 2 Score
A. Reactor Theory, Thermodynamics and Facility Operating Characteristics	37.50%	50.00%
B. Normal and Emergency Operating Procedures and Radiological Controls	52.94%	41.18%
C. Facility and Radiation Monitoring Systems	65.63%	68.75%
Final Grade	52.04%	53.06%

In addition to the low written scores, both candidates showed generic weaknesses during their operating tests, with one of the candidates failing the operating test. The following generic weaknesses were noted during the administration of the operating tests:

- The candidates demonstrated a basic lack of understanding of 10 CFR 50.59 and how it relates to reactor safety.
- Although the candidates could provide the applicable dose rates, they were unfamiliar with the requirements of 10 CFR 20, and with sources of radioactivity at the facility.
- Both candidates had trouble describing the three nuclear instrumentation channels, which includes the two safety channels.
- Although both candidates were able to quickly reference the applicable procedures, they both demonstrated a lack of familiarity with those procedures. The candidates were

unable to explain calculations associated with the procedures. This was especially noted during reference to the power calibration, and the rod calibration procedures. Both candidates admitted to the examiner that they had neither trained on nor observed either the fuel inspection or the fuel measurement surveillances.

During the exit meeting the examiner stressed that the NRC expects the facility licensee to verify that all candidates are ready to take and pass an NRC administered examination. Facility licensee management signatures on the license application (NRC Form 396) certify that the candidate has successfully completed the facility licensee's training program to be licensed as an operator/senior operator pursuant to Title 10, Code of Federal Regulations, Part 55. It is the facility licensee's responsibility to withdraw applications or reschedule examinations for candidates who are not prepared well enough to pass the NRC administered examination.

The NRC is providing copies of the individual candidates' written examination answer sheets and the examiner's operating tests comments under a separate letter. This letter will not be released to the public. This letter will contain information identifying a number of generic and individual deficiencies which should have been identified by the facility licensee prior to submitting the candidate's applications. Please review these documents closely so as to be able to identify areas within your training program which must be modified to avoid a repeat of these results.

In order to assure that these identified deficiencies are being addressed, please provide a timely written response relating how you plan on addressing these concerns and a list of actions you will take to improve program performance, and specify how these actions will result in improved written examination scores and operating test pass rate.

In accordance with Title 10 of the *Code of Federal Regulations* Section 2.390, a copy of this letter and the enclosures will be available electronically for public inspection in the NRC Public Document Room or from the Publicly Available Records (PARS) component of NRC's Agencywide Documents Access and Management System (ADAMS). ADAMS is accessible from the NRC Web site at http://www.nrc.gov/reading-rm/adams.html. Should you have any questions concerning this examination, please contact Mr. John T. Nguyen at (301) 415-4007 or via internet e-mail John.Nguyen@nrc.gov.

Sincerely,

/RA/
Johnny H. Eads Jr., Chief
Research and Test Reactors Oversight Branch
Division of Policy and Rulemaking
Office of Nuclear Reactor Regulation

Docket No. 50-407

Enclosures:
1. Initial Examination Report No. 50-407/OL-10-01
2. Written examination

cc w/out encls: See next page

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DISTRIBUTION w/ encls:
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ADAMS Accession No: ML102440575

OFFICE	PRTB:CE		IOLB:LA	E	PRTB:BC
NAME	JNguyen		CRevelle		JEads
DATE	09/14/2010		09/15 /2010		09/14/2010

OFFICIAL RECORD COPY

cc:

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

REPORT NO.: 50-407/OL-10-01

FACILITY DOCKET NO.: 50-407

FACILITY LICENSE NO.: R-126

FACILITY: UNIVERSITY OF UTAH NUCLEAR RESEARCH REACTOR

EXAMINATION DATES: August 9, 2010

SUBMITTED BY: ***/RA/*** 09/14/2010
John T. Nguyen, Chief Examiner Date

SUMMARY:

During the week of August 9, 2010, the NRC administered operator licensing examinations to two senior operator licensing candidates. Both candidates failed the written examination and one candidate failed the NRC administered operating test.

REPORT DETAILS

1. Examiners: John T. Nguyen, Chief Examiner, NRC

2. Results:

	RO PASS/FAIL	SRO PASS/FAIL	TOTAL PASS/FAIL
Written	0/0	0/2	0/2
Operating Tests	0/0	1/1	1/1
Overall	0/0	0/2	0/2

3. Exit Meeting:
John T. Nguyen, Chief Examiner, NRC
Dr. Dong-Ok Choe, Reactor Supervisor, UUTR

The NRC examiner thanked the facility staff for their cooperation during the examination. The examiner discussed with the Reactor Supervisor regarding the training program and the generic weaknesses as mentioned above. The facility licensee had no comments on the written examination. The examiner noted that the candidates were very weak during their operating tests. The examiner also reminded the facility management that it is their responsibility to evaluate the candidates to ensure they are fully prepared for the examination, prior to NRC arrival.

U.S.NRC
UNITED STATES NUCLEAR REGULATORY COMMISSION
Protecting People and the Environment

UNIVERSITY OF UTAH TRIGA REACTOR

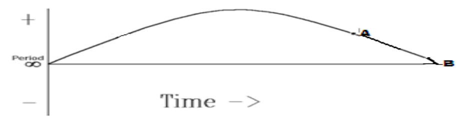
Operator Licensing Examination

Written Exam with Answer Key

August 9, 2010

ENCLOSURE 2

QUESTION A.01 [1.0 point]
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. increasing, then constant.

QUESTION A.02 [1.0 point]
Which **ONE** of the following will be the resulting stable reactor period when a 0.312 %Δk/k reactivity is inserted into an exactly critical reactor core? Given β = 0.007

a. 12 seconds

b. 24 seconds

c. 38 seconds

d. 50 seconds

QUESTION A.03 [1.0 point]
Which **ONE** of the following best describes the effects of moderator temperature increase on neutron multiplication?

a. Thermal non leakage increases and rod worth increases.

b. Thermal non leakage decreases and rod worth decreases.

c. Thermal non leakage decreases and rod worth increases.

d. Thermal non leakage increases and rod worth decreases.

QUESTION A.04 [1.0 point]
With a 30 second period, power would double in approximately:

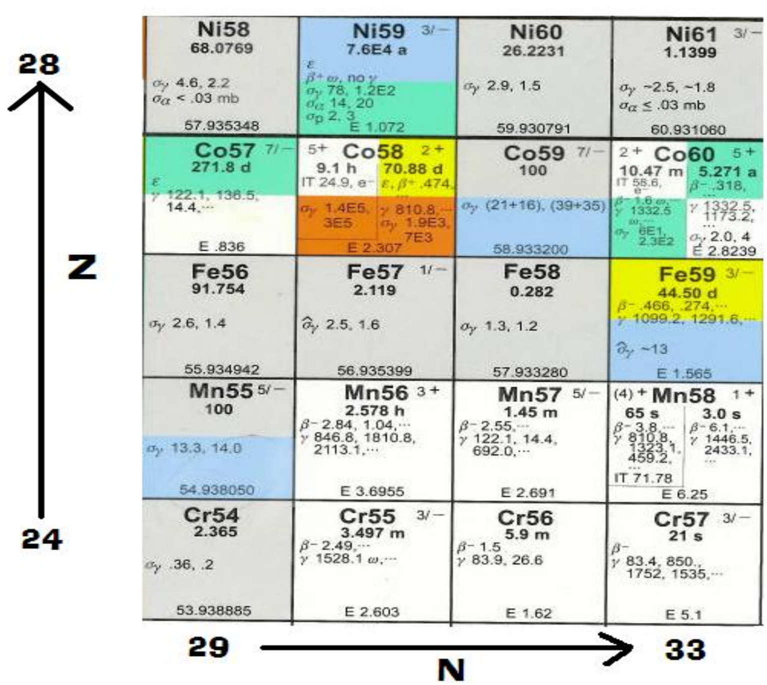
a. 15 seconds
b. 21 seconds
c. 32 seconds
d. 60 seconds

QUESTION A.05 [1.0 point]
A reactor with K_{eff} = 0.5 contributes 1000 neutrons in the first generation. Changing from the first generation to the SECOND generation, how many neutrons are there in the second generation?

a. 1250
b. 1500
c. 1750
d. 2000

QUESTION A.06 [1 point]
Using the applicable portion from the chart of the nuclides, what will Mn-56 decay into?

a. Mn-55
b. Co-60
c. Fe-56
d. Fe-58



QUESTION A.07 [1.0 point]
Which of the following types of neutrons has a mean neutron generation lifetime of 12.5 seconds?

a. Prompt

b. Delayed

c. Fast

d. Thermal

QUESTION A.08 [1.0 point]
Which **ONE** of the following is the correct amount of reactivity added if the multiplication factor, k, is increased from 0.800 to 0.950?

a. 0.150

b. 0.158

c. 0.188

d. 0.197

QUESTION A.09 [1.0 point]
Delayed neutrons are produced by:

a. decay of O-16.

b. Photoelectric Effect.

c. decay of fission fragments.

d. directly from the fission process.

QUESTION A.10 [1.0 point]
Which **ONE** of the following conditions will **INCREASE** the shutdown margin of a reactor?

a. Lowering moderator temperature (Assume negative temperature coefficient).

b. Insertion of a positive reactivity worth experiment.

c. Burnout of a burnable poison.

d. Fuel depletion.

QUESTION A.11 [1.0 point]
The reactor is exactly critical. Which **ONE** of the following is the **MINIMUM** reactivity that must be added to produce prompt criticality?

a. Reactivity equals $1.10.

b. Reactivity equals to the β_{eff}.

c. Reactivity equals 1.007 % Δk/k.

d. Reactivity when the stable reactor period equals 3 seconds.

QUESTION A.12 [1.0 point]
The following data was obtained during a reactor fuel load.

No. of Elements	Detector A (cps)
0	30
10	40
20	60
30	100
50	300

Which **ONE** of the following is the closest number of fuel elements required to make the reactor critical? (The attached figure may be used to determine the correct response.)

a. 55

b. 60

c. 65

d. 70

QUESTION A.13 [1.0 point]
Given the following worth: ρ_{excess} = \$0.90
SAFE = \$2.20
REG blade = \$0.30
SHIM = \$1.55

Calculate the ***TECHNICAL SPECIFICATION LIMIT*** of Shutdown Margin for this core.

a. \$0.95

b. \$1.25

c. \$1.55

d. \$3.15

QUESTION A.14 [1.0 point]
Which **ONE** of the following describes the term **PROMPT JUMP**?

a. A reactor is critical at 80-second period.

b. A reactor has attained criticality on prompt neutrons alone.

c. The instantaneous change in power level due to inserting a control rod.

d. The instantaneous change in power level due to withdrawing a control rod.

QUESTION A.15 [1.0 point]
The probability of neutron interaction per cm of travel in a material is defined as:

a. a neutron flux.

b. a mean free path.

c. a microscopic cross section.

d. a macroscopic cross section.

QUESTION A.16 [1.0 point]
Which **ONE** of the following is **NOT** a correct statement regarding the production/depletion of Xenon in an operating reactor?

a. Xe-135 is lost by alpha decay.

b. Xe-135 is lost by neutron absorption.

c. Xe-135 is formed by fission and I-135 decay.

d. I-135 is formed by fission and lost by beta decay to Xe-135.

***************** End of Section A ********************************

QUESTION B.01 [1.0 point]
Which **ONE** of the following conditions is a violation of Technical Specifications?

a. The pH of the pool water is between 7.2 and 7.8.

b. The reactivity worth of an individual experiment is $2.60.

c. The height of water above the top of the core is 20 ft at full power.

d. The rate of reactivity insertion by control rod motion is $0.50 per second.

QUESTION B.02 [1.0 point]
Which **ONE** of the following types of experiments shall **NOT** be irradiated at UUTR?

a. The experiment contains iodine isotopes 131 through 135.

b. The experiment contains 20-milligram explosive materials.

c. The unsecured experiment has a reactivity worth of $1.50.

d. The experiment contains materials corrosive to reactor components.

QUESTION B.03 [1.0 point]
Which **ONE** of the following is the correct statement when the airborne activity in the CENTER CAA exceeds the preset level of 10 mR/hr?

a. The ventilation system is MANUALLY secured and the reactor is permitted to operate a period of time not to exceed 48 hours.

b. The ventilation system is AUTOMATICALLY secured and the reactor is permitted to operate a period of time not to exceed 48 hours.

c. The ventilation system is AUTOMATICALLY secured and the reactor is permitted to operate a period of time not to exceed 24 hours.

d. The ventilation system is AUTOMATICALLY secured and the reactor shall not be operated.

QUESTION B.04 [1.0 point]
A radioactive source reads 160 Rem/hr on contact. Four hours later, the same source reads 40 Rem/hr. How long is the time for the source to decay from a reading of 160 Rem/hr to 10 Rem/hr?

a. 6.0 hours

b. 8.0 hours

c. 9.0 hours

d. 10.0 hours

QUESTION B.05 [1.0 point]
An example of Byproduct Material would be….

a. Pu-239

b. U-233

c. U-235

d. Co-60

QUESTION B.06 [1.0 point]
Which **ONE** of the following is the appropriate Emergency Classification when a fire occurs in the control room and the reactor facility requires an off-site assistance?

a. Non-Reactor, Safety-related Events

b. Notification of Unusual Events

c. Alert

d. Site Area Emergency

QUESTION B.07 [1.0 point]
Exposing a 2 mCi check source to the continuous air monitor (CAM) detector to verify whether it is operable is considered to be:

a. a channel test.

b. a channel check.

c. a channel calibration.

d. a channel verification.

QUESTION B.08 [1.0 point]
The following measurements are made from a beta-gamma point source:

- 2 R/hr at six inches
- 0.5 mR/hr at ten feet.

What are the relative fractions of betas and gammas emitted at six inches?

a. (1800/200) = 9

b. (2000/200) = 10

c. (1800/20) = 90

d. (2200/200) = 11

QUESTION B.09 [1.0 point]
During a reactor startup, the senior reactor operator calculates that the maximum excess reactivity for reference core conditions is $3.0. For this excess reactivity, which **ONE** of the following is the best action?

a. Increase power to 10 kW and verify the excess reactivity again.

b. Continue to operate because the excess reactivity is within TS limit.

c. Shutdown the reactor; report the result to supervisor including the NRC due to excess being above TS limit.

d Continue operation, but report the result to the supervisor since the excess reactivity is exceeding TS limit.

QUESTION B.10 [1.0 point]
An area in which radiation levels could result in an individual receiving a dose equivalent in excess of 120 mRem/hr is defined as:

a. Radiation area.

b. Restricted Area.

c. High Radiation Area.

d. Very High Radiation Area.

QUESTION B.11 [1.0 point]
Which **ONE** of the following is the UUTR Safety Limit?

a. The temperature in a stainless-steel clad fuel element shall not exceed 530°C.

b. The temperature in an aluminum clad fuel element shall not exceed 1000°C.

c. The temperature in a stainless-steel clad fuel element shall not exceed 530°C and the temperature in an aluminum clad fuel element shall not exceed 1000°C.

d. The temperature in a stainless-steel clad fuel element shall not exceed 1000°C and the temperature in an aluminum clad fuel element shall not exceed 530°C.

QUESTION B.12 [1.0 point]
Minor modifications to the original procedures may be made by…

a. the Reactor Operator on his/her own and such changes shall be documented, and reviewed by the RSC.

b. the Reactor Administrator and such changes shall be documented and reviewed by the RSC.

c. the Reactor Supervisor and such changes shall be documented and reviewed by the RSC.

d. the Radiation Safety Officer and such changes shall be documented and reviewed by the RSC.

QUESTION B.13 [1.0 point]
The radiation from an unshielded Co-60 source is 500 mrem/hr. What thickness of lead shielding will be needed to lower the radiation level to 5 mrem/hr? The HVL (half-value-layer) for lead is 6.5 mm.

a. 26 mm.

b. 33 mm.

c. 38 mm.

d. 44 mm.

QUESTION B.14 [1.0 point]
Select the list that gives the order of types of radiation from the **LEAST** penetrating to the **MOST** penetrating (i.e. travels the further in air).

a. neutron, gamma, beta, alpha.

b. alpha, beta, neutron, gamma.

c. beta, alpha, gamma, neutron.

d. alpha, neutron, beta, gamma.

QUESTION B.15 [2 points, 0.5 each]
Match the 10CFR55 requirements for maintaining an active operator license in column A with the corresponding time period from column B. Items in column B can be used once, more than once or not at all.

	Column A	Column B
a.	Renew License	1 year
b.	Medical Exam	2 years
c.	Pass Requalification Written Examination	4 years
d.	Pass Requalification Operating Test	6 years

QUESTION B.16 [1.0 point]
Which **ONE** of the following is considered a damaged fuel?

a. In measuring the transverse bend, its lateral bending exceeds 0.10 inches over the length of the cladding.

b. In measuring the elongation, its length exceeds its original length by 0.25 inches.

c. A reactivity worth of fuel element is $0.02 less than the previous measure.

d. Color of a fuel clad changes to brown.

****************************** End of Section B ********************************

QUESTION C.01 [1.0 point]
The UUTR control rods are located at:

a. C1, C5, and C9

b. D1, D7, and D13

c. E1, E9, and E17

d. E1, E10, and E18

QUESTION C.02 [1.0 point]
Which **ONE** of the following is the actual design feature which prevents siphoning of primary water on a failure of the primary piping?

a. Signal from a float switch shuts off the primary pump.

b. Signal from a float switch shuts a valve in the pump suction line.

c. Level in the pool drops below siphon break holes in the primary suction pipe.

d. Level in the pool drops below the Net Positive Suction Head pressure minimum required to operate the pump.

QUESTION C.03 [1.0 point]
Graphite inserts are placed in the top and bottom of the fuel element. Which ONE of the following best describes the function of these inserts?

a. To absorb thermal neutrons.

b. To reduce neutron leakage.

c. To absorb fission product gases.

d. To increase fast neutron flux.

QUESTION C.04 [1.0 point]
On a loss of normal electrical power, which **ONE** of the following systems is **NOT** provided by the uninterrupted power supply (UPS)?

a. ARM

b. CAM

c. Reactor Console

d. Primary Cooling Pump

QUESTION C.05 [1.0 point]
What is the maximum acceptable time between the initiation of a scram signal, and the time that the safety rod is fully inserted in the core?

a. 2500 msec.

b. 2000 msec.

c. 1000 msec.

d. 200 msec.

QUESTION C.06 [1.0 point]
The output of the compensated ion chamber (CIC) provides the signal for:

a. Integrated Power Channel

b. Log Power Channel

c. % Power Channel

d. Period meter

QUESTION C.07 [2.0 points, 0.25 each]
Match each monitor and instrument (channel) listed in column A with a specific purpose in column B. Items in column B are to be used only once.

Column A		Column B
a.	Log count rate	1. Monitor radiation level in the reactor bay
b.	% Power Channel	2. Detect radioisotopes released due to fuel failure
c.	Log Power Channel	3. Protect the ion exchange resins
d.	Portable monitor	4. Survey of laboratory
e.	Start up Channel	5. Monitor neutron level at lower power
f.	Area radiation monitor	6. Provide an interlock system
g.	Bulk water temperature monitor	7. Provide a high power level scram
h.	CAM	8. Permit reactor power to be automatically controlled during the steady state mode

QUESTION C.08 [1.0 point]
Which ONE of the following methods is actually used to minimize the shock to the control rods during a reactor scram?

a. A small spring on the pull rod.

b. A piston (part of the connecting rod), drives water out of a dashpot as the rod nears the bottom of its travel.

c. An electro-mechanical brake on the motor energizes as the rod down switch is energized.

d. A small spring on the bottom of the control rod.

QUESTION C.09 [1.0 point]
If the Linear Power Channel output is 7% higher than the calculated thermal power calibration, the reactor operator needs to adjust the Linear Power Channel output by:

a. adjusting the linear channel gain.

b. adjusting the CIC detector high voltage.

c. physically adjusting the height of the detectors in the support assembly.

d. move the graphite reflector to change the neutron flux near the detectors.

QUESTION C.10 [1.0 point]
For calibration of the control rod, the operator calculates the reactor period by measuring the time required for the power to double or power to triple. This technique is called:

a. Rod Drop Method

b. Positive Period Method

c. Negative Period Method

d. Thermal Power Calibration Method

QUESTION C.11 [1.0 point]
Which **ONE** of the following will result in a reactor scram?

a. Reactor Period = 7 sec

b. Bulk Water Temperature = 105°F

c. % Power Channel = 108%

d. Linear Power Channel = 100%

QUESTION C.12 [1.0 point]
Which ONE of the following elements is used as the neutron absorber in the Shim-Safety rods?

a. Hafnium

b. Aluminum Clad Boron Carbide

c. Borated Stainless Steel

d. Cadmium

QUESTION C.13 [1.0 point]
Which **ONE** of the following Experimental Facilities provides the **HIGHEST** neutron flux?

a. Central Irradiation Facility (CIF)

b. Pneumatic Transfer System (PTS)

c. Dry Tube Thermal Irradiator

d. Beam Port

QUESTION C.14 [1.0 point]
A neutron flux will activate isotopes in air. The primary isotope we worry about in the rabbit system is …

a. N^{16} (O^{16} (n,p) N^{16}).

b. Kr^{80} (Kr^{79} (n, γ) kr^{80}).

c. Ar^{41} (Ar^{40} (n, γ) Ar^{41}).

d. H^{2} (H^{1} (n, γ) H^{2}).

QUESTION C.15 [1.0 point]
Which **ONE** of the following is the main function of the demineralizer in the primary purification system?

a. Remove soluble impurity to maintain low conductivity in the tank water.

b. Reduce N-16 formation, thus reduce the dose rate at the reactor pool.

c. Absorb thermal neutrons, thus increase life of the reactor pool.

d. Absorb tritium, thus maintain purity of the pool water.

******************* End of Section C *****************************
******************* End of the Exam ***************************

A.01 d
REF: Standard NRC question. From point A to near point B, reactor period is positive, and since $P_f=P_o*e^{\frac{t}{T}}$, power will continue to increase. At point B, reactor period reaches to infinitive, $e^{\frac{t}{\inf initive}} = e^{0} =1$, so $P_f=P_o$. Power is stable at point B.

A.02 a
REF: Glasstone, S. and Sesonske, A, *Nuclear Reactor Engineering,* 1991, § 5.18, p. 234.
T = (β-ρ)/λρ T = (.007 - .00312)/.1 x .00312 = 12 seconds

A.03 c
REF: Burn, R., *Introduction to Nuclear Reactor Operations,* © 1982, Sec 3.3.2, page 3-19.

A.04 b
REF: $P=P_oe^{t/\tau}$ or t/T= ln (P/P_o). t=30*ln(2); t= 21 sec

A.05 b
REF: Burn, R., Introduction to Nuclear Reactor Operations, © 1982, § 5.3, p. 5.6
2-nd generation=n + K*n=1000+500=1500 neutrons

A.06 c
REF: Mn-56 is beta decay, which is the conversion of a neutron into a proton and electron. Baum, E., Knox, H., and Miller, T. 2002. Nuclides and Isotopes 16^{th} Ed. p. 28

A.07 b
REF: DOE Handbook Vol 1 Section 3.0

A.08 d
REF: Burn, R., *Introduction to Nuclear Reactor Operations,* © 1982, Sec 3.3.3, page 3-21.
. In order to solve the question A.08, the applicant can use one of the following methods:
At k=0.8; ρ = ΔKeff/Keff or ρ = Keff-1/Keff = -0.2/0.8 =-0.25. At k=0.95, ρ =-0.05/0.95 ρ = -0.053. The difference between ρ is the answer ,i.e. -0.053-(-0.25)=0.197
Δ ρ = ρ1 – ρ2 where ρ1 = Keff1-1/Keff1 and ρ2 = Keff2-1/Keff2. Substitute ρ1 and ρ2 with Keff1 and Keff2 into the equation above, the result is Δρ = keff1-keff2/(keff1 x keff2)

A.09 c
REF: Burn, R., *Introduction to Nuclear Reactor Operations,* © 1982, Sec 3.2.

A.10 d
REF Standard NRC question

A.11 b
REF: Burn, R., *Introduction to Nuclear Reactor Operations,* © 1982, Sec 4.2.

A.12 b
REF: Burn, R., *Introduction to Nuclear Reactor Operations,* © 1982, § 5.5, pp. 5-18 — 5-25.

No. fuel	A(cps)	1/M (Source/Count)
0	30	1
10	40	0.75
20	60	0.5
30	100	0.3
50	300	0.1

A.13 a
REF: Total rod worth – (excess + most active rod)
$(2.20 +1.55+0.30) –$(0.90+2.20) =$0.95

A.14 d
REF: Burn, R., *Introduction to Nuclear Reactor Operations,* © 1982, Page 4-21.

A.15 d
REF: Burn, R., *Introduction to Nuclear Reactor Operations,* © 1982, Section 2.5.2, page 2-44.

A.16 a
REF: Burn, R., *Introduction to Nuclear Reactor Operations*, Sec 8.2, page 8-3.

B.01 d
REF: TSs 3.2, 3.8, and 5.7

B.02 c
REF: TSs 3.2 & 3.6

B.03 d
REF: UUTR Training Manual, VI. Auxiliary Surveillance Systems

B.04 b
REF: $DR = DR_{\circ} * e^{-\lambda t}$
40 rem/hr = 160 rem/hr* $e^{-\lambda(4hr)}$
$\ln(40/160) = -\lambda * 4$ --> $\lambda = 0.347$; solve for t: $\ln(10/160) = -0.347 * t$ → t=8 hours

B.05 d
REF: 10 CFR 20.1003

B.06 b
REF: EP 4.2, Notification of Unusual Events

B.07 a
REF: TS 1.0, Definition

B.08 a
REF: Assume beta will not travel 10 feet in air, therefore 0.5 mr is gamma.
Gamma dose at ½ ft (6 in) is: $(DR1)(R1^2) = (DR2)(R2^2) \rightarrow DR2 = (DR1)(R1^2) / R2^2 =$ 0.5 mr x $(10\ ft)^2 / (0.5\ ft)^2$ = 200 mr/hr
Therefore, beta contribution at ½ ft is 2000 - 200 = 1800 mr/hr.
Beta contribution/Gamma contribution = 1800/200 = 9

B.09 c
REF: TS 3.1.2

B.10 c
REF: 10 CFR 20

B.11 d
REF: TS 2.1

B.12 c
REF: Administrative Procedure, Organization and Responsibilities, Part D

B.13 d
REF: $DR = DR_{\circ} * e^{-\mu X}$
HVL (=6.5 mm) means the original intensity will reduce by half when a lead sheet of 6.5 mm is inserted. Find μ if the HVL is given as follows: $1 = 2 * e^{-\mu * 6.5}$;
$\mu = 0.10664$ Find X: 5 mrem/hr = 500 mrem/hr* $e^{-0.10664 * X}$; X= 43.2 mm

B.14 b
REF: NRC standard question

B.15 a (6) b(2) c(2) d(1)
REF: 10 CFR 55.55(a)

B.16 b
REF: TS 4.4

C.01 b
REF: SAR, Figure 4.1, University of Utah Reactor Core

C.02 c
REF: III, Maintenance and Surveillance

C.03 b
REF Basic TRIGA fuel design

C.04 d
REF: UUTR Training Manual, Auxiliary Power Systems

C.05 b
REF: TS 3.3.1

C.06 a
REF: UUTR Training Manual. V.TRIGA Reactor Console, Sec I.I

C.07 a(5) or a(6) b(7) c(8) d(4) e(6) or e(5) f(1) g(3) h(2) Key answer for part a and part e were modified per NRC review

REF: TS 3.3 and SAR 7.0, Instrumentation and Control

C.08 b
REF: NRC standard question

C.09 a
REF: Form UNEP-013R4, Adjustment of Power Monitoring Channels

C.10 b
REF: UUTR Training Manual. III. Maintenance and Surveillance of TRIGA Reactor

C.11 d
REF: UUTR Training Manual. V.TRIGA Reactor Console, Sec IV

C.12 b
REF: SAR 7.3

C.13 a
REF: SAR 10.2

C.14 c
REF NRC Standard Question

C.15 a
REF: NRC Standard Question