June 29, 2017

Dr. Steven Biegalski, Director
Nuclear Engineering Teaching Lab
University of Texas at Austin
NETL-PRC Bldg 159
10100 Burnet Rd
Austin, TX 78758

SUBJECT: EXAMINATION REPORT NO. 50-602/OL-17-01, UNIVERSITY OF TEXAS AT AUSTIN

Dear Dr. Biegalski:

During the week of May 22, 2017, the U.S. Nuclear Regulatory Commission (NRC) administered an operator licensing examination at your University of Texas research 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 at the conclusion of the examination.

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. The NRC is forwarding the individual grades to you in a separate letter which will not be released publicly. Should you have any questions concerning this examination, please contact Mr. John T. Nguyen at (301) 415-4007 or via e-mail John.Nguyen@nrc.gov.

Sincerely,

/RA/

Anthony J. Mendiola, Chief
Research and Test Reactors Oversight Branch
Division of Policy and Rulemaking
Office of Nuclear Reactor Regulation

Docket No. 50-602

Enclosure: Examination Report No. 50-602/OL-17-01

cc: Paul Whaley, University of Texas
cc w/o enclosures: See next page

SUBJECT: EXAMINATION REPORT NO. 50-602/OL-17-01, UNIVERSITY OF TEXAS AT AUSTIN DATED JUNE 29, 2017.

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NAME	JNguyen	ABaxter	AMendiola
DATE	06/13/2017	06/28/2017	06/29/2017

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cc:

Governor's Budget
and Policy Office
PO Box 12428
Austin, Texas 78711-2428

Bureau of Radiation Control
State of Texas
1100 West 49th Street
Austin, TX 78756

Dr. Gregory L. Fenves
The University of Texas at Austin
Office of the President
110 Inner Campus Drive, G3400
Austin, TX 78712-3400

Maurie McInnis
Executive Vice President and Provost
The University of Texas at Austin
1 University Station, G1000
Austin, TX 78712

Roger Mulder
Office of the Governor
P.O. Box 12428
Austin, TX 78711

Mr. Paul Whaley, Associate Director
Nuclear Engineering Teaching Laboratory
The University of Texas at Austin
10100 Burnet Road, Building 159
Austin, TX 78613

Test, Research and Training
Reactor Newsletter
P.O. Box 118300
University of Florida
Gainesville, FL 32611

Michael Krause, Reactor Supervisor
The University of Texas at Austin
1 University Station, R9000
Austin, TX 78712

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

REPORT NO.: 50-602/OL-17-01

FACILITY DOCKET NO.: 50-602

FACILITY LICENSE NO.: R-129

FACILITY: UNIVERSITY of TEXAS at AUSTIN

EXAMINATION DATES: May 22 - 25, 2017

SUBMITTED BY: /RA/ 6/13/17
John T. Nguyen, Chief Examiner Date

SUMMARY:

During the week of May 22, 2017, the NRC administered the operator licensing examinations to four Reactor Operator candidates and one Senior Reactor Operator Instant candidate. All candidates passed all portions of the examination.

REPORT DETAILS

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

2. Results:

	RO PASS/FAIL	SRO PASS/FAIL	TOTAL PASS/FAIL
Written	4/0	1/0	5/0
Operating Tests	4/0	1/0	5/0
Overall	4/0	1/0	5/0

3. Exit Meeting:
Steve Biegalski, Director, NETL
Paul Whaley, Associate Director, NETL
John Nguyen, Chief Examiner, NRC
William Schuster, Examiner-in-training, NRC

The examiner thanked the facility for their support during the examination. The examiner found no generic weaknesses observed during the operating examination.

Enclosure 1

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

FACILITY: Pool

REACTOR TYPE: TRIGA

DATE ADMINISTERED: 05/23/2017

CANDIDATE: ______________________

INSTRUCTIONS TO CANDIDATE:
Answers are to be written on the Answer sheet provided. Attach all Answer sheets to the examination. Point values are indicated in parentheses for each question. A 70% in each category is required to pass the examination. Examinations will be picked up three (3) hours after the examination starts.

CATEGORY VALUE	**% OF TOTAL**	**CANDIDATE'S SCORE**	**% OF CATEGORY VALUE**	**CATEGORY**
20.00	**33.3**	___________	_____	**A. REACTOR THEORY, THERMODYNAMICS AND FACILITY OPERATING CHARACTERISTICS**
20.00	**33.3**	___________	_____	**B. NORMAL AND EMERGENCY OPERATING PROCEDURES AND RADIOLOGICAL CONTROLS**
20.00	**33.3**	___________	_____	**C. FACILITY AND RADIATION MONITORING SYSTEMS**
60.00		___________ **FINAL GRADE**	_____ %	**TOTALS**

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

____
Candidate's Signature

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.

A01 a b c d ___

A02 a b c d ___

A03 a b c d ___

A04 a b c d ___

A05 a ___ b ___ c ___ d ___ (0.25 each)

A06 a b c d ___

A07 a b c d ___

A08 a b c d ___

A09 a b c d ___

A10 a b c d ___

A11 a b c d ___

A12 a ___ b ___ c ___ d ___ (0.25 each)

A13 a b c d ___

A14 a b c d ___

A15 a b c d ___

A16 a b c d ___

A17 a b c d ___

A18 a b c d ___

A19 a b c d ___

A20 a b c d ___

(***** 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.

B01 a b c d ___

B02 a ___ b ___ c ___ d ___ (0.25 each)

B03 a ___ b ___ c ___ d ___ (0.25 each)

B04 a b c d ___

B05 a b c d ___

B06 a b c d ___

B07 a b c d ___

B08 a b c d ___

B09 a b c d ___

B10 a b c d ___

B11 a b c d ___

B12 a b c d ___

B13 a ___ b ___ c ___ (0.33 each)

B14 a b c d ___

B15 a ___ b ___ c ___ d ___ (0.25 each)

B16 a b c d ___

B17 a b c d ___

B18 a b c d ___

B19 a b c d ___

B20 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.

C01 a b c d ___

C02 a b c d ___

C03 a b c d ___

C04 a b c d ___

C05 a ___ b ___ c ___ d ___ (0.25 each)

C06 a b c d ___

C07 a b c d ___

C08 a b c d ___

C09 a b c d ___

C10 a b c d ___

C11 a b c d ___

C12 a ___ b ___ c ___ (0.33 each)

C13 a b c d ___

C14 a b c d ___

C15 a b c d ___

C16 a b c d ___

C17 a b c d ___

C18 a ___ b ___ c ___ d ___ (0.25 each)

C19 a b c d ___

C20 a b c d ___

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

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 complete the examination.

3. Restroom trips are to be NETL 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 <u>only</u> 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 [brackets] 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.

EQUATION SHEET

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

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

$$\lambda^* = 1 \text{ x } 10^{-4} \text{ seconds}$$

$$\lambda_{eff} = 0.1 \sec^{-1}$$

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

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

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

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

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

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

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

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

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

$$T = \frac{\lambda^*}{\rho - \overline{\beta}}$$

$$T = \frac{\lambda^*}{\rho} + \left[\frac{\overline{\beta} - \rho}{\lambda_{eff}\,\rho}\right]$$

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

$$T_{‰} = \frac{0.693}{\lambda}$$

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

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

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

$$DR_1 d_1^{\,2} = DR_2 d_2^{\,2}$$

$\lambda_{eff} = 0.1/sec$

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1 Curie = 3.7×10^{10} dps	1 kg = 2.21 lbm
1 hp = 2.54×10^{3} BTU/hr	1 Mw = 3.41×10^{6} BTU/hr
1 BTU = 778 ft-lbf	°F = 9/5°C + 32
931 Mev = 1 amu	°C = 5/9 (°F - 32)

Section A L Theory, Thermo & Fac. Operating Characteristics

QUESTION A.01 [1.0 point]
The first pulse has a reactivity worth of **$1.25** which results in a peak power of **500 MW**. If the second pulse has a peak power of **5000 MW**, the corresponding reactivity worth is:
Given: β_{eff}=0.0070

a. $1.60

b. $1.80

c. $2.00

d. $3.20

QUESTION A.02 [1.0 point]
10,000 FAST neutrons exist at the beginning of a generation. What is a number of neutrons that reach thermal energies after the resonance escape probability at the same generation? Given the six factor multiplication values as follows:

ε = 1.031 L_f = 0.889 f = 0.751
p = 0.803 L_{th} = 0.905 η = 2.012

a. 6,660

b. 7,360

c. 10,064

d. 13,401

QUESTION A.03 [1.0 point]
During the time following a reactor scram, reactor power decreases on an 80 second period, which corresponds to the half-life of the longest-lived delayed neutron precursors of:

a. 80 seconds

b. 55 seconds

c. 40 seconds

d. 20 seconds

QUESTION A.04 [1.0 point]
Which ONE of the reactions below describes a method of production and removal of Xenon?

a. ${}_{52}Te^{134} \rightarrow \gamma + {}_{52}I^{135} \rightarrow p + {}_{54}Xe^{135} \rightarrow \beta^- + {}_{55}Cs^{135} \rightarrow \beta^- + {}_{56}Ba^{135}$

b. ${}_{52}Te^{135} \rightarrow \gamma + {}_{52}I^{135} \rightarrow \beta^- + {}_{54}Xe^{135} \rightarrow {}_{0}n^{1} + {}_{54}Xe^{136} \rightarrow \beta^- + {}_{56}Ba^{135}$

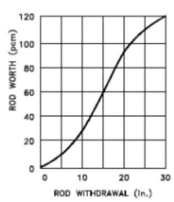
c. ${}_{52}Te^{135} \rightarrow \beta^- + {}_{53}I^{135} \rightarrow \beta^- + {}_{54}Xe^{135} \rightarrow \beta^- + {}_{55}Cs^{135} \rightarrow \beta^- + {}_{56}Ba^{135}$

d. ${}_{52}Te^{134} \rightarrow \beta^- + {}_{53}I^{135} \rightarrow \beta^- + {}_{54}Xe^{135} \rightarrow \gamma + {}_{55}Cs^{135} \rightarrow \beta^+ + {}_{56}Ba^{135}$

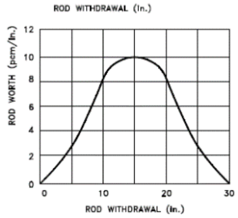
QUESTION A.05 [1.0 point, 0.25 each]
Identify the descriptions or graphs in Column A in accordance with describe or depict integral control rod worth or differential rod worth

	Column A	Column B
a.	total reactivity worth of the control rod at that height	1. Differential Rod Worth
b.	reactivity change per unit movement of a control rod	2. Integral Rod Worth

c.



d.



QUESTION A.06 [1.0 point]
A reactor contains a neutron source that produces 10,000 neutrons/second. The reactor has a k_{eff} = 0.92. What is the stable total neutron production rate in the reactor?

a. 100,000 neutrons/sec

b. 115,074 neutrons/sec

c. 125,000 neutrons/sec

d. 135,135 neutrons/sec

QUESTION A.07 [1.0 point]
Which ONE of the following is a number of protons in the tritium nucleus ($_1T^3$ or $_1H^3$)?

a. 1

b. 2

c. 3

d. 4

QUESTION A.08 [1.0 point]
Which ONE of the following is the MAIN reason for operating reactor with thermal neutrons instead of fast neutrons?

a. The atomic weight of thermal neutrons is larger than fast neutrons, so thermal neutrons are easily to slow down and be captured by the fuel.

b. The neutron lifetime of thermal neutrons is longer than fast neutrons, so the fuel has enough time to capture thermal neutrons.

c. Fast neutrons give off higher radiation than thermal neutrons. Reactor needs to reduce radiation limit by using thermal neutrons.

d. The fission cross section of the fuel is much higher for thermal energy neutrons than fast neutrons.

QUESTION A.09 [1.0 point]
Which ONE of the following is the MINIMUM amount of reactivity that makes the NETL (**finite)** critical reactor to be a prompt critical reactor? This MINIMUM amount is equal to:

a. the shutdown margin

b. the k-effective value

c. 1.0 % $\Delta K/K$

d. the β-effective value

QUESTION A.10 [1.0 point]
A few minutes following a reactor scram at full power, the reactor period has stabilized and the power level is decreasing at a CONSTANT rate. What is a reactor power level five minutes later from 4 kW?

a. 1500 W

b. 940 W

c. 94 W

d. 15 W

QUESTION A.11 [1.0 point]
Reactor A increases power from 10% to 20% with a period of 25 seconds. Reactor B increases power from 80% to 100% with a period of also 25 seconds. Compared to Reactor A, the time required for the power increase of Reactor B is:

a. longer than A

b. exactly the same as A

c. twice that of A

d. shorter than A

QUESTION A.12 [1.0 point, 0.25 each]
Match the following Neutron Interactions in Column A with the appropriate definition in Column B (each used only once)

Column A	Column B
a. Fission	1. Neutron enters nucleus, forms a compound nucleus, then decays by gamma emission.
b. Radiative capture	2. Particle enters nucleus, forms a compound nucleus and is excited enough to eject a new particle with incident neutron remaining in nucleus.
c. Scattering	3. Nucleus absorbs neutron and splits into two similarly sized parts.
d. Particle ejection	4. Nucleus is struck by a neutron and emits a single neutron.

QUESTION A.13 [1.0 point]
The Reactor is critical at 50 watts. A reactor operator makes a mistake by inserting a sample worth of $1.50 into the reactor core. Which ONE of the following best describes the values of K_{eff} and ρ during the power increment?

a. $K_{eff} = 1$ and $\rho = 1$

b. $K_{eff} > 1$ and $\beta\text{-eff} < \rho < 1$

c. $K_{eff} > 1$ and $\rho = 1$

d. $K_{eff} > 1$ and $0 < \rho < \beta\text{-eff}$

QUESTION A.14 [1.0 point]
Which ONE of the following physical characteristics of the TRIGA fuel is the MAIN contributor for the prompt negative temperature coefficient?

a. As the fuel heats up, the resonance absorption peaks broaden and increases the likelihood of absorption in U-238 and/or Pu-240.

b. As the fuel heats up, a rapid increase in moderator temperature occurs through conduction and convection of heat transfer mechanism which adds negative reactivity.

c. As the fuel heats up, the oscillating hydrogen in the ZrH lattice imparts energy to a thermal neutron, thereby increasing its mean free path and probability of escape.

d. As the fuel heats up, fission product poisons (e.g., Xenon) increase in concentration within the fuel matrix and add negative reactivity via neutron absorption.

QUESTION A.15 [1.0 point]
Which of the following is an example of a **FERTILE** material?

a. Th-232

b. U-233

c. U-235

d. Pu-239

QUESTION A.16 [1.0 point]
Which ONE of the following describes the term **PROMPT DROP**?

a. A reactor is subcritical at negative 80-second period

b. A reactor has attained criticality on prompt neutrons alone

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

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

QUESTION A.17 [1.0 point]
Which ONE of the following is a correct statement describing prompt and delayed neutrons? Prompt neutrons:

a. are released during U-238 interacts with fast neutrons, while delayed neutrons are released during U-235 interacts with thermal neutrons.

b. account for less than 1% of the neutron population, while delayed neutrons account for the rest.

c. are released during the fission process, while delayed neutrons are released during the decay of fission products.
.
d. are the dominating factor in determining reactor period, while delayed neutrons have no effect on reactor period.

QUESTION A.18 [1.0 point]
In a 50-watt power, adding 1.0% ΔK/K worth of reactivity will cause:

a. The peak power to be equal to 1.1 MW.

b. The reactor period to be equal to $(\beta-\rho)/\lambda\rho$.

c. A number of prompt neutrons equals to a number of delayed neutrons.

d. The resultant period to be a function of the prompt neutron lifetime ($T=\ell^*/\rho$).

QUESTION A.19 [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.20 [1.0 point]
If the multiplication factor, k, is increased from 0.800 to 0.950, the amount of reactivity added is:

a. 0.157 $\Delta K/K$

b. 0.167 $\Delta K/K$

c. 0.187 $\Delta K/K$

d. 0.197 $\Delta K/K$

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

Section B Normal/Emergency Procedures and Radiological Controls

QUESTION B.01 [1.0 point]
Which ONE of the following is NOT the MAIN function of the reactor coolant system?

a. Minimize corrosion of all reactor components

b. Provide shielding of the reactor radiation

c. Dissipate heat generated in the reactor

d. Minimize Ar-41 release to the environment

QUESTION B.02 [1.0 points, 0.25 each]
Match the radiation reading from Column A with its corresponding radiation area classification (per 10 CFR 20) listed in Column B. Answer in Column B can be used more than once, or not at all.

	Column A	Column B
a.	5 mrem/hr at 30 cm	1. Public Area
b.	50 mrem/hr at 30 cm	2. Radiation Area
c.	20 mrem/hr at 1 m	3. High Radiation Area
d.	5.5 grays/hr at 1 m	4. Very High Radiation Area

QUESTION B.03 [1.0 point, 0.25 each]
Identify each of the following surveillances as a channel check (**CHECK)**, a channel test (**TEST)**, or a channel calibration (**CAL)**.

a. During reactor operation, you compare readings of fuel temperature channels.

b. During the startup, you verify the reactor interlock system by performing simultaneous manual withdrawal of two control rods.

c. During the startup, you verify a reactor manual scram.

d. Adjust the Wide Range Linear Power Channel in accordance with recent data collected on the reactor thermal power calibration.

QUESTION B.04 [1.0 point]
The radiation from an unshielded source is 100 mrem/hr. You insert a lead sheet with 20 mm thickness; the radiation level reduces to 25 mrem/hr. What is the half-value-layer (HVL) of lead? (HVL: thickness of lead is required so that the original intensity will be reduced by half)?

a. 10 mm

b. 20 mm

c. 30 mm

d. 40 mm

QUESTION B.05 [1.0 point]
Which ONE of the following would be an initiating condition for Non-reactor Specific Events?

a. Fuel cladding damage

b. Earthquake with damage to reactor core

c. Fire in the reactor room lasting in 10 minutes

d. Abnormal loss of core coolant at a rate that exceeds the makeup capacity

QUESTION B.06 [1.0 point]
Which ONE of the following conditions does NOT require a Radiation Work Permit (RWP)?

a. Opening a beam port shutter.

b. Entry into a known radiation area of 75 mrem/hr.

c. Operations likely to result in area contamination.

d. Entry into a known airborne radiation area.

QUESTION B.07 [1.0 point]
Per NETL Technical Specifications, which ONE of the following will exceed the Limiting Safety System Settings?

a. Pulse operation exceeds 2.0 %Δk/k

b. Instrumented fuel temperature exceeds 550 °C

c. Steady State power exceeds 1.0 MW

d. Pool water temperature = 80 °C

QUESTION B.08 [1.0 point]
Which ONE of the following changes must be submitted to NRC for approval prior to implementation?

a. Replace a primary cooling pump with an identical pump.

b. Add new limitation to the Pre-Startup Checklist Procedure.

c. Add more responsibilities to the Radiation Protection Officer listed in the health physics procedure.

d. Delete an objective of Safety Limit listed in the TS 2.1.

QUESTION B.09 [1.0 point]
What is the **HALF LIFE** of the isotope contained in a sample which produces the following count rates?

Time (Minutes)	Counts per Minute (cpm)
Initial count	900
30	740
60	615
90	512
180	294

a. 321 minutes

b. 211 minutes

c. 111 minutes

d. 91 minutes

QUESTION B.10 [1.0 point]
Per NETL Emergency Plan, who is responsible for authorization of radiation exposure to personnel during an emergency response function that are in excess of normal occupational dose?

a. Police Chief with the occurrence of Emergency Director

b. Public Relations Coordinator with the occurrence of Reactor Director

c. Radiation Safety Officer with the occurrence of Dean of School

d. Emergency Director with the occurrence of Radiation Safety Officer

QUESTION B.11 [1.0 point]
An example of Byproduct Material would be:

a. Pu-239

b. U-238

c. U-235

d. Co-60

QUESTION B.12 [1.0 point]
A five-curie source, emitted 100% of 1 Mev gamma, is to be stored in the reactor building. How far from the source should a HIGH RADIATION AREA sign be posted?

a. 7 feet

b. 17 feet

c. 27 feet

d. 54 feet

Section B Normal/Emergency Procedures and Radiological Controls

QUESTION B.13 [1.0 point, 0.33 each]
Match the following experiments listed in Column A with its corresponding Experiment Classes listed in Column B.

	Column A	Column B
a.	Activate 10 milligrams of explosive material	1. Class A
b.	Activate gold foils to determine the reactor neutron flux	2. Class B
c.	Change the old reactor pump with identical pump	3. Class C

QUESTION B.14 [1.0 point]
Assume that there is no leak from outside of the demineralizer tank. You use a survey instrument with a window probe to measure the dose rate from the demineralizer tank. Compare to the reading with a window **CLOSED,** the reading with a window **OPEN** will:

a. increase, because it can receive an additional alpha radiation from [(Al-27) (n,α) → (Na-24)] reaction.

b. remain the same, because the Quality Factors for gamma and beta radiation are the same.

c. increase, because the Quality Factor for beta and alpha is greater than for gamma.

d. remain the same, because the survey instrument would not be detecting beta and alpha radiation from the demineralizer tank.

QUESTION B.15 [1.0 point, 0.25 each]
Match type of radiation listed in column A with their quality factor listed in column B. Items in column B can be used once, more than once or not at all.

	Column A	Column B	
a.	X-ray	1.	1
b.	Gamma	2.	5
c.	Alpha particles	3.	10
d.	High-energy photons	4.	20

QUESTION B.16 [1.0 point]
Which ONE of the following is the definition of Total Effective Dose Equivalent (TEDE)?

a. The sum of thyroid dose and external dose.

b. The sum of the external deep dose and the organ dose.

c. The sum of the deep dose equivalent and the committed effective dose equivalent.

d. The dose that your whole body is received from the source, but excluded from the deep dose.

QUESTION B.17 [1.0 point]
Which ONE of the following is **NOT** considered an unscheduled shutdown?

a. During a reactor operation, the NPP-1000 high voltage failed and caused all the control rods to scram.

b. During the annual surveillance check, a reactor operator inserted a channel test signal of 1250 kW, caused all the control rods to scram.

c. The operator was not watching reactor increase during startup; caused all the control rods to scram.

d. The operator inadvertently leaned on the scram bar with their elbow and caused all the control rods to scram.

QUESTION B.18 [1.0 point]
Which ONE of the following events requires an evacuation?

a. During an earthquake.

b. A contamination event on the reactor floor.

c. A tornado reported nearby.

d. A measured dose of greater than 20 mrem/hr at operational boundary where source of radiation is unknown.

QUESTION B.19 [1.0 point]
Which ONE of the following materials shall NOT be irradiated in the reactor core?

a. Explosive material = 15 milligrams

b. Any corrosive material

c. Isotope iodine-131 with the total inventory release of 850 millicuries

d. Any movable experiment

QUESTION B.20 [1.0 point]
Reactor Operator works in a high radiation area for eight (8) hours a day. The dose rate in the area is 100 mR/hour. Which ONE of the following is the MAXIMUM number of days in which Reactor Operator may perform his duties WITHOUT exceeding 10 CFR 20 limits?

a. 5 days

b. 6 days

c. 7 days

d. 12 days

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

Section C Facility and Radiation Monitoring Systems

QUESTION C.01 [1.0 point]
You perform a Square Wave operation. In Square Wave mode, you press a FIRE button and verify the power ramp-up. If demand power is NOT reached in 10 seconds, the control system will automatically:

a. Scram

b. Exit to Manual Mode

c. Exit to Auto Mode

d. Stay at Square Wave Mode

QUESTION C.02 [1.0 point]
Use the following diagram of an instrumented fuel element. Which ONE of the following is the correct match for the position locator (Column A) to the correct component (Column B)?

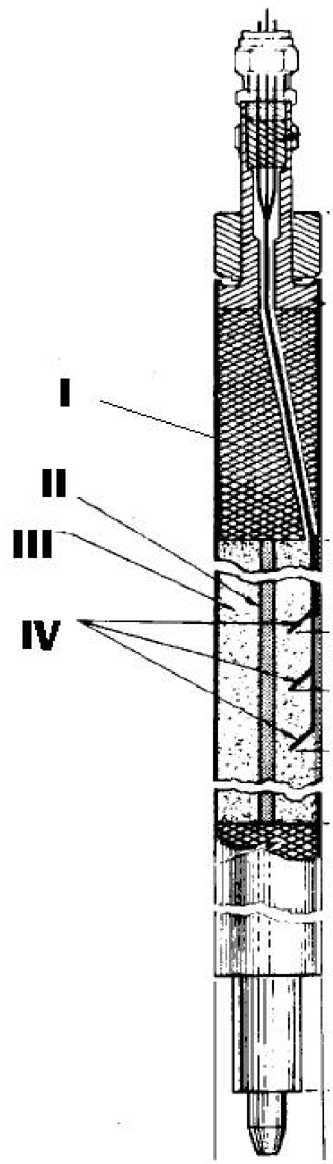
Column A	Column B
I	A. Zirconium Hydride-Uranium
II	B. Stainless steel
III	C. Samarium Burnable Poison
IV	D. Graphite Reflector
	E. Zirconium Rod
	F. Spacer
	G. Thermocouples

a. I-C, II-F, III-A, IV-C

b. I-D, II-A, III-E, IV-C

c. I-D, II-E, III-A, IV-G

d. I-C, II-B, III-E, IV-G


I
II
III
IV

QUESTION C.03 [1.0 point]
A three-way solenoid valve controls the air supplied to the pneumatic cylinder of the transient rod. Which ONE of the following statements correctly describes when the solenoid is de-energized? When the solenoid is de-energized:

a. The valve cuts off the compressed air supply and exhausts the pressure in the cylinder, thus allowing the piston to drop by gravity to its original position.

b. The valve opens the compressed air supply and supplies the pressure in the cylinder, thus allowing the compressed air drives the piston upward in the cylinder and causes the rapid withdrawal of the transient rod from the core.

c. The valve cuts off the compressed air supply and apply the pressure in the top of the cylinder, thus allowing the piston to drop by forcing the transient rod down.

d. The valve opens the compressed air supply and exhausts the pressure in the cylinder to an accumulator tank, thus allowing the piston to drop by gravity to its original position.

QUESTION C.04 [1.0 point]
You plan to perform a $1.50 pulse. Using the Transient Rod (TR) worth curve provided, find the pre-pulse TR position to be placed in for the initial 50 watt critical condition.

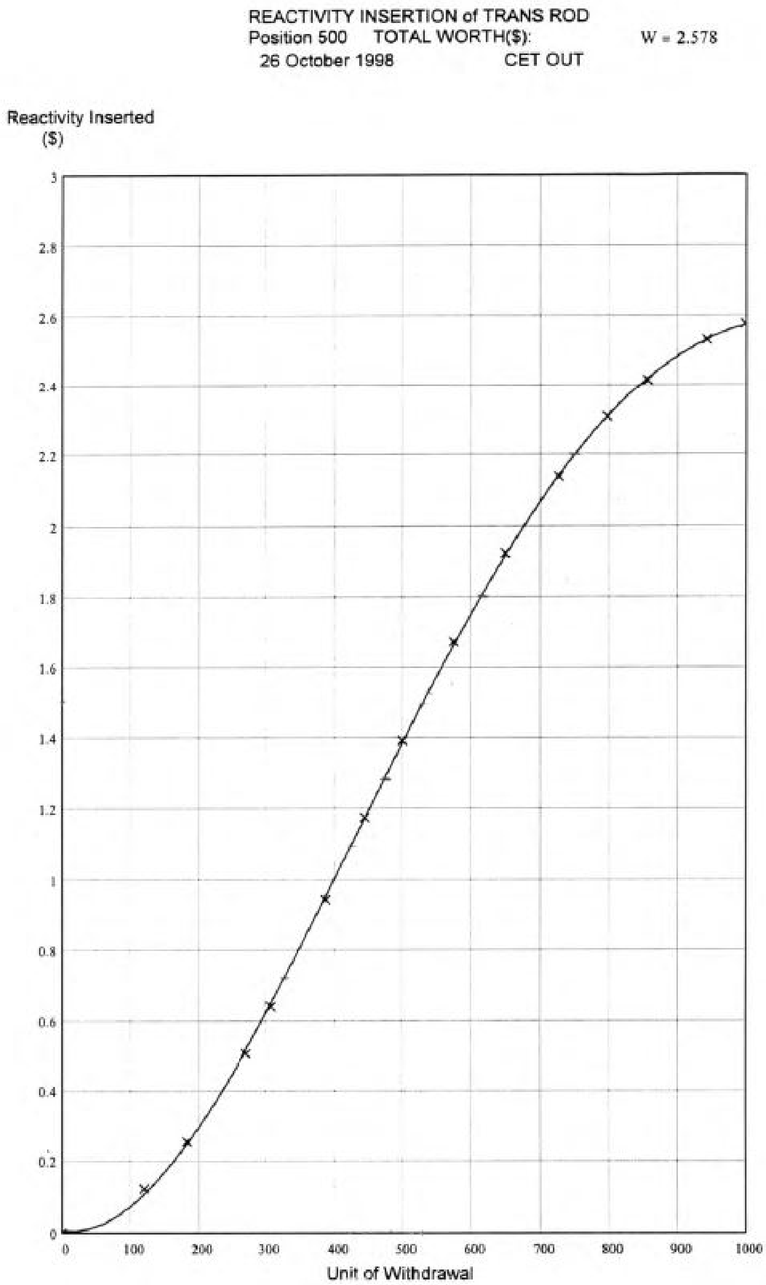
a. Fully down position

b. Fully up position

c. Between 425 – 435 position

d. Between 520 – 530 position

Section C Facility and Radiation Monitoring Systems



QUESTION C.05 [1.0 point, 0.25 each]
Match the input signals listed in column A with their AUTOMATIC Control Systems responses (reactor will automatically response when exceeding the conditions) in column B. (Items in column B may be used once, more than once or not at all). Assume that the reactor is in operation.

Column A		Column B
a. HV loss to the Safety Channel	1.	Indication ONLY
b. Servo Fault	2.	Rod withdraw prohibit
c. Power Channel = 1.25 MW	3.	Scram
d. Withdrawal of shim rod during a pulse mode	4.	Rod run-in

QUESTION C.06 [1.0 point]
For calibration of the control rod, the operator determines the rod reactivity by measuring the rate of decrease in power level by scram of the calibrated rod from the desired height. This technique is called:

a. Rod Drop Method

b. Positive Period Method

c. Thermal Power Calibration Method

d. Positive Period-Differential Worth Method

Section C Facility and Radiation Monitoring Systems

QUESTION C.07 [1 point]
Which ONE of the following elements is MAINLY used as the neutron absorber on the NETL control rods?

a. Boron ONLY

b. Zirconium-hydride

c. Boron carbide

d. Gold-indium-cadmium

QUESTION C.08 [1.0 point]
Reactor is in a PULSE ready mode and you want to switch to a STEADY STATE mode. Which ONE of the following can cause the control rod interlock when you switch it?

a. SHIM rod drive DOWN and SHIM control rod DOWN

b. SHIM rod drive UP and SHIM control rod DOWN

c. Pneumatic cylinder DOWN

d. Pneumatic cylinder UP

QUESTION C.09 [1.0 point]
Nominal Hydrogen- Zirconium atom ratio in the TRIGA LEU fuel elements is:

a. 1.6 H atoms to 1.0 Zr atom

b. 1.0 H atom to 1.6 Zr atoms

c. 30 H atoms to 20 Zr atoms

d. 8.5 H atoms to 20 Zr atoms

<u>Section C Facility and Radiation Monitoring Systems</u>

QUESTION C.10 [1.0 point]
During the annual calibration, you test a pulsing operation by collection of the reading on the peak power channel (nv) and integrated power-time channel (nvt). The nv channel information comes from the _______ and the nvt channel information comes from the _________.

a. NPP 1000 channel, NM 1000 channel

b. NM 1000 channel, NPP 1000 channel

c. NPP 1000 channel, NP 1000 channel

d. NPP 1000 channel; NPP 1000 channel

QUESTION C.11 [1.0 point]
The Main purpose for setting a conductivity limit of the pool water is to:

a. Maintain the departure of nucleate boiling ratio (DNBR) greater than the unity.

b. Minimize the possibility of corrosion of the cladding on the fuel elements.

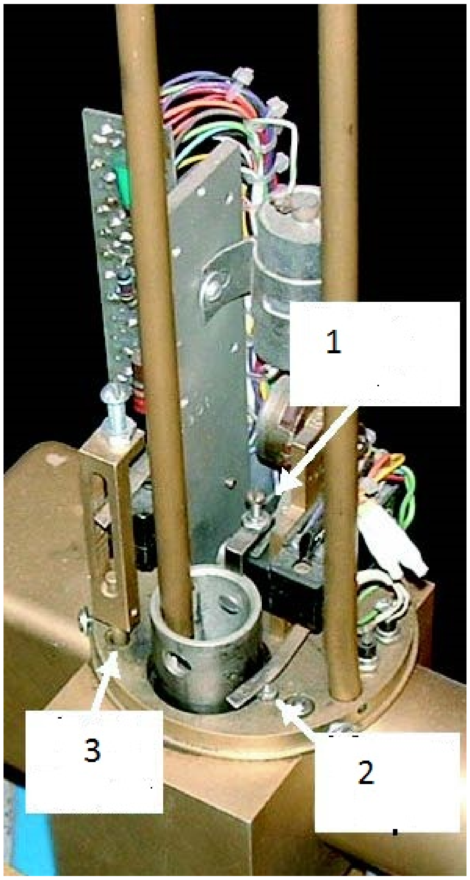
c. Extend integrity of resin bed on the demineralizer.

d. Minimize Ar-41 released to the public.

QUESTION C.12 [1.0 point, 0.33 each]
Use the following diagram of the control rod. Match the three limit switches listed in Column A to the appropriate labels in Column B?

Column A	Column B
a. The “Down” position of the magnet	1
b. The “Down” position of the rod	2
c. The “Up” position of the magnet	3

Section C Facility and Radiation Monitoring Systems



Section C Facility and Radiation Monitoring Systems

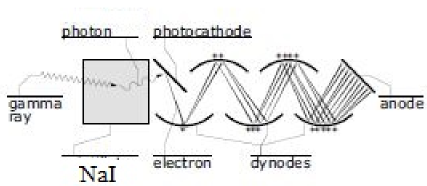
QUESTION C.13 [1.0 point]
The figure attached is a basic design of:

a. Thermoluminescent Dosimeter (TLD)

b. Film badge

c. Pocket ionization chamber

d. Scintillation detector



QUESTION C.14 [1.0 point]
Which ONE of the following would best describe the beam tube facilities of the UT TRIGA reactor? Five beam tubes of 6 inch diameter with:

a. THREE beam ports are tangential to the reactor core, all terminating at the tangential point to the core, and TWO radial beam ports that terminate at the outer edge of the reflector.

b. ONE beam port tangential to the reactor core, extending both directions from the reflector and out opposite sides of the reactor shield, and THREE radial beam ports that terminate at the outer edge of the reflector.

c. THREE beam ports are tangential to the reactor core, all terminating at the tangential point to the core, and TWO radial beam ports that terminate at the outer edge of the reflector.

d. ONE radial beam port that terminates at the outer edge of the reflector; and, ONE radial beam port that terminates at the inner shroud; and, TWO beam ports are tangential to the reactor core, one terminating at the tangential point to the core and the other extending both directions from the reflector and out opposite sides of the reactor shield

QUESTION C.15 [1.0 point]
What is the alarm set point for the continuous air monitor (particulate) according to Technical Specifications 3.3.3?

a. 2×10^{-5} μCi/cm^3

b. 2×10^{-6} μCi/cm^3

c. 2×10^{-8} μCi/cm^3

d. 2×10^{-9} μCi/cm^3

QUESTION C.16 [1.0 point]
What is a type K thermocouple?

a. It is an electrical device with two dissimilar conductors (chromel–alumel) forming electrical junctions at differing temperatures. A thermocouple produces a temperature-dependent voltage as a result of the thermoelectric effect.

b. It is an electrical device with two dissimilar conductors (chromel–constantan) forming electrical junctions at differing temperatures. A thermocouple produces a temperature-dependent resistance as a result of the thermoelectric effect.

c. It is an electrical device with two dissimilar conductors (chromel–alumel) forming electrical junctions at differing temperatures. A thermocouple produces a temperature-dependent resistance as a result of the thermoelectric effect.

d. It is an electrical device with two dissimilar conductors (chromel–constantan) forming electrical junctions at differing temperatures. A thermocouple produces a temperature-dependent current as a result of the thermoelectric effect.

QUESTION C.17 [1.0 point]
During reactor operation, a leak develops in the SECONDARY to PRIMARY heat exchanger. Which ONE of the following correctly explains the reactor pool level?

a. Pool level will increase because the Primary pressure is HIGHER than the Secondary pressure.

b. Pool Level will increase because the Primary pressure is LOWER than the Secondary pressure.

c. Pool Level will be the same because the Primary pressure is EQUAL to the Secondary pressure.

d. Pool Level will decrease because the Primary pressure is LOWER than Secondary pressure.

QUESTION C.18 [1.0 point, 0.25 each]
Reactor is in operation. Match the input signals listed in column A with their AUTOMATIC responses listed in column B. (Items in column B may be used more than once or not at all.)

	Column A		Column B
a.	Loss of NPP-1000 High Voltage	1.	Normal Operation
b.	Watchdog Timer time out	2.	Alarm ONLY
c.	CAM = 1,000 cpm	3.	Interlock
d.	Attempt to perform a pulse at 2 kW	4.	Scram

QUESTION C.19 [1.0 point]
A diffuser nozzle is located a short distance above the top grid plate and directs water downward over the core. The purpose of this diffuser is to:

a. enhance heat transfer across all fuel elements in the core.

b. ensure consistent water chemistry in the core.

c. better distribute heat throughout the pool.

d. reduce the dose rate at the pool surface from N-16.

QUESTION C.20 [1.0 point]
Which ONE of the following is the purpose of the ½-inch aluminum safety plate suspended beneath the lower grid plate?

a. Prevents the control rods from dropping out of the core if the mechanical connections fail.

b. Provides a catch plate for small tools and hardware dropped while working on the core.

c. Provides structural support for the lower grid plate and the suspended core.

d. Prevents fuel rods from dropping out of the core.

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

A.01
Answer: b
$\rho1=(\rho\$1)(\beta_{eff})=(\$1.25)(.007)=(.00875)$
$[(\rho2-\beta_{eff})^2]/Peak2 = [(\rho1-\beta_{eff})^2]/Peak1$
$Peak2/Peak1*[(\rho1- \beta_{eff})^2]=[(\rho2-\beta_{eff})^2]$
$(5000/500)*[(.00875-.007)^2]= [(\rho2-\beta_{eff})^2]$
$[(.000030625)^{1/2}]+\beta_{eff} =\rho2=.012534$
$\rho\$2=(\rho2/\beta_{eff})=(.012534/.007)= \$1.79 \approx \$1.80$
Reference: Burn, R., Introduction to Nuclear Reactor Operations, 1988. § 4.6, p. 4-16

A.02
Answer: b
After resonance escape probability. $N = N_o\, \varepsilon\, L_f\, p$ = 7360 neutrons
Reference: DOE Fundamentals Handbook, NPRT, Vol. 2, Module 3, EO 1.5, p. 13

A.03
Answer: b
Reference: Group 1 is the longest-lived delayed neutron precursor for thermal fission in U-235, with a half-life of 55.72 sec.
Lamarsh, J. "Introduction to Nuclear Engineering" p. 88

A.04
Answer: c
Reference: DOE Fundamentals Handbook, NPRT, Vol. 2, Module 3, EO 4.1, p.35
KAPL, "Chart of the Nuclides", 17th Ed.

A.05
Answer: a. 2; b. 1; c. 2; d. 1
Reference: DOE Fundamentals Handbook, NPRT, Vol. 2, Module 3,
EO 5.4, EO 5.5, EO 5.6, pp 51-53

A.06
Answer: c
N = (S) (M)
$M = 1 / (1-k_{eff}) = 1 / (1-0.92) = 12.5$
N = (10,000)(12.5) = 125,000 neutrons/second
Reference: DOE Fundamentals Handbook, NPRT, Vol. 2, Module 4, EO 1.2, p 4

A.07
Answer: a
Reference: Nuclides and Isotopes
Z=1, A=3 , N=2

A.08
Answer: d
Reference: Burn, R., *Introduction of Nuclear Reactor Operations*, © 1982, Figure 2.6, page 2-39

A.09
Answer: d
Reference: Burn, R., *Introduction of Nuclear Reactor Operations*, © 1988, Sec 4.6

A.10
Answer: c
Reference: $P = P0\ e^{-t/T}$ = 4 kW * e(300sec/-80sec) = 4 kW * exp(-3.75) = 0.0235 * 4 kW = 0.094 kW = 94 W

A.11
Answer: d
Reference: The power of reactor A increases by a factor of 2, while the power of reactor B increases by a factor of 1.25. Since the periods are the same (rate of change is the same), power increase B takes a shorter time.

A.12
Answer: a (3) b (1) c (4) d (2)
Reference: DOE Fundamentals Handbook Nuclear Physics and Reactor Theory, Volume 1, Module 1, Page 43-46

A.13
Answer: b
Reference: Burn, R., *Introduction of Nuclear Reactor Operations*, © 1988, Sec 4.2

A.14
Answer: c
Reference: TRIGA Fuel Design

A.15
Answer: a
Reference: DOE Fundamentals Handbook, NPRT, Vol. 1, Module 1, EO 4.3, p.52

A.16
Answer: d
Reference: Burn, R., *Introduction to Nuclear Reactor Operations,* © 1982, Page 4-21.

A.17
Answer: c
Reference: Burn, R., Introduction to Nuclear Reactor Operations, © 1988

A.18
Answer d
Reference: Burn, R., *Introduction to Nuclear Reactor Operations,* © 1988, Sec 4.6
page 417

A.19
Answer: d
Reference: decreasing the reactivity worth in the core will increase the shutdown margin.

A.20
Answer: d
Reference: Burn, R., *Introduction to Nuclear Reactor Operations,* © 1982, Sec 3.3.3, page 3-21.
In order to solve the question, the applicant can use one of the following methods:
At k=0.8; $\rho = \Delta Keff/Keff$ or $\rho = Keff-1/Keff = -0.2/0.8 = -0.25$. At k=0.95, $\rho = -0.05/0.95$
$\rho = -0.053$. The difference between ρ is the answer ,i.e.
-0.053-(-0.25)=0.197 $\Delta K/K$
$\Delta \rho = \rho 1 - \rho 2$ where $\rho 1 = Keff1-1/Keff1$ and $\rho 2 = Keff2-1/Keff2$. Substitute $\rho 1$ and $\rho 2$ with Keff1 and Keff2 into the equation above, the result is $\Delta\rho$ = (keff1-keff2)/(keff1 x keff2) = (0.95-0.8) /(0.8*0.95)=0.197 $\Delta K/K$

Section B Normal/Emergency Procedures and Radiological Controls

B.01
Answer: d
Reference: SAR, Chapter 5, Introduction

B.02
Answer: a(2); b(2); c(3); d(4)
Reference: 10 CFR 20.1003 Definitions
For part c, 20 mrem/hr at 1m will be equal to 222 mrem/hr at 30 cm :=> high radiation area
5.5 grays→ 550 rad/hr at 1 m ➔ very high radiation area
Definition
High Radiation Area: 100 mrem/hr at 30 cm
Radiation Area : 5 mrem/hr at 30 cm
Very High Radiation Area: 500 rads/hr at 1 m

B.03
Answer: a = CHECK; b = TEST; c = TEST; d = CAL
Reference: NRC Standard Question

B.04
Answer: a
Reference: $DR = DR_{\circ} * e^{-\mu X}$
Find μ : $25 = 100 * e^{-\mu * 20}$; μ = 0.0693
If insertion of an HVL (thickness of lead), the original intensity will be reduced by half.
Find X: $1 = 2 * e^{-0.0693 * X}$; X= 10 mm
Find HVL by shortcut:
100mR- 50 mR is the 1st HVL
50 mR – 25 mR is the 2nd HVL
So HVL=20mm/2 = 10 mm

B.05
Answer: c
Reference: Emergency Response Plan, Section 1.2.2

B.06
Answer: b
Reference: HP-7

B.07
Answer: b
Reference: TS 2.2

B.08
Answer: d
Reference: NRC Standard Questions

B.09
Answer: c
Reference: $A = A_o e^{-\lambda t}$
$294 = 900e^{-180\lambda}$, 180λ = -ln 0.327, λ = 0.00623 min^{-1}
$t_{1/2} = 0.693 / \lambda$, $= 0.693 / 0.00623\ min^{-1} = 111$ minutes

B.10
Answer: d
Reference: EP 2.1.1

B.11
Answer: d
Reference: Byproduct material is any radioactive material (except special nuclear material) made radioactive by the process of producing or using special nuclear material.
10 CFR Part 20.1003

B.12
Answer: b
Reference: 6CEN = R/hr @ 1 ft. -> 6 x 5 x 1 x 1 = 30 R/hr at 1ft. $I_0D_0^2 = I*D^2$
30 R/hr*(1 ft)^2 = 0.1 R/hr *D ^{2}
D= sqrt(30/0.1) = 17.3 ft.

B.13
Answer: a(1); b(2); c(3);
Reference: ADMN-6

B.14
Answer: d
Reference: Basic radiological concept (beta and alpha radiation don't make through the demineralizer tank)

B.15
Answer: a(1) b(1) c(4) d(1)
Reference: 10 CFR 20

B.16
Answer: c
Reference: 10 CFR 20.1003

B.17
Answer: b
Reference: NRC Standard Questions

B.18
Answer: d
Reference: Emergency Plan

B.19
Answer: c
Reference: TS 3.4

B.20
Answer: b
Reference: 10CFR20.1201(a)(1) [5000 mr x $\frac{1\ hr}{100\ mr}$ x $\frac{day}{8\ hr}$ = 6.25 days

Section C Facility and Radiation Monitoring Systems

C.01
Answer: b
Reference: OPER-3, Section C

C.02
Answer: c
Reference: NRC Standard Question

C.03
Answer: a
Reference: SAR 4.4.8.3

C.04
Answer: c
Reference: OPER-2

C.05
Answer: a(3) b(1) c(3) d(2)
Reference: SAR, Instrumentation and Control

C.06
Answer: a
Reference: SURV-6

C.07
Answer: c
Reference: SAR 4.4.8

C.8
Answer: d
Reference: TS 3.2.2 and MAIN-1

C.09
Answer: a
Reference: SAR 4.4.5

C.10
Answer: d
Reference: SAR 6.1, Figure 6.1

C.11
Answer: b
Reference: NRC Standard Questions

C.12
Answer: a(1) b(3) c(2)
Reference: SAR 4.4.8.1

Section C Facility and Radiation Monitoring Systems

C.13
Answer: d
Reference: Basic knowledge of radiation detector

C.14
Answer: d
Reference: SAR 8.1.4

C.15
Answer: d
Reference: TS 3.3.3

C.16
Answer: a
Reference: SURV-1

C.17
Answer: b
Reference: NRC Standard Questions

C.18
Answer: a(4) b(4) c(1) d(3)
Reference: SAR 6.1

C.19
Answer: d
Reference: SAR 5.2.1

C.20
Answer: a
Reference: SAR, Description of TRIGA Mark II Reactor