UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

December 19, 2018

Dr. Sean McDeavitt, Director Nuclear Science Center
Texas A&M University
1095 Nuclear Science Road
College Station, TX 77843

SUBJECT: EXAMINATION REPORT NO. 50-128/OL-19-01, TEXAS A&M UNIVERSITY

Dear Dr. McDeavitt:

During the week of October 15, 2018, the U.S. Nuclear Regulatory Commission (NRC) administered an operator licensing examination at your Texas A&M University 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 internet e-mail John.Nguyen@nrc.gov.

Sincerely,

/RA/

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

Docket No. 50-128

Enclosures:
1. Examination Report No. 50-128/OL-19-01
2. Written examination

cc: w/o enclosures: See next page

SUBJECT: EXAMINATION REPORT NO. 50-128/OL-19-01, TEXAS A&M UNIVERSITY DATED DECEMBER 19, 2018

DISTRIBUTION:
PUBLIC
RidsNrrDlpPrlb Resource
RidsNrrDlpProb Resource
Facility File (CJRandiki)

ADAMS Accession No.: ML18355A919 **NRR-079**

OFFICE	NRR/DLP/PROB/CE	NRR/DLP/IOLB/OLA	NRR/DLP/PROB/BC
NAME	JNguyen	CJRandiki	AMendiola
DATE	12/10/2018	12/12/2018	12/19/2018

OFFICIAL RECORD COPY

cc:

Mayor, City of College Station
P.O. Box Drawer 9960
College Station, TX 77840-3575

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

Dr. Dimitris C. Lagoudas, Deputy Director
Texas A&M University
Texas Engineering Experiment Station
241 Zachry Engineering Center
College Station, Texas 77843

Mr. Jerry Newhouse, Assistant Director
Nuclear Science Center
Texas A&M University
Texas Engineering Experiment Station
1095 Nuclear Science Road, MS 3575
College Station, Texas 77843

Radiation Program Officer
Bureau of Radiation Control
Department of State Health Services
Division for Regulatory Services
1100 West 49th Street, MC 2828
Austin, TX 78756-3189

Technical Advisor
Office of Permitting, Remediation &
Registration
Texas Commission on Environmental
Quality
P.O. Box 13087, MS 122
Austin, TX 78711-3087

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

Mr. Scott Miller, Manager
Reactor Operations
Texas A&M University
Texas Engineering Experiment Station
1095 Nuclear Science Road, MS 3575
College Station, Texas 77843

State Energy Conservation Office
Comptroller of Public Accounts
P.O. Box 13528
Austin, TX 78711-3528

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

REPORT NO.: 50-128/OL-19-01

FACILITY DOCKET NO.: 50-128

FACILITY LICENSE NO.: R-83

FACILITY: Triga

EXAMINATION DATES: October 15 - 17, 2018

SUBMITTED BY: ***/RA/*** 12/10/2018
John T. Nguyen, Chief Examiner Date

SUMMARY:
During the week of October 15, 2018, the NRC administered an operator licensing examination to six Reactor Operator (RO), one Senior Reactor Operator Instant (SROI) and two Senior Reactor Operator Upgrade (SROU) candidates. One SROU candidate failed the operating test, two RO candidates failed the written examination, and one RO candidate failed both written and operating examinations. All other candidates passed all applicable portions of the examination.

REPORT DETAILS

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

2. Results:

	RO PASS/FAIL	SRO PASS/FAIL	TOTAL PASS/FAIL
Written	3/3	1/0	4/3
Operating Tests	5/1	2/1	7/2
Overall	3/3	2/1	5/4

3. Exit Meeting:
John T. Nguyen, Chief Examiner, NRC
Jerry Newhouse, Associate Director, Texas A&M University
Scott Miller, Reactor Operations Manager, Texas A&M University
Cameron MacDonnell, Training Supervisor, Texas A&M University

Per discussion with the facility, prior to administration of the examination, adjustments were accepted. The examiner discussed the generic weaknesses observed during the operating test to include questions related to the administrative procedure for replacing facility safety and non-safety significant equipment, the Technical Specifications license amendment, the 10 CFR 50.59 process, and the nuclear instrumentation systems and their calibration procedures. At the conclusion of the meeting, the NRC examiner thanked the facility for their support in the administration of the examination.

ENCLOSURE 1

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

FACILITY: Texas A&M University

REACTOR TYPE: Pool

DATE ADMINISTERED: 10/17/2018

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

ENCLOSURE 2

Category A – Reactor Theory, Thermodynamics, & Facility Operating Characteristics

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 ___ (0.25 each)

A02 a b c d ___

A03 a b c d ___

A04 a b c d ___

A05 a b c d ___

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 ___

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 *****)

Category B – Normal/Emergency Operating Procedures and Radiological Controls

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 ___

B03 a b c d ___

B04 a b c d ___

B05 a b c d ___

B06 a ___ b ___ c ___ d ___ (0.25 each)

B07 a b c d ___

B08 a b c d ___

B09 a b c d ___

B10 a ___ b ___ c ___ d ___ (0.25 each)

B11 a b c d ___

B12 a b c d ___

B13 a ___ b ___ c ___ d ___ (0.25 each)

B14 a b c d ___

B15 a b c d ___

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 ___ (0.5 each)

C06 a b c d ___

C07 a b c d ___

C08 a b c d ___

C09 a ___ b ___ c ___ d ___ (0.5 each)

C10 a b c d ___

C11 a ___ b ___ c ___ d ___ (0.25 each)

C12 a b c d ___

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 ___ (0.25 each)

C18 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 limited and only one candidate at a time may leave. You must avoid all contacts with anyone outside the examination room to avoid even the appearance or possibility of cheating.

4. Use black ink or dark pencil only to facilitate legible reproductions.

5. Print your name in the blank provided in the upper right-hand corner of the examination cover sheet and each Answer sheet.

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

7. The point value for each question is indicated in [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

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

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

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

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

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

$$\lambda^* = 1 \times 10^{-4} \text{ sec}$$

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

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

$$CR_1 (-\rho_1) = CR_2 (-\rho_2)$$

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

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

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

$$M = \frac{1 - K_{eff_1}}{1 - K_{eff\,2}}$$

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

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

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

$$T_{\frac{1}{2}} = \frac{0.693}{\lambda} \quad \Delta\rho = \frac{K_{eff_2} - K_{eff_1}}{K_{eff_1} K_{eff_2}}$$

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

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

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

$$DR = \frac{6 Ci \, E(n)}{R^2}$$

$$\frac{(\rho_2 - \beta)^2}{Peak_2} = \frac{(\rho_1 - \beta)^2}{Peak_1}$$

DR – Rem, Ci – curies, E – Mev, R – feet

1 Curie = 3.7 x 10^{10} dis/sec

1 kg = 2.21 lb

1 Horsepower = 2.54 x 10^3 BTU/hr

1 Mw = 3.41 x 10^6 BTU/hr

1 BTU = 778 ft-lb

°F = 9/5 °C + 32

1 gal (H_2O) ≈ 8 lb

°C = 5/9 (°F - 32)

c_P = 1.0 BTU/hr/lb/°F

c_p = 1 cal/sec/gm/°C

Category A: Reactor Theory, Thermodynamics, and Facility Operating Characteristics

QUESTION A.01 [1.0 point, 0.25 each]
Match the term listed in Column A with its corresponding unit listed in column B.

	Column A	Column B
a.	1 barn	1. cm^{-1}
b.	Macroscopic Cross Section	2. $10^{-24}\ cm^2$
c.	Neutron Flux	3. Neutrons / cm^2 /sec
d.	Reaction Rate	4. Fissions / cm^3 sec

QUESTION A.02 [1.0 point]
Which ONE of the following conditions will require the control rod withdrawal to maintain constant power level after the following change?

a. Adding of a fuel experiment such as U-235 into the core.

b. Removal of an experiment containing borated graphite.

c. Increase of pool water temperature.

d. Burnout of Xenon in the core.

QUESTION A.03 [1.0 point]
The reactor is critical at 100 watts. A control rod is withdrawn to insert a positive reactivity of 0.126% $\Delta k/k$. Which ONE of the following will be the stable reactor period as a result of this reactivity insertion? Given beta effective = 0.0078

a. 13 seconds

b. 46 seconds

c. 52 seconds

d. 80 seconds

QUESTION A.04 [1.0 point]
For the alpha decay of a nuclide, the number of protons will _____ and its atomic mass number will _____.

a. increase by 2 / increase by 2

b. decrease by 2 /decrease by 4

c. decrease by 2 / decrease by 2

d. increase by 2 / increase by 4

QUESTION A.05 [1.0 point]
Which ONE of the following best describes the likelihood of fission occurring in U-235 and U-238?

a. Neutrons at low energy levels (eV) are more likely to cause fission with U-235 than neutrons at higher energy levels (MeV).

b. Neutron cross section of U-235 increases with increasing neutron energy, whereas neutron cross section of U-238 decreases with increasing neutron energy.

c. Neutrons at low energy levels (eV) are more likely to cause fission with U-238 than neutrons at higher energy levels (MeV).

d. Neutron cross sections of U-235 and U-238 are independent from the neutron energy levels.

QUESTION A.06 [1.0 point]
The FAST FISSION FACTOR is defined as a ratio of:

a. the number of neutrons that reach thermal energy over the number of fast neutrons that start to slow down.

b. the number of fast neutrons produced from fission in a generation over the number of fast neutrons produced from fission in the previous generation.

c. the number of fast neutrons produced from U-238 over the number of thermal neutrons produced from U-235.

d. the number of fast neutrons produced from all fission over the number of fast neutrons produced from thermal fission.

Category A: Reactor Theory, Thermodynamics, and Facility Operating Characteristics

QUESTION A.07 [1.0 point]
Reactor power is 1 watts. Reactor Operator inserts a sample worth of 0.008 $\Delta k/k$ into the reactor core. Which ONE of the following best describes the reactor kinetic? The reactor is:

a. subcritical

b. critical

c. supercritical

d. prompt critical

QUESTION A.08 [1.0 point]
Reactor power is rising on a 10 second period. Approximately how long will it take for power to quadruple?

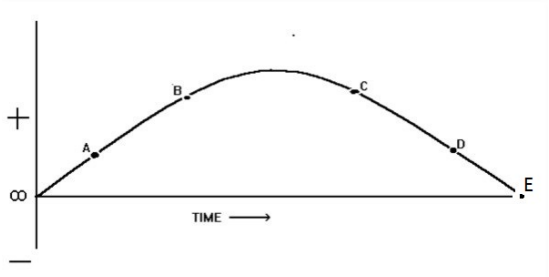
a. 14 seconds

b. 29 seconds

c. 55 seconds

d. 72 seconds

QUESTION A.09 [1.0 point]
Shown below is a trace of reactor period as a function of time. Between points D and E reactor power is:



a. constant.

b. continually decreasing.

c. continually increasing.

d. increasing, then constant.

QUESTION A.10 [1.0 point]
Given a source strength of 1000 neutrons per second (N/sec) and a multiplication factor of 0.8, which ONE of the following is the expected stable neutron count rate?

a. 700 N/sec

b. 5000 N/sec

c. 10000 N/sec

d. 20000 N/sec

QUESTION A.11 [1.0 point]
If the multiplication factor, k, is increased from 0.800 to 0.950, the amount of reactivity added is:

a. 0.150 $\Delta k/k$

b. 0.197 $\Delta k/k$

c. 0.250 $\Delta k/k$

d. 0.297 $\Delta k/k$

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

Step	No. of Elements	Detector A (count/sec)
1	0	100
2	4	120
3	8	140
4	12	200
5	15	400

The estimated number of **additional** elements required to achieve criticality is between:

a. 2 to 3

b. 4 to 5

c. 6 to 8

d. 8 to 10

Category A: Reactor Theory, Thermodynamics, and Facility Operating Characteristics

QUESTION A.13 [1.0 point]
A reactor is slightly supercritical with the thermal utilization factor = 0.900. A control rod is inserted to bring the reactor back to critical. Assuming all other factors remain unchanged, the new value for the thermal utilization factor is:

a. 0.898

b. 0.900

c. 0.902

d. 0.904

QUESTION A.14 [1.0 point]
Which ONE of the following isotopes has the largest microscopic absorption cross-section for thermal neutrons?

a. Sm^{149}

b. U^{235}

c. Xe^{135}

d. B^{10}

QUESTION A.15 [1.0 point]
Which ONE of the following atoms will cause a neutron to lose the most energy in an elastic collision?

a. U-238

b. Ar-40

c. O-16

d. H-1

QUESTION A.16 [1.0 point]
Which ONE of the following statements correctly describes the concentration of Xenon in the core following a scram from extended operation of 1 Megawatts? Xenon concentration …

a. initially decreases due to the loss of Iodine production, then increases to maximum concentration.

b. eventually decreases to zero in approximately 10 to 15 hours due to burn out.

c. increases to maximum in approximately 7 to 10 hours due to I-135 decay.

d. increases to maximum in approximately 7 to 10 hours due to Cs-135 decay.

QUESTION A.17 [1.0 point]
Which ONE of the following is the stable reactor period which will result in a power rise from 10% to 100% power in 10 seconds?

a. 4 seconds

b. 10 seconds

c. 24 seconds

d. 43 seconds

QUESTION A.18 [1.0 point]
A mechanism by which a nucleus can gain stability by converting a neutron to a proton or vice versa is called:

a. gamma decay

b. beta decay

c. alpha decay

d. photoelectric effect

QUESTION A.19 [1.0 point]
Delayed neutrons are produced by:

a. decay of N-16

b. Pair Production process

c. decay of fission fragments

d. directly from the fission

QUESTION A.20 [1.0 point]
Reactor is at 100 % power. The following graph shows the reactor time behavior following a reactor scram. Which ONE of the following best describes the transition of power between point B and C after the initial rod insertion? .

a. An immediate decrease in the prompt neutron fraction due to leakage, absorption, and a reduction in the fission rate.

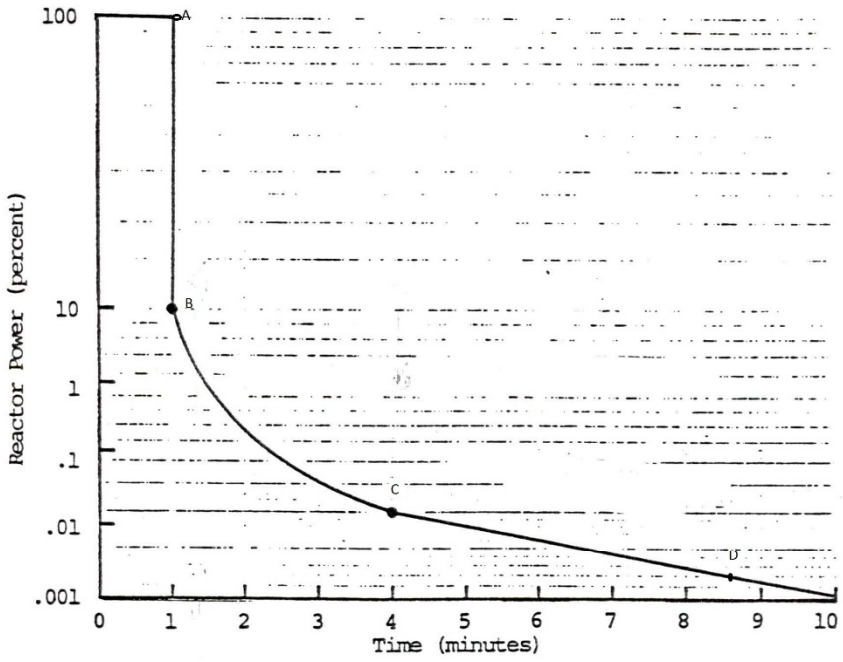
b. Fission product gases such as xenon begin to buildup causing the expansion of fuel density.

c. The **longest** lived delayed neutron precursor begins to effect such as Bromine-87.

d. The **short** lived delayed neutron precursors begin to effect such as Iodine-137, Cesium-144, and Krypton-95.

INTRODUCTION TO NUCLEAR REACTOR OPERATIONS
Reactor Kinetics
Reed Robert Burn
December 1988

Figure 4.3 Reactor Time Behavior Following a Reactor Scram



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

Category B: Normal/Emergency Operating Procedures and Radiological Controls

QUESTION B.01 [1.0 point]
The CURIE content of a radioactive source is a measure of:

a. number of radioactive atoms in the source.

b. number of nuclear disintegrations per unit time.

c. amount of damage to soft body tissue per unit time.

d. amount of energy emitted per unit time by the source.

QUESTION B.02 [1.0 point]
How long will it take a 1 Curie source, with a half-life of 1 year, to decay to 0.01 Curie?

a. 4.6 Years

b. 6.6 Years

c. 10.6 Years

d. 16.6 Years

QUESTION B.03 [1.0 point]
An irradiated sample provides a dose rate of 0.5 rem/hr at 2 ft. Approximately how far from the sample reads 5 mrem/hr?

a. 6 ft.

b. 9 ft.

c. 14 ft.

d. 20 ft.

Category B: Normal/Emergency Operating Procedures and Radiological Controls

QUESTION B.04 [1.0 point]
Per SOP, what is a minimum level of authority to approve temporary changes to the operating procedures that do not change the effectiveness or the original intent of the procedures?

a. Reactor Safety Board

b. NSC Director or his designated alternate

c. Reactor Supervisor

d. Senior Reactor Operator

QUESTION B.05 [1.0 point]
Per NSC Technical Specifications, when Reactor Bridge ARM is inoperable, the reactor operations may continue only if:

a. Stack Gas Monitor (FAM Ch.3) is still operable.

b. Stack Particulate Monitor (FAM Ch.1) is still operable.

c. Stack Particulate Monitor (FAM Ch.1) and Building Particulate Monitor (FAM Ch.4) are still operable.

d. Portable gamma sensitive instruments having their own alarm are substituted.

QUESTION B.06 [1.0 point, 0.25 each]
Fill out the blanks with the Limiting Conditions of Operation (LCO) listed in the NSC Technical Specifications.

	Safety System	LCO
a.	Core excess reactivity	_____ %Δk/k
b.	Steady State reactor power	_____ KW
c.	Preset timer	_____ sec
d.	Pool water temperature	_____°C

Category B: Normal/Emergency Operating Procedures and Radiological Controls

QUESTION B.07 [1.0 point]
You are currently the licensed operator at NSC reactor. Which ONE of the following will violate 10 CFR Part 55.53 “Conditions of licenses”?

a. Last licensed renewal was 60 months ago.

b. Last requalification operating test was 18 months ago.

c. Last quarter you were the licensed operator for 5 hours.

d. Last requalification written examination was 18 months ago.

QUESTION B.08 [1.0 point]
The radioactive solid waste is surveyed with the NaI (Tl) detector. The reading is between 20 % - 25 % above background. How do you deal with this radioactive waste?

a. Considering it is a non-radioactive waste.

b. Reporting it is an emergency event, Notification of Unusual Event.

c. Classifing the entire room is a radiation area in accordance with 10 CFR 20.

d. Considering it is a radioactive waste and placed into a “radioactive“ bag.

QUESTION B.09 [1.0 point]
The dose rate from a mixed beta-gamma point source is 100 mrem/hour at a distance of one (1) foot, and is 0.1 mrem/hour at a distance of ten (10) feet. What percentage of the source consists of beta radiation?

a. 30%

b. 50%

c. 70%

d. 90%

Category B: Normal/Emergency Operating Procedures and Radiological Controls

QUESTION B.10 [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 the startup, you verify a reactor high power scram.

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

c. During reactor operation, you compare reading of radiation monitors.

d. Adjust the scram set point of the Reactor Bridge ARM with recent data collected on the calibration.

QUESTION B.11 [1.0 point]
Which ONE of the following statements correctly describes the relationship between the Safety Limit (SL) and the Limiting Safety System Setting (LSSS)?

a. The SL is a maximum operationally limiting value that prevents exceeding the LSSS during normal operations.

b. The SL is a parameter that assures the integrity of the fuel cladding. The LSSS initiates protective actions to preclude reaching the SL.

c. The SL is a maximum setpoint for instrumentation response. The LSSS is the minimum number of channels required to be operable.

d. The LSSS is a parameter that assures the integrity of the fuel cladding. The SL initiates protective action to preclude reaching the LSSS.

QUESTION B.12 [1.0 point]
In accordance with 10CFR20.1301, individual members of the public are limited to a TEDE in one year of:

a. 50 mrem.

b. 100 mrem.

c. 500 mrem.

d. 1250 mrem.

Category B: Normal/Emergency Operating Procedures and Radiological Controls

QUESTION B.13 [1.0 point, 0.25 each]
Identify each of the following as either a Safety Limit (SL) a Limiting Safety System Setting (LSSS) or a Limiting Condition for Operation (LCO).

a. The temperature in a stainless steel-clad TRIGA LEU fuel element shall not exceed 1150°C under any conditions of operation.

b. The reactor power level shall not exceed 1.0 megawatt (MW) during steady state operation.

c. The fuel temperature shall not exceed 525°C as measured in an instrumented fuel element (IFE).

d. The central exhaust system shall be considered operating when it creates a minimum of 0.1 inch of water negative pressure at the sample point in the central exhaust system duct work.

QUESTION B.14 [1.0 point]
In order to ensure the health and safety of the public, 10CFR50 allows the operator to deviate from Technical Specifications. What is the minimum level of authorization needed to deviate from Technical Specifications?

a. Director of Reactor Operations

b. NSCSC

c. Licensed Senior Reactor Operator.

d. Licensed Reactor Operator.

QUESTION B.15 [1.0 point]
Which ONE of the following experiments is not allowed to be installed in the reactor or experiment facilities under ANY condition? The experiment:

a. contains corrosive materials.

b. contains 15 milligrams of TNT material.

c. has an secured experiment worth of $1.9.

d. has a single, movable experiment worth of $1.0.

Category B: Normal/Emergency Operating Procedures and Radiological Controls

QUESTION B.16 [1.0 point]
A two-curie source, emitted 80% of 100 Kev gamma, is to be stored in the reactor building. How far from the source will it read 100 mrem/hr?

a. 3 feet

b. 10 feet

c. 13 feet

d. 100 feet

QUESTION B.17 [1.0 point]
All applicants for an RO or SRO license must submit NRC Form 396 and 398 to the U.S. NRC before taking the examinations. This requirement is specified in 10 CFR:

a. Part 19

b. Part 20

c. Part 50

d. Part 55

QUESTION B.18 [1.0 point]
According to emergency classification guide, the pool leakage which indicated abnormal loss at a rate exceeding makeup capacity is defined as:

a. Operational Event

b. Notification of Unusual Event

c. Alert

d. Site Area Emergency

Category B: Normal/Emergency Operating Procedures and Radiological Controls

QUESTION B.19 [1.0 point]
Per NSC Technical Specifications, the primary coolant temperature channel shall be calibrated:

a. monthly.

b. quarterly.

c. semiannually.

d. annually.

QUESTION B.20 [1.0 point]
To measure the scram time measurement (Oscilloscope Method) for the SHIM rod, the SHIM rod should be withdrawn to _____before pressing the fuel temperature scram test button.

a. 25%

b. 50%

c. 75%

d. 100%

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

Category C: Facility and Radiation Monitoring Systems

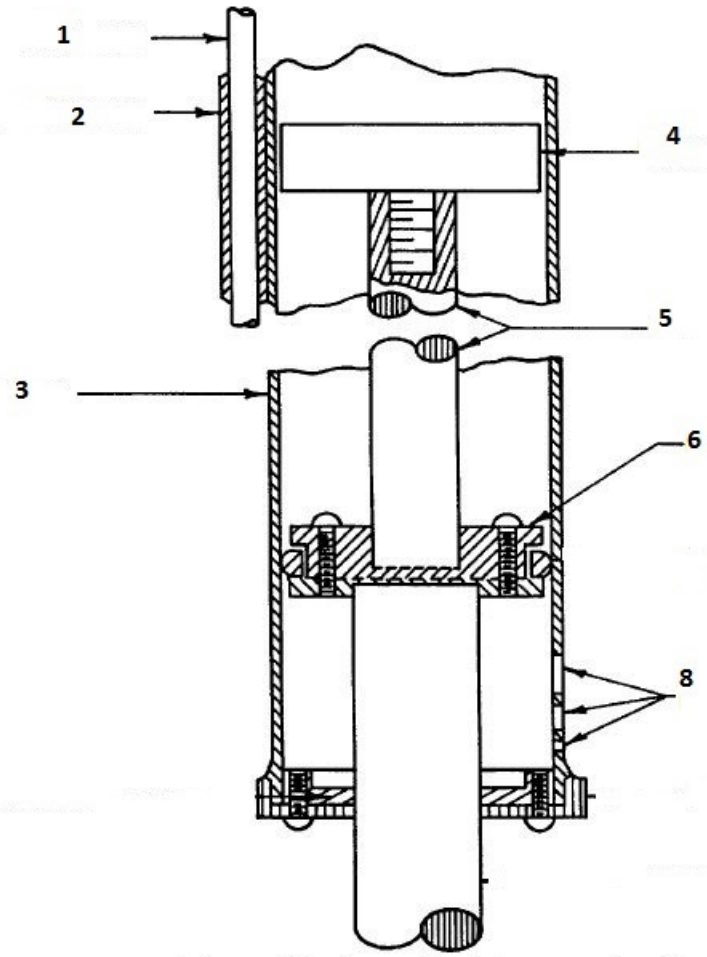
QUESTION C.01 [1.0 point]
The following diagram depicts the control rod armature. Which ONE of the following numbers listed on the diagram correctly describes the Dashpot Port?

a. 1

b. 4

c. 6

d. 8



Category C: Facility and Radiation Monitoring Systems

QUESTION C.02 [1.0 point]
The Facility Air Monitor (FAM) air flow configuration is color coded in accordance with the location where its air sample is coming from. If the air sample is coming from the reactor bridge, the color code is:

a. Blue

b. Red

c. Green

d. Yellow

QUESTION C.03 [1.0 point]
If a presence of ____ is found in the secondary side of the heat exchanger, a possible leak occurs from the primary system to the secondary system.

a. Na-24

b. Neutrons

c. Ar-41

d. N-16

QUESTION C.04 [1.0 point]
Which ONE of the following is the main purpose of the thermal column?

a. To enhance natural convection flow.

b. Provide a thermal neutron flux for a film irradiation facility.

c. Provide a fast (high energy) neutron flux for a film irradiation facility.

d. To shield a radiation dose from reactor core to the experiment area.

Category C: Facility and Radiation Monitoring Systems

QUESTION C.05 [2.0 points, 0.5 each]
Identify whether each of the following Reactor Safety Channels shall be effective in the Steady State (SS) mode, the Pulse mode (PULSE), or both modes (BOTH)

a. Console Scram Button

b. High Power Level

c. Preset Timer

d. Fuel Element Temperature

QUESTION C.06 [1.0 point]
The main purpose of the fuel followers installed in the control rods is to:

a. decrease the fast neutron flux in the core.

b. enhance their control characteristics.

c. increase the core excess reactivity in the reactor core.

d. increase the effectiveness for reactor pulsing.

QUESTION C.07 [1.0 point]
Reactor power is 1 KW. If you accidently press the “Period Scram Bypass” button, the reactor will:

a. scram.

b. prevent rod withdrawal.

c. run down.

d. be in normal (nothing happen).

Category C: Facility and Radiation Monitoring Systems

QUESTION C.08 [1.0 point]
The Safety control rod is partially withdrawn from the core. At this point, the Log Power level, for some unknown reason, drops to $1.0 * 10^{-3}$ W. As a result:

a. the control rod cannot be withdrawn any further.

b. the control rod cannot be inserted any further.

c. the control rod stuck and cannot be moved in any direction.

d. the control rod can only be inserted by placing the key switch in the "OFF" position.

QUESTION C.09 [2.0 points, 0.5 each]
Match the item provided in column A, with the correct Nuclear Instrumentation Channel from column B. (Items in column B may be used once, more than once, or not at all.)

	Column A		Column B
a.	< 1 cps rod withdrawal inhibit	1.	Safety Power Channel
b.	1 KW Interlock	2.	Log Power Channel
c.	Scram at 125% of full power	3.	Wide Range Linear Channel
d.	Energy (MW-Sec)	4.	Reactor Pool Temperature
		5.	Pulse Channel

Category C: Facility and Radiation Monitoring Systems

QUESTION C.10 [1.0 point]
A three-way solenoid valve controls the air supplied to the pneumatic cylinder of the Transient rod. De-energizing the solenoid causes the valve to shift to:

a. open, admitting air to the cylinder.

b. close, admitting air to the cylinder.

c. open, removing air from the cylinder.

d. close, removing air from the cylinder.

QUESTION C.11 [1.0 point, 0.25 each]
Match the input signals listed in column A with their display on reactor control room listed in column B. (Items in column B may be used more than once or not at all). Assume that the reactor is in operation.

	Column A		Column B
a.	Cell door open (in stall)	1.	Alarm only
b.	Servo Fault	2.	Rod withdraw prohibit
c.	125% Safety Power Channel	3.	Alarm and scram
d.	Withdrawal of safety rod if its rod height is fully out	4.	Alarm and rod run-in

QUESTION C.12 [1.0 point]
The Figure below depicts:

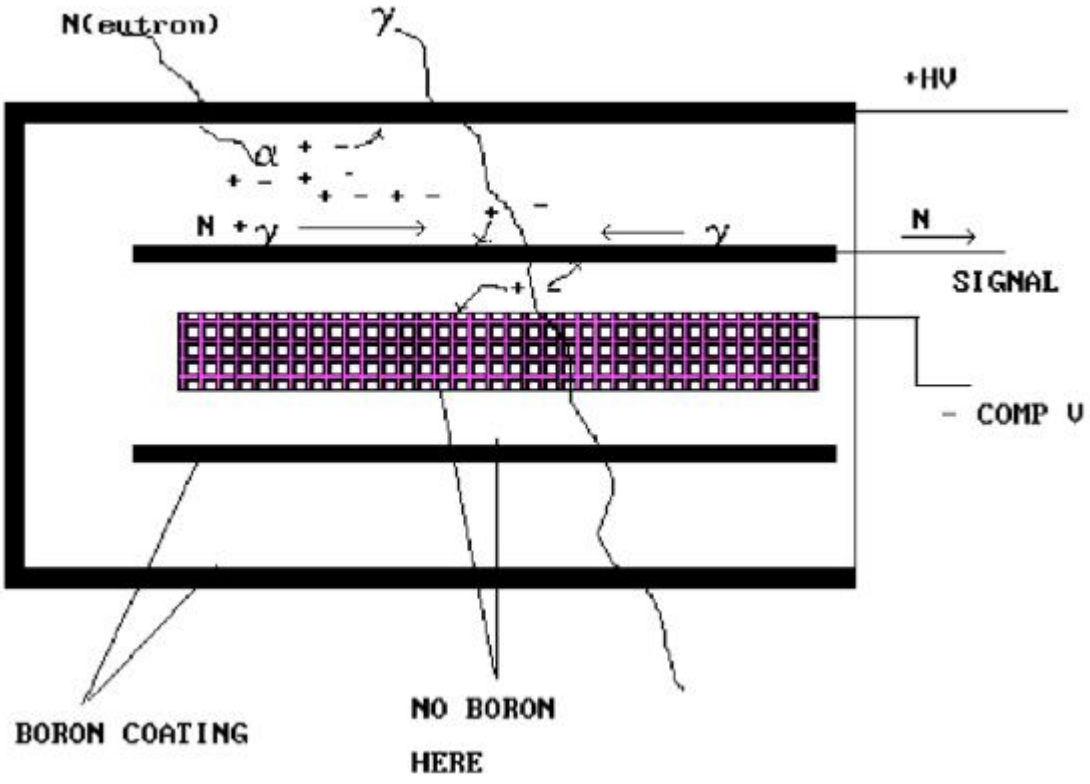
a. The Compensated Ion Chamber.

b. The Uncompensated Ion Chamber.

c. The Gamma Ion Chamber.

d. The Fission Chamber.

Category C: Facility and Radiation Monitoring Systems



Category C: Facility and Radiation Monitoring Systems

QUESTION C.13 [1.0 point]
Which ONE of the following is NOT true regarding the configuration of TAMU TRIGA-LEU fuel elements?

a. Uranium content: Maximum of 30 wt% enriched to maximum 19.95% Uranium-235 with nominal enrichment of 19.75% Uranium-235.

b. Hydrogen-to-zirconium atom ratio (in the ZrHx): nominal 1.0 H atoms to 1.6 Zr atoms with a maximum H to Zr ratio of 1.05.

c. Natural erbium content (homogeneously distributed): nominal 0.90 wt%.

d. Cladding: 304 stainless steel.

QUESTION C.14 [1.0 point]
Reactor is subcritical with the following conditions:
The SHIM rods and drives are “DOWN”
The Carriage of the Transient rod is UP
Reactor is in the Steady State Mode
If you apply “AIR” to the Transient rod system, the reactor will:

a. scram.

b. inhibit (interlock).

c. change to Pulse Mode.

d. increase to critical.

QUESTION C.15 [1.0 point]
Reactor power is 10 W. A reactor staff accidentally open the door of the Beam Port 4 Cave. His action will cause:

a. an annunciator light in the control room.

b. normal operation, no indication.

c. a reactor scram.

d. a reactor interlock.

Category C: Facility and Radiation Monitoring Systems

QUESTION C.16 [1.0 point]
When the pool level falls to approximately 90% of normal operating level, it will initiate visual and audible alarms in certain locations. Which ONE of the following locations gets an indication of visual and audible alarms?

a. Reception Room

b. University Communications Room

c. Director Office

d. Reactor Bay

QUESTION C.17 [1.0 point, 0.25 each]
The following diagram depicts the FUEL FOLLOWED control rod. Match each distractor with an appropriate label listed in the diagram.

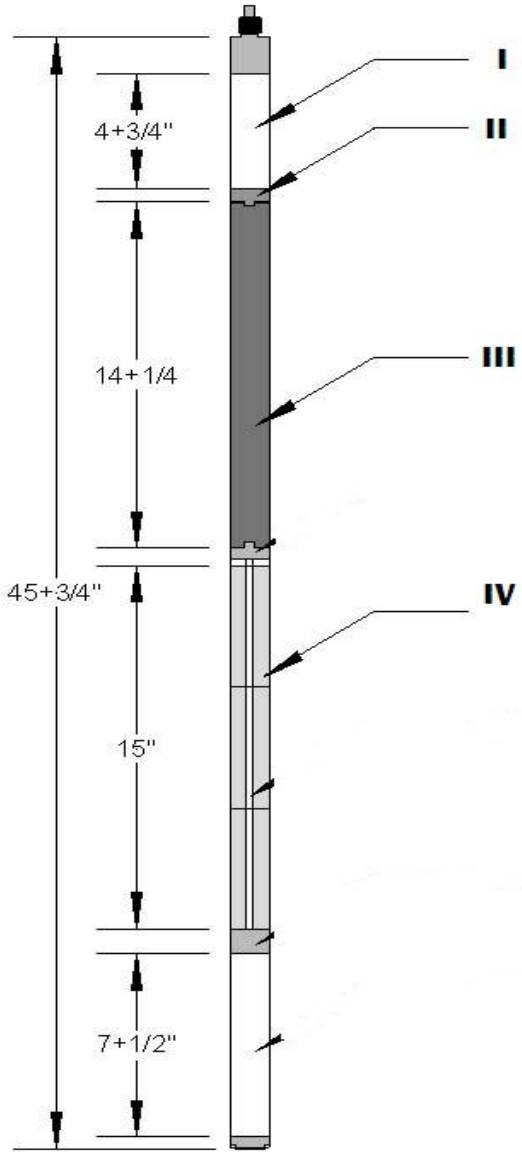
a. Fuel

b. Stainless steel plug

c. Void

d. Borated Graphite

Category C: Facility and Radiation Monitoring Systems



Category C: Facility and Radiation Monitoring Systems

QUESTION C.18 [1.0 point]
If any significant buildup of radioactivity from the reactor pool, the conductivity of the pool water will be:

a. increase.

b. decrease.

c. the same.

d. no relationship between radioactivity and conductivity in the pool water.

(***** END OF CATEGORY C *****)
((***** END OF EXAM *****))

Category A: Reactor Theory, Thermodynamics, and Facility Operating Characteristics

A.01
Answer: a(2) b(1) c(3) d(4) (0.25 each)
Reference: Burn, R., *Introduction to Nuclear Reactor Operations,* © 1988, Sec 2.6

A.02
Answer: c
Reference: Burn, R., Introduction of Nuclear Reactor Operations, © 1988, Sec 3.3.1

A.03
Answer: c
Reference: Reactivity added = 0.126 % $\Delta k/k$ = 0.00126 Δ k/k
$\tau = (\beta-\rho)/\lambda_{eff}\rho = \frac{0.0078 - 0.00126}{(0.1)(0.00126)} = 51.9$ seconds

A.04
Answer: b
Reference: Chart of the Nuclides

A.05
Answer: a
Reference: Burn, R., Introduction to Nuclear Reactor Operations, © 1988, Section 3.2

A.06
Answer: d
Reference: Burn, R., *Introduction of Nuclear Reactor Operations*, © 1982, Sec 3.3.1, page 3-16.

A.07
Answer: d
Reference: Burn, R., *Introduction of Nuclear Reactor Operations*, © 1988, Sec 4.2
When the insertion of 0.008 $\Delta k/k$ > Keff, reactor is prompt critical.

A.08
Answer: a
Reference: $P = P_0 e^{t/T}$ —> ln(4) = time ÷ 10 seconds –> time = ln (4) x 10 sec. 1.386 x 10 ≈ 13.8 sec.

A.09
Answer: d
Reference: Reactor is increasing, then constant when reactor period reaches to infinitive.

A.10
Answer: b
Reference: CR = S/(1-K) → CR = 1000/(1 - 0.8) = 5000 N/sec

A.11
Answer: b
Reference: Burn, R., *Introduction to Nuclear Reactor Operations,* © 1982, Sec 3.3.3, page 3-21.
$\Delta\rho$ = keff1-keff2/(keff1 x keff2) = 0.95-0.8 /(0.8*0.95)=0.197 $\Delta k/k$

Category A: Reactor Theory, Thermodynamics, and Facility Operating Characteristics

A.12
Answer: a
Reference: Burn, R., Introduction to Nuclear Reactor Operations, © 1982, Sec 5.5, page 5-18-5-25.

A.13
Answer: a
Reference: Burn, R., Introduction of Nuclear Reactor Operations, © 1988, Sec 3.3.1

A.14
Answer c
Reference: Introduction to Nuclear Operation, Reed Burn, 1988, Sec 8.1

A.15
Answer: d
Reference: Burn, R., *Introduction of Nuclear Reactor Operations*, © 1988, Sec 2.5.3

A.16
Answer: c
Reference: Burn, R., *Introduction of Nuclear Reactor Operations*, © 1988, Sec 8.2

A.17
Answer: a
Reference: $P = P_0 e^{t/T}$ —> $T = t/Ln(P/P_0)$
$T = 10/Ln(100/10)$; $T = 4.34$ sec.

A.18
Answer: b
Reference: NRC Standard Question

A.19
Answer: c
Reference: Burn, R., *Introduction of Nuclear Reactor Operations*, © 1982, Sec 3.2.1

A.20
Answer: d
Reference: Burn, R., Introduction to Nuclear Reactor Operations, ©4.5, 1988

Category B: Normal/Emergency Operating Procedures and Radiological Controls

B.01
Answer: b
Reference: Standard Health Physics Definition

B.02
Answer: b
Reference: $A = A_{\circ} * e^{-\lambda t}$
$0.01Ci = 1\ Ci * e^{-\lambda(t)}$
$\lambda = \ln(2) / (\text{half-life})$
$\lambda = 0.693 / 1\ \text{year} = 0.693$
$\ln(0.01/1) = -0.693*(t) \rightarrow -4.60/-0.693$
solve for t: 6.6 years

B.03
Answer: d
Reference: $DR_1*(D_1)^2 = DR_2*(D_2)^2$;
$500\ \text{mrem}\ (2)^2 = 5\ \text{mrem}\ (d)^2$
D = 20 ft

B.04
Answer: b
Reference: SOP, Procedure F, Section I

B.05
Answer: d
Reference: TS 5.1

B.06
Answer: a. = 5.5; b. = 1000; c. = 15; d. = 60 (0.25 each)
Reference: TS 3.1.1, TS 3.1.5, TS 3.2.2

B.07
Answer: b
Reference: 10 CFR Part 55.53
• 55.53(i) – the licensee shall have a biennial medical examination.
• 55.53(h), 55.59(c) – annual operating tests
• 55.53(e) – the licensee shall actively perform the functions of a licensed operator for a minimum of 4 hours per calendar quarter.
• 55.53(h), 55.59(c)(1) – ”The requalification program must be conducted for a continuous period not to exceed 2 years”
License renewal : 6 years

B.08
Answer: d
Reference: SOP, Procedure C7, Section VII

Category B: Normal/Emergency Operating Procedures and Radiological Controls

B.09
Answer: d
Reference: 10CFR20 - At 10 feet, there is no beta radiation.
Calculate gamma at 1 ft.
$DR_1*(D_1)^2 = DR_2*(D_2)^2$
$0.1*(10)^2 = DR_2*(1)^2$
gamma at 1 foot = 10 mrem/hour.
Therefore, beta at 1 foot = 90 mrem/hour or 90%.

B.10
Answer: a. = TEST; b. = TEST; c. = CHECK; d. = CAL (0.25 each)
Reference: TS Definitions

B.11
Answer: b
Reference: TS 2.1.2 and 2.2.1, Objective

B.12
Answer: b
Reference: 10CFR20

B.13
Answer: a. = SL; b. = LCO; c. = LSSS; d. = LCO (0.25 each)
Reference: TS 2.1, TS 2.2, TS 3.1, TS 3.2, and TS 3.3

B.14
Answer: c
Reference: 10CFR50.54(y)

B.15
Answer: d
Reference: TS 3.6

B.16
Answer: a
Reference: 6CEN = R/hr @ 1 ft. -> 6 x 2 x 0.8 x 0.1 = 0.96 R/hr at 1ft.
$I_0D_0^2 = I*D^2$
$0.96\ R/hr*(1\ ft)^2 = 0.1\ R/hr*D^2$
D= sqrt(0.96/0.1) = 3 ft.

B.17
Answer: d
Reference: 10CFR55

B.18
Answer: c
Reference: Emergency Plan, Section 4, Emergency Classification System Table-I.

Category B: Normal/Emergency Operating Procedures and Radiological Controls

B.19
Answer: c
Reference: TS 4.8.3

B.20
Answer: d
Reference: SOP, Procedure I, Section III

Category C: Facility and Radiation Monitoring Systems

C.01
Answer: d
Reference: SAR 7.3.1

C.02
Answer: b
Reference: SOP, Procedure VII-F1, Section VII

C.03
Answer: a
Reference: NRC Standard Questions

C.04
Answer: b
Reference: SAR 10.1.2

C.05
Answer: a. = BOTH; b. = SS; c. = PULSE; d. = BOTH (0.5 each)
Reference: TS 3.2

C.06
Answer: c
Reference: SAR 1.8

C.07
Answer: d
Reference: SOP, Procedure D, Section II

C.08
Answer: a
Reference: TS 3.2

C.09
Answer: a,2 b,2 c,1 d,5 (0.5 each)
Reference: SAR 7.2.3

C.10
Answer: d
Reference: TS 7.3.1

C.11
Answer: a(1) b(1) c(3) d(2) (0.25 each)
Reference: TS 3.3 and SAR 7.0, Instrumentation and Control

C.12
Answer: a
Reference: NRC Standard Questions

Category C: Facility and Radiation Monitoring Systems

C.13
Answer: b
Reference: TS 5.2

C.14
Answer: b
Reference: TS 3.2.2

C.15
Answer: c
Reference: SOP, Procedure D, Section IV

C.16
Answer: b
Reference: SOP, Procedure O, Section III, Reactor Pool Surveillance

C.17
Answer: a (IV) b (II) c (I) d (III) (0.25 each)
Reference: SAR 4.2.2

C.18
Answer: a
Reference: NRC Standard Questions