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

June 13, 2018

Paul Whaley, Associate 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-18-01, UNIVERSITY OF TEXAS AT AUSTIN

Dear Mr. Whaley:

During the week of April 23, 2018, the U.S. Nuclear Regulatory Commission (NRC) administered an operator licensing examination at your University of Texas - Austin 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 Licensing Projects
Office of Nuclear Reactor Regulation

Docket No. 50-602

Enclosures:
1. Examination Report No. 50-602/OL-18-01
2. Written examination with the facility comments

cc: Larry Hall
cc: w/o enclosures: See next page

SUBJECT: EXAMINATION REPORT NO. 50-602/OL-18-01, UNIVERSITY OF TEXAS AT AUSTIN DATED JUNE 13, 2018

<u>DISTRIBUTION</u>:
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ADAMS Accession No.: ML18165A219 **NRR-074**

OFFICE	NRR/DLP/PROB/CE	NRR/DLP/PROB/OLA	NRR/DLP/PROB/BC
NAME	JNguyen	CRandiki	AMendiola
DATE	05/30/2018	06/12/2018	06/13/2018

OFFICIAL RECORD COPY

cc:

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

REPORT NO.: 50-602/OL-18-01

FACILITY DOCKET NO.: 50-602

FACILITY LICENSE NO.: R-129

FACILITY: UNIVERSITY of TEXAS at AUSTIN

SUBNETLTED BY: ***/RA/*** ***05/30/2018***
John T. Nguyen, Chief Examiner Date

SUMMARY:
During the week of April 23, 2018, the NRC administered operator licensing examinations to four Reactor Operator (RO) candidates. One RO candidate failed both the operating test and the written exam. Other candidates passed all applicable portions of the examinations.

REPORT DETAILS

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

2. Results:

	RO PASS/FAIL	SRO PASS/FAIL	TOTAL PASS/FAIL
Written	3/1	0/0	3/1
Operating Tests	3/1	0/0	3/1
Overall	3/1	0/0	3/1

3. Exit Meeting:
   John T. Nguyen, Chief Examiner, NRC
   Paul Whaley, Associate Director, NETL
   Larry Hall, Reactor Manager, NETL

   At the conclusion of the meeting, the NRC examiner thanked the facility for their support in the administration of the examinations. 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, 10 CFR 50.59 process, and radiation sources and hazards. The facility licensee promised taking actions to improve program performance in the training programs.

Operator Written Examination

University of Texas

Week of April 23, 2018

ENCLOSURE 2

FACILITY COMMENT

Question B.13

Facility Comment

Per TS 6.1.3, answers “a” and “d” both are correct. We suggest “a” and “d” both be accepted.

NRC response

Facility comment accepted. Answer key changed to either “a” or “d’, both answers will be accepted as correct. In the future, the question will be modified accordingly.

Question B.15

Facility Comment

There is no correct answer listed in the distractors. Request the Question B.15 be deleted.

NRC response

Facility comment accepted. Question B.15 is deleted. This question will not factor into the candidates’ grades

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

FACILITY: University of Texas - Austin

REACTOR TYPE: TRIGA

DATE ADMINISTERED: 04/26/2018

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

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 ___ (0.25 each)

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 *****)

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   ___

B03   a   b   c   d   ___

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   ___ (0.25 each)

B09   a   b   c   d   ___

B.10   a   b   c   d   ___

B11   a   b   c   d   ___

B12   a   b   c   d   ___

B13   a   b   c   d   ___

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   ___ (0.5 each)

B19   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 ___ (0.25 each)

C03 a ___ b ___ c ___ d ___ (0.25 each)

C04 a b c d ___

C05 a b c d ___

C06 a ___ b ___ c ___ d ___ (0.50 each)

C07 a b c d ___

C08 a ___ b ___ c ___ d ___ (0.25 each)

C09 a b c d ___

C10 a ___ b ___ c ___ d ___ (0.25 each)

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 ___ (0.25 each)

C16 a b c d ___

C17 a b c d ___

C18 a b c d ___

C19 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.

$Q = m\, c_p\, \Delta T$

$Q = m\, \Delta h$

$SCR = S/(1-Keff)$

$Q = UA\, \Delta T$

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

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

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

$SUR = 26.06/\tau$

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

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

$SDM = (1-Keff)/Keff$

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

$I = I_o\, e^{-ux}$

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

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

$\tau = (P^*/\rho) + [(\bar{\beta}-\rho)/\lambda_{eff}\rho]$

$\tau = P^*/(\rho-\bar{\beta})$

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

$R = 6\, C\, E\, n/r^2$

$\rho = \Delta Keff/Keff$

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

$\bar{\beta} = 0.007$

$DR_1 D_1^2 = DR_2 D_2^2$

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

$Cp\,(H20) = 0.146\, \frac{kw}{gpm \cong F}$

$P = S\, /\, (1 - Keff)$

$\lambda_{eff} = 0.1/\sec$

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

---

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

1 kg = 2.21 lbm

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

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

1 BTU = 778 ft-lbf

F = 9/5 C + 32

931 Mev = 1 amu

C = 5/9 (F - 32)

Section A: Theory, Thermo & Facility Operating Characteristics

QUESTION A.01 [1.0 point]
If the multiplication factor, k, is increased from 0.80 to 0.90, the amount of reactivity added is:

a. 0.01 % $\Delta k/k$

b. 0.14 % $\Delta k/k$

c. 1.39 % $\Delta k/k$

d. 13.9 % $\Delta k/k$

QUESTION A.02 [1.0 point]
Which ONE of the following statement best defines the reactor excess reactivity? The reactor excess reactivity is:

a. a measure of the additional fuel loaded to overcome fission product poisoning.

b. a measure of remaining control rod worth when the reactor is exactly critical.

c. the combined control rod negative reactivity worth required to keep the reactor shutdown.

d. a measure of remaining control rod worth when the reactor is sub-critical.

QUESTION A.03 [1.0 point]
A reactor is critical at 18.1 inches on a controlling rod. The controlling rod is withdrawn to 18.4 inches. The reactivity inserted is 14.4 cents. What is the differential rod worth?

a. 14.4 cents/inch at 18.25 inches.

b. 48 cents/inch at 18.4 inches.

c. 48 cents/inch at 18.25 inches.

d. 14.4 cents/inch at 18.1.

Section A: Theory, Thermo & Facility Operating Characteristics

QUESTION A.04 [1.0 point]

Given the thermal neutron flux (Ø) is 1.0×10^{13} neutrons/cm^2/second, and the macroscopic cross-section (Σ_f) for fission is 0.1 cm^{-1}. The fission rate is:

a. 1.0×10^{12} fissions/cm/second

b. 1.0×10^{14} fissions /cm/second

c. 1.0×10^{12} fissions/cm^3/second

d. 1.0×10^{14} fissions /cm^3 / second

QUESTION A.05 [1.0 point, 0.25 each]

Replace "X" with the type of decay necessary (Alpha, Positron, Gamma, or Neutron emission) to produce the following reactions.

a. ${}_{84}Po^{210} \rightarrow {}_{82}Pb^{206} + X$

b. ${}_{83}Bi^{203} \rightarrow {}_{82}Pb^{203} + X$

c. ${}_{2}He^{4} + {}_{4}Be^{9} \rightarrow {}_{6}C^{12} + X$

d. ${}_{92}U^{238} \rightarrow {}_{90}Th^{234} + X$

QUESTION A.06 [1.0 point]

Reactor power is rising on a 10 second period. Approximately how long will it take for power to triple?

a. 11 seconds

b. 22 seconds

c. 33 seconds

d. 44 seconds

QUESTION A.07 [1.0 point]
The number of neutrons passing through a one square centimeter of target material per second is described as:

a. Microscopic cross section.

b. Macroscopic cross section.

c. Neutron Flux.

d. Fission rate.

QUESTION A.08 [1.0 point]
You are assigned to check the operation of a new nuclear instrumentation channel. 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 the time for power to decrease by a factor of 10?

a. 3 minutes

b. 60 minutes

c. 80 minutes

d. 184 minutes

QUESTION A.09 [1.0 point, 0.25 each]
Identify whether each of the following conditions will INCREASE or DECREASE the shutdown margin of a reactor.

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

b. Insertion of boron graphite to the reactor core.

c. Moving one fuel element from reactor core to fuel storage.

d. Burnout of a burnable poison.

QUESTION A.10 [1.0 point]
A reactor is slightly supercritical, with the thermal utilization factor = 0.700. 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. 0.698

b. 0.701

c. 0.702

d. 0.704

QUESTION A.11 [1.0 point]
Delayed neutrons are considered to cause “fission” easier than prompt neutrons because delayed neutrons have a:

a. higher energies than prompt fission neutrons.

b. higher fast non-leakage probability.

c. lower reproduction factor.

d. lower thermal utilization factor.

QUESTION A.12 [1.0 point]
The reactor is SHUTDOWN by 5 %Δk/k with the count rate of 1000 counts per second (cps). The control rods are withdrawn until the count rate is quadrupled. What is the value of K_{eff}?

a. 0.952

b. 0.976

c. 0.988

d. 1.002

QUESTION A.13 [1.0 point]
Which term is described by the following?
“The increase in neutron population by providing a positive additional reactivity while the reactor is subcritical”

a. Inverse Multiplication

b. Subcritical Multiplication

c. Neutron Production

d. Source Strength

QUESTION A.14 [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.15 [1.0 point]
Given the following Core Reactivity Data:

Control Rod	Total Worth (%Δk/k)	Core excess (%Δk/k) at 100 watts)
Shim 1	2.00	Full out (0.0)
Shim 2	2.00	0.50
Trans Rod	2.10	0.70
Reg rod	2.60	0.80

Which one of the following is the calculated shutdown margin that would satisfy the Technical Specification Minimum Shutdown Margin? No experiments in core.

a. 6.7 %Δk/k

b. 4.1 %Δk/k

c. 3.7 %Δk/k

d. 1.5 %Δk/k

Section A: Theory, Thermo & Facility Operating Characteristics

QUESTION A.16 [1.0 point]
A reactor is operating at a steady-state power level of 100 W. Power is increased to a new steady-state value of 1.0 kW. At the higher power level, K_{eff} is _____ comparing to the lower power.

a. lower

b. higher

c. the same

d. fluctuating between 0.95 and 1.05 when period reaches to infinitive

QUESTION A.17 [1.0 point]
Which ONE of the following factors of the Six Factor formula is most affected by changing the core structure such as control rod materials?

a. Thermal Utilization Factor (f)

b. Reproduction Factor (η)

c. Fast Fission Factor (ε)

d. Fast Non-Leakage Factor (L_f)

QUESTION A.18 [1.0 point]
Which ONE of the following is the principal source of energy (heat generation) in the reactor following a reactor shutdown from extended operation at 100% power?

a. Fission product beta and gamma decay.

b. Xenon concentration buildup.

c. Spontaneous fission of U-238.

d. Decay of fission products.

QUESTION A.19 [1.0 point]
Which ONE of the following describes the response of the subcritical reactor to equal insertions of positive reactivity as the reactor approaches critical? Each reactivity insertion causes:

a. a SMALLER increase in the neutron flux, resulting in a LONGER time to reach equilibrium.

b. a SMALLER increase in the neutron flux, resulting in a SHORTER time to reach equilibrium.

c. a LARGER increase in the neutron flux, resulting in a LONGER time to reach equilibrium.

d. a LARGER increase in the neutron flux, resulting in a SHORTER time to reach equilibrium.

QUESTION A.20 [1.0 point]
A reactor is subcritical with a K_{eff} of 0.927. If you add 7.875%Δk/k into the core, the reactor will be:

a. subcritical

b. critical

c. supercritical

d. prompt critical

***** END OF CATEGORY A *****

Section B: Normal/Emergency Procedures and Radiological Controls

QUESTION B.01 [1.0 point]
A radiation survey of an area reveals a general radiation reading of 1 mrem/hr. There is, however, a small pipe which reads 3 mrem/hr at one (1) meter. Which ONE of the following defines the posting requirements for the area in accordance with 10CFR20?

a. Public Area, no posting required.

b. Caution, Radiation Area.

c. Caution, High Radiation Area.

d. Grave Danger, Very High Radiation Area.

QUESTION B.02 [1.0 points]
Which ONE of the following conditions is the Technical Specifications reportable occurence?

a. The shutdown margin exceeds $3.0.

b. Inserting a non-secured experiment worth of $0.80.

c. Causing an unanticipated change in reactivity insertion of $1.10.

d. The sum of the absolute reactivity worth of in-core experiments exceeds $2.5.

QUESTION B.03 [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. 20%

b. 40%

c. 60%

d. 90%

QUESTION B.04 [1.0 point]
Per FUEL-1 procedure, movement of CONTROL FOLLOWER requires a minimum shutdown margin:

a. greater than 0.2 %Δk/k with removal of 1 rod out (the most reactive control rod).

b. lesser than 0.2 %Δk/k with removal of 1 rod out (the most reactive control rod).

c. greater than 0.2 %Δk/k with removal of two rods out (the rod being removed out and the most reactive control rod).

d. greater than 0.2 %Δk/k with insertion of 1 rod in (the most reactive control rod).

QUESTION B.05 [1.0 point]
In accordance with 10CFR20.1301, individual members of the public are limited to a TEDE in one year of:

a. 10 mrem.

b. 100 mrem.

c. 500 mrem.

d. 1250 mrem.

QUESTION B.06 [1.0 point]
For emergency events that require evacuation of a room or area of the building, the initial emergency assembly area shall be:

a. The reactor control room.

b. The health physics room.

c. The emergency support center.

d. The equipment access driveway.

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

a. An unanticipated change in reactivity of one dollar.

b. Instrumented fuel temperature exceeds 500 °C.

c. Power exceeds 1.2 MW power in square wave mode.

d. A major loss of reactor pool water.

QUESTION B.08 [1.0 point, 0.25 each]
Match the 10 CFR Part 55 requirements listed in Column A for an actively licensed operator with the correct time period from Column B. Column B answers may be used once, more than once, or not at all.

	Column A		Column B
a.	License Expiration	1.	1 year
b.	Medical Examination	2.	2 years
c.	Requalification Written Examination	3.	5 years
d.	Requalification Operating Test	4.	6 years

QUESTION B.09 [1.0 point]
According to ADMN-6 procedure, Class C experiments:

a. require a presence of the Reactor Supervisor.

b. require a presence of the Senior Reactor Operator.

c. require a presence of the Reactor Operator.

d. do not require a presence of the licensed operator.

QUESTION B.10 [1.0 point]
Per Technical Specifications, which ONE of the following statements defines the term "Channel Test”?

a. The introduction of a signal into a channel for verification of the operability of the channel.

b. The qualitative verification of acceptable performance by observation of channel behavior.

c. The combination of sensors, electronic circuits and output devices connected to measure and display the value of a parameter.

d. The adjustment of a channel such that its output corresponds with acceptable accuracy to known values of the parameter which the channel measures.

QUESTION B.11 [1.0 point]
Per NETL Emergency Response Plan, the area within the facility that encloses the reactor room is defined as the:

a. Confinement Area.

b. Emergency Planning Zone.

c. Safe Guard Area.

d. Site Area Boundary.

QUESTION B.12 [1.0 point]
Per NETL Technical Specifications, which ONE of the following statements is true?

a. Liquid fissionable materials shall be doubly encapsulated.

b. Explosive materials in quantities less than 5 grams may be irradiated in the reactor or experimental facilities.

c. The reactivity worth of any single movable experiment shall be less than $2.00.

d. Each fuel experiment shall be controlled such that the total inventory of Iodine isotopes 131 thru 135 in the experiment is no greater than 5 curies.

QUESTION B.13 [1.0 point]
Per NETL Technical Specifications, which ONE of the following events does **NOT** require the presence of a licensed Senior Reactor Operator in the control room?

a. Performance of a channel calibration of the Continuous Air Monitor (CAM).

b. Resumption of operation following unexpected significant reduction in power.

c. Removal of Shim control rod for inspection.

d. Insertion of experiment worth of $0.90.

QUESTION B.14 [1.0 point]
Which ONE of the following is NOT a responsibility of the Emergency Director during an emergency?

a. Authorization for reentry and access.

b. Terminating an emergency and initiating recovery actions.

c. Supervise security assistance and establish emergency communications.

d. Authorization for emergency exposures in excess of occupational limits during rescue and recovery activities.

QUESTION B.15 [1.0 point] Question B.15 is deleted per facility comment
~~What is a minimum level of authority that has the power to approve minor permanent changes such as typographical error correction or any other change that does not change the effectiveness or the intent of the procedure?~~

~~a. Reactor Safety Committee~~

~~b. Director~~

~~c. Any Senior Reactor Operator~~

~~d. Any Reactor Operator~~

QUESTION B.16 [1.0 point]
Per NETL Technical Specifications, a corrective action shall be taken or the reactor shut down if the water pool conductivity is ______ during measurement periods of 30 days:

a. average 2 micro-mho/cm

b. average 5 micro-mho/cm

c. dropping from 5 micro-mho/cm to 2 micro-mho/cm

d. exceeding 0.5 Mega-ohm/cm

QUESTION B.17 [1.0 point]
Per NETL Technical Specifications, the following measuring channels are required to be operable in any modes of operations:

a. 1 fuel temperature + 1 power level + 1 pulse

b. 2 fuel temperature + 1 power level + 1 pulse

c. 1 fuel temperature + 2 power level + 2 pulse

d. 2 fuel temperature + 2 power level + 1 pulse

QUESTION B.18 [2.0 points, 0.5 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 voltage scram.

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

c. During reactor operation, you compare readings of a reactor power.

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

QUESTION B.19 [1.0 point]
Per NETL Technical Specifications, the minimum safety interlocks shall be tested:

a. Biennially

b. Annually

c. Semi-annually

d. Quarterly

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

Section C Facility and Radiation Monitoring Systems

QUESTION C.01 [1.0 point]
A control rod is partially withdrawn from the core. At this point, the source level, for some unknown reason, drops to 1 count per second. 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.02 [1.0 point, 0.25 each]
Match the purification system functions in column A with the purification component listed in column B. (Note: items from column B may be used more than once, or not at all.)

	Column A		Column B
a.	Prevent clogging in the demineralizer.	1.	Resin in demineralizer
b.	Remove dissolved impurities	2.	Filter
c.	Remove suspended solids		
d.	Maintain pH		

QUESTION C.03 [1.0 point, 0.25 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.	NM-1000
b.	Scram at high pulse power	2.	NP-1000
c.	Scram on loss HV of fission chamber	3.	NPP-1000
d.	Using output signal in mV range	4.	Fuel Temperature Channel

Section C Facility and Radiation Monitoring Systems

QUESTION C.04 [1.0 point]
Which ONE of the following statements correctly describes the reactor pool?

a. Siphon break holes in suction and discharge lines are above the 7.60 meter level to protect against excess radiation at the pool surface and should not extend below 2 meters from the top of the tank.

b. Siphon break holes in suction and discharge lines are above the 7.60 meter level to protect against pool water loss and suction line should not extend below 2 meters from the top of the tank.

c. Siphon break holes in suction and discharge lines are above the 6.00 meter level to protect against excess radiation at the pool surface and should not extend below 3 meters from the top of the tank.

d. Siphon break holes in suction and discharge lines are above the 6.00 meter level to protect against pool water loss and should not extend below 3 meters from the top of the tank.

QUESTION C.05 [1.0 point]
A Reactor Operator completely sets up a $1.20 pulse except forgetting to input a pulse description into the computer system. Which ONE of the following correctly describes the reactor status when a Reactor Operator presses a FIRE button?

a. Reactor changes from Pulse mode to Manual mode.

b. Reactor Scram.

c. Completely fire a $1.20 Pulse.

d. Nothing happen, still waiting for data input in the Pulse mode.

Section C Facility and Radiation Monitoring Systems

QUESTION C.06 [2.0 points, 0.5 each]
Reactor is in operation. Match the input signals listed in column A with their AUTOMATIC response listed in column B. (Items in column B may be used once, more than once, or not at all.)

	Column A	Column B	
a.	Fuel temperature = 550 °C	1.	Indication
b.	Source count rate = 5 cps	2.	Interlock
c.	NP-1000 Channel = 130% power	3.	Scram
d.	Beam Port not secure		

QUESTION C.07 [1 point]
Water returning to the pool from the primary system is ejected through an angled nozzle, which causes a swirling motion in the pool. Which ONE of the following is the PRIMARY purpose for this design?

a. To increase the heat transfer rate due to increased convective flow.

b. To increase the transport time for N^{16} to reach the surface of the pool.

c. To break up O^{16} bubbles in the pool thereby decreasing the production of N^{16}.

d. To decrease the activation rate of O^{16} to N^{16} due to a decrease in time within the core.

QUESTION C.08 [1.0 point, 0.25 each]
When reactor is at full power, identify the transfer mechanism (Forced Convection, Force Flow with no heat transfer) Natural Convection or Conduction) for each of the following:

a. Cooling the Core.

b. Cooling the Pool.

c. Remove ions by demineralizer.

c. Transfer of heat across the tubes of the heat exchanger.

Section C Facility and Radiation Monitoring Systems

QUESTION C.09 [1.0 point]
Which ONE of the following will have an emergency power during a loss of the electrical building power?

a. Building security system, emergency lights, and exit signs.

b. Building security system and Bridge Radiation Area monitor.

c. Reactor console, emergency lights, and exit signs.

d. Primary coolant pump and Bridge Radiation Area monitor.

QUESTION C.10 [1.0 point, 0.25 each]
Use the following diagram of the control rod armature; match the components listed in Column A to the appropriate position locator listed in the diagram.

Column A

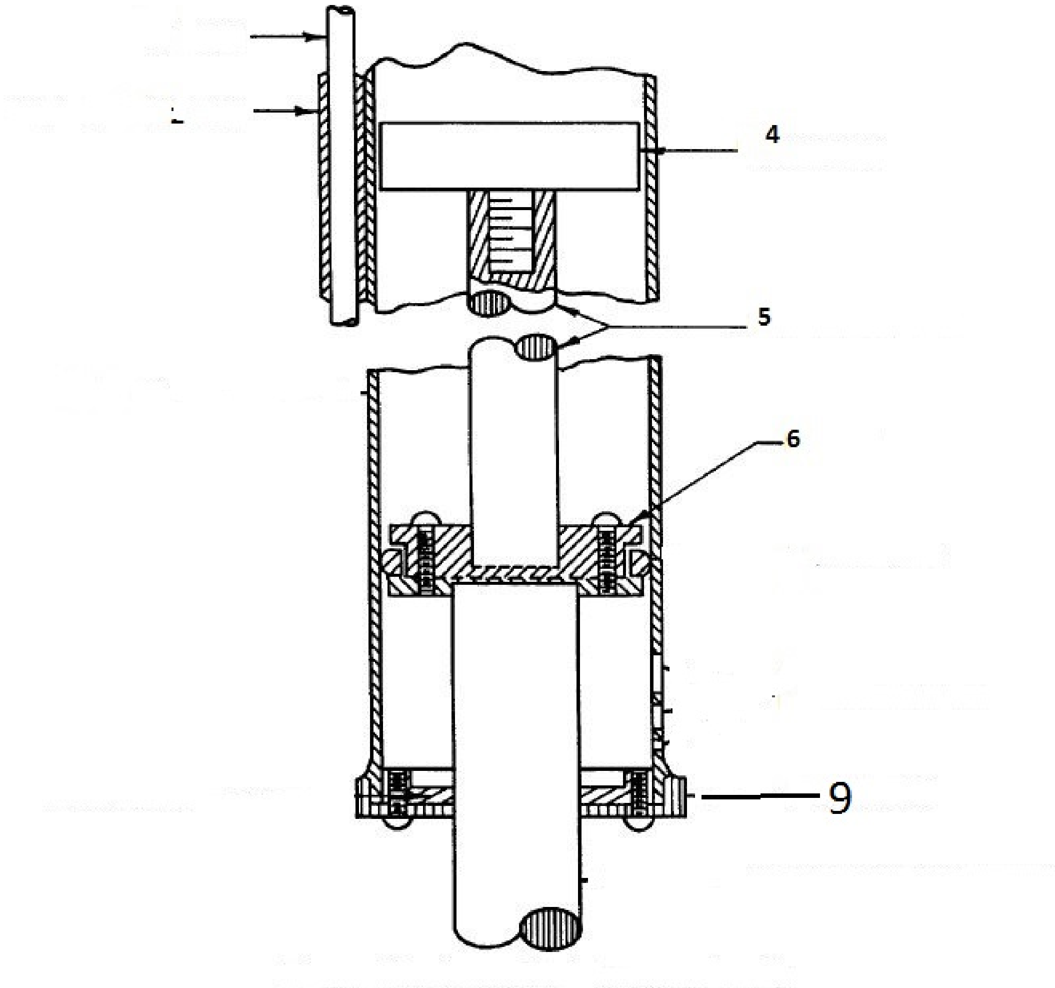
a. Barrel End

b. Piston

c. Armature

d. Connecting Rod

Section C Facility and Radiation Monitoring Systems



QUESTION C.11 [1.0 point, 0.25 each]
Match the control rods listed in column A with their core location ring listed in column B. (Items in column B may be used once, more than once, or not at all.)

Column A		Column B	
a.	Shim 1	1.	Ring B
b.	Shim 2	2.	Ring C
c.	Regulating	3.	Ring D
d.	Transient	4.	Ring E
		5.	Ring F

QUESTION C.12 [1.0 point]
Thermocouples in an instrumented TRIGA fuel element measure temperature at the:

a. surface of the cladding.

b. interior of the fuel section.

c. surface of graphite reflector.

d. center of the zirconium rod.

QUESTION C.13 [1.0 point]
When the OUTLET conductivity of the demineralizer reads 0.1 micro-mho and the INLET conductivity reads 1 micro-mho, it indicates that:

a. the resin bed has been depleted and it needs to be changed.

b. the outlet leg of the demineralizer has been logged.

c. the inlet leg of the demineralizer has been logged.

d. The demineralizer is operable and no need to change the resin bed.

QUESTION C.14 [1.0 point]
The majority of the facility's Ar-41 is produced in the:

a. Experimental facilities.

b. Reactor bay area.

c. Fume sorting hood area.

d. Reactor pool.

QUESTION C.15 [1.0 point, 0.25 each]
The Shim rod is continuously rising from 100 to 500 units. Select (Open/Closed) for the Limit Switches and (ON/OFF) for the lights. Note: OPEN means the limit switch does NOT activate.

a. Rod DOWN limit switch (Open/Close)

b. Motor UP limit switch (Open/Close)

c. DOWN light (ON/OFF)

d. MAGNET light (ON/OFF)

QUESTION C.16 [1.0 point]
The ALERT level set point for the Ar-41 CAM is:

a. 2000 cpm

b. 4000 cpm

c. 6000 cpm

d. 10000 cpm

QUESTION C.17 [1.0 point]
When the reactor is in the Steady State mode, two or more control rods shall NOT be withdrawn simultaneously. The purpose of this interlock is to:

a. prevent the possibility of a source-less startup.

b. prevent the inadvertent pulsing of a reactor in the steady state mode.

c. assure sufficient amount of startup neutrons are available to achieve a controlled approach to criticality.

d. prevent violation of the maximum reactivity insertion rate for steady state operation.

QUESTION C.18 [1.0 point]
Reactor Operator is performing a SQUARE WAVE operation. In Square Wave Mode, the reactor will automatically switch to AUTO mode if demand power is reached in 10 seconds. If demand power is not reached in 10 seconds, the system will:

a. switch to a MANUAL mode.

b. scram.

c. run down.

d. prevent any rod movement.

QUESTION C.19 [1.0 point]
What is the MAIN reason that you would NOT bring the power level to exceed 1000 watts during the control rod calibration?

a. Taking too long to obtain the reactor period.

b. Avoiding the maximum reactivity insertion rate.

c. Preventing the possibility of a rod withdraw prohibit.

d. Avoiding temperature feedback that induced reactivity effects.

***** END OF CATEGORY C *****
***** END OF EXAMINATION *****

Section A: Theory, Thermo & Fac. Operating Characteristics

A.01
Answer: d
Reference: Burn, R., *Introduction to Nuclear Reactor Operations,* © 1982, Sec 3.3.3, page 3-21.
$\Delta\rho$ = (keff1-keff2)/(keff1 x keff2) = 0.9-0.8 /(0.8*0.9)=0.139
or 13.9 % $\Delta k/k$

A.02
Answer: b
Reference: Burn, R., *Introduction of Nuclear Reactor Operations*, © 1988, Sec 6.2

A.03
Answer: c
Reference: Burn, R., *Introduction of Nuclear Reactor Operations*, © 1988, Sec 7.3
Differential position is at the midpoint (18.25)
$\Delta\rho$ = 14.4 cents
Δx = 18.4 - 18.1 = 0.3 inches
Differential rod worth ($\Delta\rho$/in) = ($\Delta\rho$)/(Δx)
= 14.4 cents /0.3 = 48 cents at midpoint (18.25 inches)

A.04
Answer: c
Reference: Fission rate = thermal flux (Ø) x macroscopic cross-section. (Σ_f) = 1.0×10^{13} x 0.1 cm^{-1} = 1.0×10^{12} neutrons/cm^3/second
Burn, R., *Introduction of Nuclear Reactor Operations*, © 1988, Sec 2.6.2

A.05
Answer: a, alpha b, $_{+1}\beta^0$ c, neutron d, alpha
Reference: Burn, R., Introduction of Nuclear Reactor Operations, © 1988, Sec 2.8

A.06
Answer: a
Reference: $P = P_0 e^{t/T}$ —> ln(3) = time ÷ 10 seconds –> time = ln (3) x 10 sec. 1.1 x 10 ≈ 11 sec.

A.07
Answer: c
Reference: Burn, R., *Introduction of Nuclear Reactor Operations*, © 1988, Sec 2.6.1

A.08
Answer: a
Reference: $P/P_0 = e^{-T/\tau}$ ln(0.1) = - time/period Time = ln (0.1) × -80 sec = 184 seconds ≈ 3 minutes

A.09
Answer: a, DECREASE; b, INCREASE;
c, INCREASE; d, DECREASE
Reference: DOE Fundamentals Handbook, Volume 2, Module 4, Reactor Theory (Reactor Operations), Enabling Objective 3.6

A.10
Answer: a
Reference: Burn, R., *Introduction of Nuclear Reactor Operations*, © 1988, Sec 3.3.1
Thermal Utilization factor will be decreased due to thermal neutrons absorbed by the control rod.

A.11
Answer: b
Reference: Burn, R., *Introduction of Nuclear Reactor Operations*, © 1988, Sec 3.3.1

A.12
Answer: c
Reference:
Keff1=1/1- ρ1
Keff1 =1/(1-(-.05)) —>Keff1= 0.952,
Count1*(1-Keff1) = Count2*(1-Keff2)
Count1*(1-0.952) = Count2*(1-Keff2)
1000*(1-0.952) = 4000(1- Keff2); Keff2 = 0.988

A.13
Answer: b
Reference: Burn, R., *Introduction to Nuclear Reactor Operations,* © 1988, Section 5.1, Subcritical Multiplication

A.14
Answer: d
Reference: Burn, R., *Introduction of Nuclear Reactor Operations*, © 1988, Sec 2.5.3

A.15
Answer: c
Reference: Shutdown = Rod withdrawal of Shim1, Shim2 and Reg
2.0 %Δk/k +1.5 %Δk/k + 1.8 %Δk/k = 5.3 %Δk/k
Minimum SDM = Shut down – (highest worth of control rod)
5.3%Δk/k – 2.6%Δk/k = 2.7 %Δk/k
SOP: SURV-3

A.16
Answer: c
Reference: UT Training Manual, Vol. IV, Nuclear Physics and Reactor Theory

A.17
Answer: a
Reference: Burn, R., *Introduction of Nuclear Reactor Operations*, © 1988, Sec 3.3.1

A.18
Answer: d
Reference: Burn, R., *Introduction of Nuclear Reactor Operations*, © 1988, Sec 3.2.1

A.19
Answer: c
Reference: NRC Standard Question

A.20

Answer: b

Reference: SDM = (1- keff)/keff = (1-0.927)/0.927 = 0.07875 Δk/k. So if you add the same amount of SDM, the reactor is critical.
Another method: you can find the new value of Keff when adding 0.07875 Δk/k to reactor.
Δp = (k2 –k1)/ k1*k2
0.07875 = (k2- 0.927)/(0.927* k2), solve for k2
K2 = 1, hence the reactor is critical

Section B Normal/Emergency Procedures and Radiological Controls

B.01
Answer: b
Reference: $DR_1 * D_1^2 = DR_2 * D_2^2$;
5 mrem/hr at one meter (100 cm.)
results in 33.3 mrem/hr at 30 cm.

B.02
Answer: c
Reference: TS 6.6.2

B.03
Answer: d
Reference: 10CFR20 - At 10 feet, there is no beta radiation. Gamma at 10 feet = 0.1 mrem/hour. Using $DR_1 * D_1^2 = DR_2 * D_2^2$, so gamma at 1 foot = 100*0.1 mrem/hour = 10 mrem/hour. Therefore, beta at 1 foot = 90 mrem/hour or 90%.

B.4
Answer: c
Reference: SOP FUEL-1, Section II.A.15.d

B.05
Answer: b
Reference: 10 CFR 20

B.06
Answer: b
Reference: UT Emergency Response Plan, Section 4.1

B.07
Answer: c
Reference: TS 2.2.2

B.08
Answer: a,4 b,2 c,2 d,1 (0.25 each)
Reference: 10CFR55

B.09
Answer: d
Reference: ADMN-6

B.10
Answer: a
Reference: TS 1.0

B.11
Answer: a
Reference: ERP 1.1.2

B.12
Answer: a
Reference: TS 3.4

Section B Normal/Emergency Procedures and Radiological Controls

B.13
Answer: a or d   Answers “a” and “d” both are correct per facility comment
Reference: TS 6.1.2

B.14
Answer: c
Reference: ERP 2.1.1

~~**B.15**~~
~~Answer: b~~   Question B.15 is deleted per facility comment
~~Reference: TS 6.3~~

B.16
Answer: b
Reference: TS 3.3.1

B.17
Answer: d
Reference: TS 3.2.4

B.18
Answer: a = TEST; b = TEST; c = CHECK; d = CAL (0.5 each)
Reference: TS 1.0

B.19
Answer: c
Reference: TS 4.2.2

Section C Facility and Radiation Monitoring Systems

C.01
Answer: a
Reference: TS 3.2.2

C.02
Answer: a = 2; b = 1; c = 2; d= 1 (0.25 each)
Reference: Standard NRC purification system question.

C.03
Answer: a = 1; b = 3; c = 1; d= 4 (0.25 each)
Reference: SAR 6.1

C.04
Answer: b
Reference: SAR Section 5.2.1, page 5-6

C.05
Answer: d
Reference: OPER-3

C.06
Answer: a = 3 b = 1; c = 3; d= 1 (0.5 each)
Reference: TS 3.2

C.07
Answer: b
Reference: SAR 5.6

C.08
Answer: a = NC; b = FC; c = FF d = Con (0.25 each)
Reference: Standard NRC question

C.09
Answer: a
Reference: SAR 8.1

C.10
Answer: a(9) b(6) c(4) d(5) (0.25 each)
Reference: SAR Figure 4.14

C.11
Answer: a = 3 b = 3; c = 2; d= 2 (0.25 each)
Reference: FUEL-1, Core arrangement

C.12
Answer: b
Reference: SAR 4.1.1

Section C Facility and Radiation Monitoring Systems

C.13
Answer: d
Reference: SAR 5.1.4
0.1 micromho = 10 MΩ at outlet
1 micromho = 1 MΩ at inlet
So, the demineralizer is working!

C.14
Answer: a
Reference: SAR Section 7.4.2, page 7-27

C.15
Answer: a (Open) b(Open) c(OFF) d(ON) (0.25 each)
Reference: SAR 6.1.4

C.16
Answer: a
Reference: OPER-1, Startup - Shutdown Checks, Attachment, Radiation Monitors, pg. 1 of 2
MAIN-4, Area Radiation Monitor Systems, PRM AR-1000 gas monitor Calibration, 3, pg. 1 of 2

C.17
Answer: d
Reference: TS 3.2.1 & 3.2.2

C.18
Answer: a
Reference: OPER-2, Square Wave Mode

C.19
Answer: d
Reference: SURV-6