April 11, 2012

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-12-01, UNIVERSITY OF TEXAS AT AUSTIN

Dear Mr. Whaley:

During the week of March 12, 2012, the Nuclear Regulatory Commission (NRC) administered an operator licensing examination at your TRIGA Reactor. The examination was 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/

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

Docket No. 50-602

Enclosures: 1. Examination Report No. 50-602/OL-12-01
2. Written examination with facility comments incorporated

cc: Michael Krause, Reactor Supervisor
cc w/o enclosures: See next page

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cc: Michael Krause, Reactor Supervisor
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DISTRIBUTION:
PUBLIC RidsNrrDprPrta RidsNrrDprPrtb
Facility File (CRevelle) O-07 F-08

ADAMS ACCESSION #: ML12081A109 **TEMPLATE #: NRR-079**

Office	PROB/CE	IOLB/OLA	PROB/BC	
Name	JNguyen	CRevelle	JEads	
Date	3/21/12	3/21/12	3/21/12	

OFFICIAL RECORD COPY

cc:

Governor's Budget and
Planning Office
P.O. Box 13561
Austin, TX 78711

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

Mr. William Powers, Jr., President
University of Texas at Austin
Nuclear Engineering teaching Laboratory
Austin, TX 78758

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

Test, Research, and Training
Reactor Newsletter
University of Florida
202 Nuclear Sciences Center
Gainesville, FL 32611

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

REPORT NO.: 50-602/OL-12-01

FACILITY DOCKET NO.: 50-602

FACILITY LICENSE NO.: R-129

FACILITY: UNIVERSITY of TEXAS at AUSTIN

EXAMINATION DATES: March 12, 2012

SUBMITTED BY: /RA/ 03/21/2012
John Nguyen, Chief Examiner Date

SUMMARY:

During the week of March 12, 2012, the NRC administered the operator licensing examinations to one Reactor Operator candidate and one Senior Reactor Operator Upgraded candidate. All candidates passed all portions of the examination.

REPORT DETAILS

1. Examiners:
   John Nguyen, Examiner, NRC

2. Results:

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

3. Exit Meeting:
   John Nguyen, NRC
   Michael Krause, Reactor Manager
   Hunter Fuentes, Senior Reactor Operator

The examiner thanked the facility for their support during the examination and their comments on questions B.1, C.1, and C.6. The examiner indicated no generic weaknesses were noted during the operating examination.

ENCLOSURE 1

U. S. NUCLEAR REGULATORY COMMISSION
RESEARCH AND TEST REACTOR OPERATOR LICENSING EXAMINATION

FACILITY: UNIVERSITY of TEXAS at AUSTIN

REACTOR TYPE: TRIGA

DATE ADMINISTERED: 03/12/2012

CANDIDATE: ______________________________

INSTRUCTIONS TO CANDIDATE:

Answers are to be written on the answer sheets provided. Points for each question are indicated in brackets for each question. You must score 70% in each section to pass. Examinations will be picked up three (3) hours after the examination starts.

Category Value	% of Total	Candidates Score	% of Category Value	Category
20.00	33.33	______	____	A. Reactor Theory, Thermodynamics and Facility Operating Characteristics
20.00	33.33	______	____	B. Normal and Emergency Operating Procedures and Radiological Controls
20.00	33.33	______	____	C. Plant and Radiation Monitoring Systems
FINAL GRADE		______	% TOTALS	

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

____
Candidate's Signature

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 <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. The point value for each question is indicated in [brackets] after the question.

7. If the intent of a question is unclear, ask questions of the examiner only.

8. To pass the examination you must achieve a grade of 70 percent or greater in each category.

9. There is a time limit of three (3) hours for completion of the examination.

10. When you have completed and turned in you examination, leave the examination area

EQUATION SHEET

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

$$T_{‰} = \frac{0.693}{\lambda}$$

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

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

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

$$DR_1 d_1^2 = DR_2 d_2^2$$

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

1 Curie = 3.7×10^{10} dis/sec

1 kg = 2.21 lbm

1 Horsepower = 2.54×10^{3} BTU/hr

1 Mw = 3.41×10^{6} BTU/hr

1 BTU = 778 ft-lbf

1 gal (H_2O) ≈ 8 lbm

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

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

ANSWER SHEET

Multiple Choice (Circle or X your choice)
If you change your answer, write your selection in the blank.

A001 a b c d _____

A002 a b c d _____

A003 a b c d _____

A004 a b c d _____

A005 a b c d _____

A006 a b c d _____

A007 a b c d _____

A008 a b c d _____

A009 a b c d _____

A010 a b c d _____

A011 a b c d _____

A012 a b c d _____

A013 a b c d _____

A014 a b c d _____

A015 a b c d _____

A016 a b c d _____

A017 a b c d _____

A018 a b c d _____

A019 a b c d _____

A020 a b c d _____

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.

B001 a b c d ______

B002 a ______ b ______ c ______ d ______

B003 a b c d ______

B004 a b c d ______

B005 a b c d ______

B006 a b c d ______

B007 a b c d ______

B008 a b c d ______

B009 a b c d ______

B010 a b c d ______

B011 a b c d ______

B012 a b c d ______

B013 a b c d ______

B014 a b c d ______

B015 a b c d ______

B016 a ______ b ______ c ______ d ______

B017 a b c d ______

B018 a b c d ______

B019 a b c d ______

B020 a b c d ______

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.

C001 a b c d _____

C002 a b c d _____

C003 a b c d _____

C004 a b c d _____

C005 a _____ b _____ c _____ d __

C006 a b c d _____

C007 a b c d _____

C008 a b c d _____

C009 a b c d _____

C010 a b c d _____

C011 a _____ b _____ c _____ d __

C012 a b c d _____

C013 a b c d _____

C014 a b c d _____

C015 a b c d _____

C016 a b c d _____

C017 a b c d _____

C018 a b c d _____

C019 a b c d _____

C020 a b c d _____

***** END OF EXAMINATION *****

Question A.1 [1.0 point]
In a subcritical reactor, K_{eff} is increased from 0.931 to 0.946. Which ONE of the following is the amount of reactivity that was added to the core?

a. 1.50 %Δk/k

b. 1.70 %Δk/k

c. 3.40 %Δk/k

d. 5.40 %Δk/k

Question A.2 [1.0 point]
Which ONE of the following isotopes has the highest thermal neutron cross section?

a. Xe-135

b. Sm-149

c. U-235

d. U-238

Question A.3 [1.0 point]
Which ONE of the following best describes the effects of moderator temperature increase on neutron multiplication?

a. Resonance escape probability ↑; Thermal non-leakage↓; Rod worth ↑

b. Resonance escape probability ↓; Thermal non-leakage↓; Rod worth ↑

c. Resonance escape probability ↑; Thermal non-leakage↑; Rod worth ↓

d. Resonance escape probability ↓; Thermal non-leakage↓; Rod worth ↓

Question A.4 [1.0 point]
Two critical reactors at low power are identical, except that Reactor 1 has a beta fraction of 0.0065 and Reactor 2 has a beta fraction of 0.0072. Which ONE of the following best describes the response if an equal amount of positive reactivity is inserted into both reactors?

a. Period of the Reactor 1 will be longer than the period of the Reactor 2

b. Period of the Reactor 1 will be shorter than the period of the Reactor 2

c. Power of the Reactor 1 will be higher than the power of the Reactor 2

d. Power of the Reactor 1 will be lower than the power of the Reactor 2

Question A.5 [1.0 point]
Given the following Core Reactivity Data during startup:

Control Rod	Total Rod Worth (%Δk/k)	Rod Worth at Critical (%Δk/k)
SHIM Rod 1	1.90	1.30
REG Rod	1.20	1.00
SHIM Rod 2	1.80	1.00
Transient Rod	2.60	1.20

After reactor shutdown, the operator plans to remove the SHIM Rod 1 out of the reactor core for an inspection. Which ONE of the following would be the Shutdown Margin specified in the NETL Tech Spec if the operator removes the SHIM Rod 1? Removing the SHIM Rod 1 out of the reactor core would:

a. violate the Tech Spec Shutdown Margin because the calculated result is 0.0 %Δk/k

b. NOT violate the Tech Spec Shutdown Margin because the calculated result is 2.6 %Δk/k

c. violate the Tech Spec Shutdown Margin because the calculated result is - 3.0 %Δk/k

d. NOT violate the Tech Spec Shutdown Margin because the calculated result is 4.5 %Δk/k

Question A.6 [1.0 point]
Which ONE of the following best describes the beta decay (β_{-1}) of a nuclide?

The atomic mass number unchanged, and the number of protons increases by 1.

The atomic mass number unchanged, and the number of protons decreases by 1.

The atomic mass number increases by 1, and the number of protons decrease by 1.

The atomic mass number increases by 2, and the number of protons increase by 1.

Question A.7 [1.0 point]
An example of a **FISSIONABLE NUCLEI** is:

a. Pu-239

b. U-238

c. U-235

d. U-233

Question A.8 [1.0 point]
The time period in which the MAXIMUM amount of Xe 135 will be present in the core is approximately 8 hours after:

a. a startup to 100%power

b. a scram from 100% power

c. a power increase from 0% to 50%

d. a power decrease from 100% to 50%

Question A.9 [1.0 point]
In a just critical reactor, adding $0.50 worth of reactivity in the SQUARE-WAVE MODE will cause:

a. A sudden drop in delayed neutrons

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.10 [1.0 point]
During a reactor startup, criticality occurred at a **LOWER ROD HEIGHT** than the last startup. Which ONE of the following reasons could be the cause?

a. Higher moderator temperature (assume negative temperature coefficient).

b. Insertion of a negative reactivity worth experiment.

c. Burnout of a burnable poison.

d. Fuel depletion.

Question A.11 [1.0 point]
Which ONE of the following will be the resulting stable reactor period when a $0.35 reactivity insertion is made into an **exactly critical** reactor core? Neglect any effects from prompt. Given β_{eff} =0.0070 and λ=0.1

a. 13 seconds

b. 19 seconds

c. 28 seconds

d. 31 seconds

Question A.12 [1.0 point]

You are the reactor operator performing two pulsing operations. The first pulse has a reactivity worth of **$1.20** which results in a peak power of **200 MW**. If the second pulse has a reactivity worth of **$2.00**, the corresponding peak power is:

Given:
β_{eff} =0.0070

a. 1000 MW

b. 1750 MW

c. 2500 MW

d. 5000 MW

Question A.13 [1.0 point]

A reactor with K_{eff} = 0.7 contributes 2000 neutrons in the first generation. Changing from the first generation to the SECOND generation, how many total neutrons are there after the second generation?

a. 2250

b. 2600

c. 3400

d. 4000

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 heat transfer mechanisms which adds negative reactivity

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

d. 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

Question A.15 [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 inserting a control rod.

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

Question A.16 [1.0 point]
About two minutes following a reactor scram, the reactor period has stabilized and the power level is decreasing at a CONSTANT rate. Given that reactor power at time t_0 is 90 kW power, what will it be five minutes later?

a. 0.2 kW

b. 2.1 kW

c. 3.4 kW

d. 117.5 kW

Question A.17 [1.0 point]
The reactor is subcritical with the count rate of 100 counts per second (cps) and K_{eff} of 0.950. The control rods are withdrawn until the count rate is doubled. What is the new value of K_{eff}?

a. 0.952

b. 0.975

c. 0.998

d. 1.020

Question A.18 [1.0 point]
Xenon-135 (Xe^{135}) is produced in the reactor by two methods. One is directly from fission; the other is indirectly from the decay of :

a. Xe^{136}

b. Sm^{136}

c. Cs^{135}

d. I^{135}

Question A.19 [1.0 point]
The reactor is on a **CONSTANT** positive period. Which ONE of the following power changes will take the **longest time** to complete?

a. 5%, from 95% to 100%

b. 10%, from 80% to 90%

c. 15%, from 15% to 30%

d. 20%, from 60% to 80%

Question A.20 [1.0 point]
Delayed neutrons are produced by:

a. decay of O-16

b. Photoelectric Effect

c. decay of fission fragments

d. directly from the fission process

Question B.1 [1.0 point] change was made during the exit meeting. Change will not affect the candidate's score

An area in which radiation levels from radiation source to the body could result in an individual a dose equivalent of 500 mRem/hr at 30 cm is defined as:

a. Radiation area

b. Controlled Area

c. High Radiation Area.

d. Very High Radiation Area

Question B.2 [1.0 point, 0.25 each]

Match the terms in column A with their respective definitions in column B.

	Column A		Column B
a.	Radioactivity	1.	To remove a facility or site safely from service and reduce residual radioactivity to a level that permits in 10 CFR 52.
b.	Contamination	2.	An impurity pollutes or adulterates another substance. The transferable radioactive materials are the sources of ionizing radiations.
c.	Dose	3.	The quantity of radiation absorbed per unit mass by the body or by any portion of the body.
d.	Decommission	4.	That property of a substance which causes it to emit ionizing radiation. This property is the spontaneous transmutation of the atoms of the substance.

Question B.3 [1.0 point]
Which ONE of the following reactor Safety System Channels does NOT require its operation in the PULSE MODE?

a. Power Level Scram at 1.1 Mw

b. Fuel Temperature

c. Magnet Current

d. Loss of Watchdog timer

Question B.4 [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 the most reactive control rod.

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

c. greater than 0.2 %Δk/k with removal of two most reactive control rods.

d. lesser than 0.2 %Δk/k with removal of two most reactive control rods.

Question B.5 [1.0 point]
In the event of an emergency that do not threaten the building systems, the emergency assembly area is:

a. The reactor control room

b. The health physics room

c. The emergency support center

d. The equipment access driveway

Question B.6 [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)?

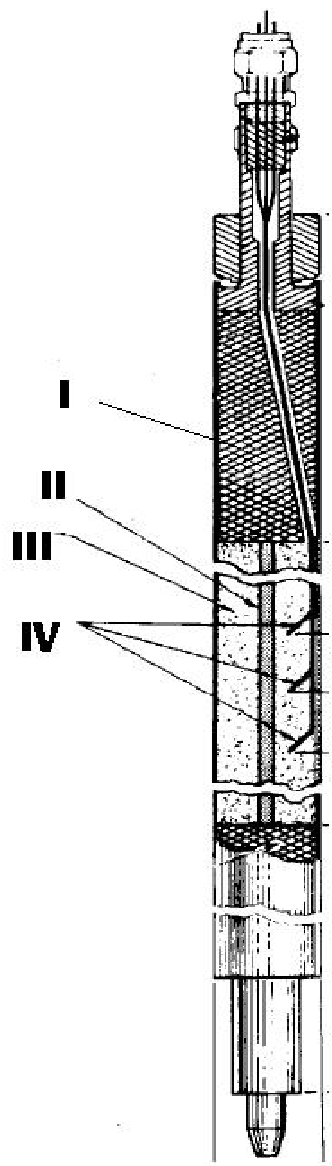
Column A	Column B
I	A. Zirconium Hydride-Uranium
II	B. Stainless steel
III	C. Samarium Burnable Poison
IV	D. Graphite Reflector
	E. Zirconium Rod
	F. Spacer
	G. Thermocouples

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



Question B.7 [1.0 point]
According to NETL Technical Specifications, which ONE of the following would most likely be considered a reportable occurrence?

a. You receive a bomb threat directed toward the facility.

b. You load an unknown sample to the core, which causes an unexplained change in a $1.20 worth of reactivity.

c. You observe an abnormal loss of core coolant at a rate that exceeds the normal makeup capacity.

d. You miss calculation of reactivity worth, cause reactor scram after performing a pulse.

Question B.8 [1.0 point]
Which one of the following is the definition of Total Effective Dose Equivalent (TEDE) specified in 10 CFR Part 20?

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.9 [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 systems

c. Discovery of forced entry directed to the reactor facility

d. Radioactive contamination of a reactor operator during removal of experiment

Question B.10 [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. 551 minutes

b. 312 minutes

c. 111 minutes

d. 88 minutes

Question B.11 [1.0 point]

During reactor operations involving a removal of pneumatic samples, the Reactor Operator (RO) becomes ill and is taken to the hospital. Only the Senior Reactor Operator (SRO) and an experienced student remain in the facility. Reactor operations:

a. must be discontinued because both an RO and an SRO must be in the facility to satisfy NETL Administrative Policy

b. must be discontinued because both an RO and an SRO must be in the facility to satisfy Technical Specifications

c. may continue until a replacement RO can arrive at the facility within 30 minutes

d. may continue since the SRO can monitor the console while the student can retrieve samples.

Question B.12 [1.0 point]
According to NETL procedure, Class C experiments:

a. require the presence of the Reactor Supervisor

b. require the presence of the Senior Reactor Operator

c. require the presence of the Reactor Operator

d. do not require the licensed operator

Question B.13 [1.0 point]
The maximum operating power level for the operation of the NETL reactor shall be 1.1 MW in the manual, auto and square wave modes. This is an example of:

a. Safety Limit (SL)

b. Limiting Safety System Setting (LSSS)

c. Limiting Conditions for Operation (LCO)

d. Safety Operational Limit (SOL)

Question B.14 [1.0 point]
What is the MINIMUM level of management who may authorize temporary changes to the procedures that do NOT changes their original intent?

a. Reactor Operator

b. Senior Reactor Operator

c. Reactor Supervisor

d. The Reactor Operations Committee

Question B.15 [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 tank.

Question B.16 [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 performance of the Daily Checklist, you press a RED button on the NP-1000 to verify the reactor scram.

b. During 500 kW power, you compare the readings of Fuel Temperature 1 and Fuel Temperature 2.

c. Exposing a 2 mCi check source to the continuous air monitor (CAM) detector to verify that its output is operable.

d. Adjust the wide range linear channel in accordance with recent data collected on the reactor power calibration.

Question B.17 [1.0 point]
A radioactive source reads 35 Rem/hr on contact. Five hours later, the same source reads 1.5 Rem/hr. How long is the time for the source to decay from a reading of 35 Rem/hr to 100 mRem/hr?

a. 6.5 hours.

b. 7.5 hours.

c. 8.5 hours.

d. 9.5 hours.

Question B.18 [1.0 point]
Which ONE of the following documents requires the NRC approval for changes?

a. Major changes in the startup checklist

b Minor modification to the Technical Specifications

c Rearrange chapters in the Safety Analysis Report

d Revise the requalification operator licensing examination

Question B.19 [1.0 point]
How many hours per calendar quarter must you perform the functions of an RO or SRO to maintain an active RO or SRO license?

a. 2

b. 4

c. 6

d. 8

Question B.20 [1.0 point]

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

a. 26 mm.

b. 33 mm.

c. 38 mm.

d. 44 mm.

Question C.1 [1.0 point] Accept either "a" or "b" as the correct answers since the interlock signal comes from the NM-1000.

The safety interlock system will prevent air actuation if linear power is above 1kW and the PULSE mode is selected. This safety interlock signal comes from:

a. Wide-Range Log Channel (NM-1000)

b. Multi -Range Linear Channel (NM-1000)

c. High Flux Safety Channel (NPP-1000)

d. Control Rod limited switch

Question C.2 [1.0 point]
You are a reactor operator performing 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 Auto mode

c. exit to Manual mode

d. stay at Square Wave mode

Question C.3 [1.0 point]
During a reactor startup, you calculate the maximum excess reactivity for reference core conditions of 5.00% $\Delta k/k$. For this excess reactivity, you will:

a. continue to operate because the excess reactivity is within TS limit.

b. increase power to 1 kW and verify the excess reactivity again.

c. shutdown the reactor; immediately report the result to the supervisor due to excess being above TS limit.

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

Question C.4 [1.0 point]
Which ONE of the following best describes the thermocouples in each of the instrumented fuel elements (IFE)?

a. There are consisted of two Resistance Temperature Detectors (RTD) embedded at the midpoint and one inch above vertical center in the IFE.

b. There are consisted of three chromel-alumel thermocouples embedded at the midpoint, one inch above, and below vertical center in the IFE.

c. There are consisted of three Resistance Temperature Detectors (RTDs) embedded at the midpoint and one inch below vertical center in the IFE.

d. There are consisted of three platinum-rhodium thermocouples embedded at the midpoint, one inch above, and below vertical center in the IFE.

Question C.5 [1.0 point, 0.25 each]
Match each of the safety channels in column A with the reactor modes of operations in column B. Items in column B can be used once, more than once or not at all.

	Column A		Column B
a.	Fuel Temperature	1.	Steady State ONLY
b.	Multi-range Linear Power	2.	Pulse ONLY
c.	Watchdog Timer	3.	Square wave ONLY
d.	NPP-1000 for nvt measurement	4.	All Modes

~~**Question C.6 [1.0 point]**~~ Question deleted during the exit meeting. No correct answer in the distractors. This question will not factor into the candidates' grades

~~Given the configuration of the LIGHTS associated with the SHIM rod/drive as follows: UP:OFF, DOWN: ON, MAGNET: OFF, and no failure of switch lights. Identify the conditions of the SHIM rod.~~

~~a. Normal condition, rod insertion permissible~~

~~b. Abnormal condition, misadjusted rod down limit switch~~

~~c. Abnormal condition, rod has stuck above lower limit switch~~

~~d. Normal condition, either rod insertion or withdrawal permissible~~

Question C.7 [1.0 point]
Which ONE of the following controls the AMOUNT OF REACTIVITY that is inserted by the transient rod during pulse operations?

a. The preset pulse timer setting that vents the pneumatic piston

b. The steady state power of the reactor prior to firing the pulse

c. The pressure of the air applied to the pneumatic piston

d. The position of the cylinder

Question C.8 [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.9 [1.0 point]
An illuminated YELLOW light alarm on the ARM Monitors indicates:

a. calibration is required.

b. battery power has switched OFF.

c. the ARM may be failing or malfunctioning.

d. alert for radiation level in its immediate area.

Question C.10 [1.0 point]
During operation, you receive a message "SCRAM-DAC DIS64 Timeout". This message means that communication is disrupted between:

a. DAC Network and CSC Network

b. DAC Computer and DAC Digital Scanner board

c. DAC Computer and CSC Digital Scanner board

d. CSC Computer and DAC Digital Scanner board

Question C.11 [1.0 point, 0.25 each]
Match the inputs listed in column A with their responses listed in column B. (Items in column B may be used more than once or not at all). Assume the reactor is in operation.

Column A	Column B
a. Database Timeout	1. Indicate only
b. Magnet Power Grounded	2. Interlocks
c. Pool water conductivity = 1 micomho/cm	3. Alarm and scram
d. Withdrawal of Shim and Transient rods simultaneously in Steady State mode	

Question C.12 [1.0 point]
Which ONE of the following equipments does NOT require during the thermal power calibration?

a. Micro-volt meter

b. Thermocouple array

c. Micro-amp source

d. Ice bath reference junction for thermocouple array

Question C.13 [1.0 point]
Significant quantities of Nitrogen-16 are produced by the irradiation of :

a. air in the beam ports

b. oxygen-16 in the reactor pool

c. air in irradiation cell

d. reactor building atmosphere

Question C.14 [1.0 point]
Which ONE of the following best describes the design of fuel element used at NETL reactor?

a. The fuel is a mixture of U-**Zn**-H alloy containing 8.5% weight of uranium enriched to 19.7% U^{235}.

b. The fuel is a mixture of U-**Zn**-H alloy containing 19.7% weight of uranium enriched to 8.5% U^{235}.

c. The fuel is a mixture of U-**Zr**-H alloy containing 19.7% weight of uranium enriched to 8.5% U^{235}.

d. The fuel is a mixture of U-**Zr**-H alloy containing 8.5% weight of uranium enriched to 19.7% U^{235}.

Question C.15 [1.0 point]
The reactor operator is conducting the Thermal Power Calibration. Which ONE of the following is an initial setup before recording pool temperature?

a. Primary water system: ON, Secondary water system: ON, Power level: 500 kW

b. Primary water system: ON, Secondary water system: OFF, Power level: 900 KW

c. Primary water system: OFF, Secondary water system: ON, Power level: 500 kW

d. Primary water system: OFF, Secondary water system: OFF, Power level: 900 kW

Question C.16 [1.0 point]
Given the following sequence of events during the course of pulsing:

(1) The reactor is in steady state at 50 watts
(2) Power is applied to the pulse integrator
(3) The mode selector switch is in the pulse mode
(4) A preset time sets 3 seconds

Reactor operator initiates a pulse by pressing the fire button. Which ONE of the following sequences of events takes place?

a. The transient rod air will be energized and de-energized in 1 second. The transient rod will drop back into the core. The transient cylinder automatically drives down.

b. The transient rod air will be energized and de-energized in 3 seconds. The transient rod will drop back into the core. The transient cylinder automatically drives down.

c. The transient rod air will be energized and immediately de-energized. The transient rod will drop back into the core. The transient cylinder stays at the same location.

d. The transient rod air will be de-energized and then energized in 3 seconds. The transient rod and the cylinder stay at the same locations.

Question C.17 [1.0 point]
You are adding the makeup water to the reactor pool. In order to obtain volume of water added, you will multiply a pool level change (in cm) by:

a. 20.4 liters/cm

b. 32.6 liters/cm

c. 49.4 liters/cm

d. 56.4 liters/cm

Question C.18 [1.0 point]
During a reactor operation, you discover the particulate air monitor pump failure. Other monitors are operating. Which ONE of the following is the best action?

a. Continue to operate because the pump failure does NOT affect the operation of the particulate air monitor.

b. Continue to operate because the particulate air monitor may be out of service for a period of 1 week.

c. Shutdown the reactor; immediately report the result to the supervisor because the pump failure is a Tech Spec violation.

d Shutdown the reactor, immediately report the result to the U.S. NRC because it is a reportable occurrence.

Question C.19 [1.0 point]
In order to prevent radiation streaming through a beam port, each beam port contains:

a. a step (or steps) to provide for divergence of the radiation beam

b. an inner shield plug and outer shield plug

c. a lead-filled shutter and a lead-lined door

d. a removable cover plate

Question C.20 [1.0 point]
You perform a fuel element inspection. In measuring the elongation, you find the length of one fuel element exceeds the original length by 1.5875 mm (1/16 inches). For this measurement, you will:

a. continue the fuel inspection because this elongation is within TS limit.

b. continue the fuel inspection because the NETL Tech Spec requires the transverse bend measurement only.

c. stop the fuel inspection; immediately report the result to the supervisor because it is considered a damaged fuel element.

d stop the fuel inspection, immediately report the result to the supervisor since the length is exceeding the facility operation limit.

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

Answer Key

A.1
Answer: b
Reference: Burn, R., *Introduction to Nuclear Reactor Operations,* © 1982, Sec 3.3.3, page 3-21.
$\Delta\rho = (Keff_1 - Keff_2)/(Keff_1 * Keff_2)$. $\Delta\rho = (0.946-0.931)/(0.946*0.931) = 0.017 \Delta k/k = 1.7\% \Delta k/k$

A.2
Answer: a
Reference: Burn, R., *Introduction to Nuclear Reactor Operations,* © 1988, Table2.5, page 2-59.

A.03
Answer: b
Reference: Burn, R., *Introduction of Nuclear Reactor Operations*, © 1988, Sec 3.3.2

A.4
Answer: b
Reference: Equation Sheet. $\tau = (\ell^*/\rho) + [(\beta-\rho)/\lambda_{eff}\rho]$

A.5
Answer: a
Reference:
Shut Down Margin = ∑rod worth at critical – SHIM rod 1 worth
= (1.3+1.0+1.0+1.2) – 1.9 =4.5-1.9 = 2.6 %Δk/k
Tech Spec SDM =SDM– most reactivity control rod worth (Transient rod)
= 2.6 – 2.6 = 0.0 %Δk/k
Violate the TS SDM : 0.0 %Δk/k < 0.2 %Δk/k by TS 3.1.2

A.6
Answer a
Reference: Chart of the Nuclides

A.7
Answer: b
Reference: Burn, R., *Introduction to Nuclear Reactor Operations,* 1988 Section 3.2 page 3-2

A.8
Answer b
Reference: Burn, R., *Introduction to Nuclear Reactor Operations,* © 1982, Sec 8.4, page 8-9

A.9
Answer b
Reference: Burn, R., *Introduction to Nuclear Reactor Operations,* © 1988, Sec 4.6, page 4-17

A.10
Answer c
Reference: Standard NRC question.

A.11
Answer: b
$\rho = \rho(\$)*\beta$; $\rho = \$0.35*0.007 = 0.00245\ \Delta k/k$; $T = (\beta - \rho)/\lambda\rho$
$T = (0.0070 - 0.00245)/0.1 \times 0.00245 = 18.57$ seconds

A.12
Answer: d

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

$\rho = \rho(\$)*\beta$; $\rho 1 = \$1.20*0.007 = 0.0084\ \Delta k/k$
$\rho 2 = \$2.0*0.007 = 0.014\ \Delta k/k$
Peak2 = Peak1*$(0.014-.007/.0084-.007)^2$ = 5000 MW
Or
Peak2 = Peak1*$(\$2-\$1 / \$1.2-\$1)^2$ = 5000 MW

A.13
Answer: c
Reference: Burn, R., Introduction to Nuclear Reactor Operations, © 1982, § 5.3, p. 5.6
2-nd generation=n + K*n=2000+1400=3400 neutrons

A.14
Answer: d
Reference: TRIGA Fuel Design

A.15
Answer: c
Reference: Burn, R., *Introduction to Nuclear Reactor Operations,* © 1982, Page 4-21.

A.16
Answer: b
Reference: $P = P_0\, e^{-T/\tau} = 90\ kW \times e^{(300sec/-80sec)} = 900\ kW \times e^{-3.75} = 0.0235 \times 90\ kW = 2.1\ kW$

A.17
Answer: b
Reference: $Count_1*(1-K_{eff1}) = Count_{2*}(1-K_{eff2})$ $100*(1-0.950) = 200*(1-K_{eff2})$
$100*(1-0.95) = 200(1- K_{eff2})$; $K_{eff2} = 0.975$

A.18
Answer: d
Reference: Burn, R., Introduction to Nuclear Reactor Operations, © 1988,
§§ 8.1 —8.4, pp. 8-3 — 8-14.

A.19
Answer: c
Reference: Time is related to ratio of final power to initial power. 2:1 is the largest ratio.

A.20
Answer: c
Reference: Burn, R., *Introduction to Nuclear Reactor Operations,* © 1982, Sec 3.2.

Answer Key

B.1
Answer: c
Reference: 10 CFR 20

B.2
Answer: a(4) b(2) c(3) d(1)
Reference: 10 CFR 20

B.3
Answer: a
Reference: TS 3.2.4

B.4
Answer: c
Reference: SOP FUEL-1, Section V.b

B.5
Answer: b
Reference: Plan-E, Emergency Response, Section D.1.a

B.6
Answer: c
Reference: SAR, Figure 4-29

B.7
Answer: b
Reference: TS 6.6.2 and TS 3.4.1

B.8
Answer: c
Reference: 10 CFR 20.

B.9
Answer: d
Reference: Emergency Response Plan, Section 1.2.2

B.10
Answer: c
Reference: $A = A_o e^{-\lambda t}$
$294 = 900e^{-180\lambda}$, $180\lambda = -\ln 0.327$, $\lambda = 0.00623\ \text{min}^{-1}$
$t_{1/2} = 0.693 / \lambda$, $= 0.693 / 0.00623\ \text{min}^{-1}$, $= 111$ minutes

B.11
Answer: d
Reference: TS 6.1.3

B.12
Answer: d
Reference: ADMN-6

B.13
Answer: b
Reference: Technical Specifications, Section 2.2.2

B.14
Answer: b
Reference: Technical Specifications 6.3

B.15
Answer: d
Reference: BASIC Radiological Concept (Betas and alpha don't make through the demineralizer tank)

B.16
Answer: a = TEST; b = CHECK; c = TEST; d = CAL
Reference: NETL Technical specification § 1, Definitions

B.17
Answer: d
Reference: $DR = DR_{\circ} * e^{-\lambda t}$
1.5 rem/hr $= 35$ rem/hr* $e^{-\lambda(5hr)}$
$Ln(1.5/35) = -\lambda * 5$ --> $\lambda = 0.623$; solve for t: $Ln(.1/35) = -0.623\ (t)$ → $t = 9.4$ hours

B.18
Answer: b
Reference: 10 CFR 50.59

B.19
Answer: b
Reference: 10CFR55.53(e)

B.20
Answer: d
Reference: $DR = DR_{\circ} * e^{-\mu X}$
HVL (=6.5 mm) means the original intensity will reduce by half when a lead sheet of 6.5 mm is inserted. Find μ if the HVL is given as follows: $1 = 2 * e^{-\mu * 6.5}$; $\mu = 0.10664$
Find X: 5 mrem/hr = 500 mrem/hr* $e^{-0.10664 * X}$; X= 43.2 mm

Answer Key

C.1 Accept either "a" or "b" as the correct answers since the interlock signal comes from the NM-1000.
Answer: a or b
Reference: SAR 6.1.1 and walkthrough information

C.2
Answer: c
Reference: OPER-3, Section C

C.3
Answer: c
Reference: TS 3.1.1

C.4
Answer: b
Reference: NRC Standard Question

C.5
Answer: a (4) b(1) c(4) d(2)
Reference: SAR 6.1.1 through 6.1.5

~~**C.6**~~ Question deleted during the exit meeting. No correct answer in the distractors. This question will not factor into the candidates' grades
~~Answer: b~~
~~Reference: SAR 6.1.4~~

C.7
Answer: d
Reference: NRC Standard Question

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

C.9
Answer: d
Reference: MAIN-4, Section B, Response Checks

C.10
Answer: b
Reference: MAIN-1, Section 7.2

C.11
Answer: a(3) b(3) c(1) d(2)
Reference: TS 3.3 and MAIN-1

C.12
Answer: c
Reference: SURV-2, Section IV

C.13
Answer: b
Reference: NRC Standard Question

C.14
Answer: d
Reference: TS 5.3

C.15
Answer: d
Reference: SURV-2, Section V

C.16
Answer: b
Reference: information during Walkthrough

C.17
Answer: c
Reference: SURV-4, Section A.1.c, page 3

C.18
Answer: b
Reference: SAR 9.5.4

C.19
Answer: a
Reference:

C.20
Answer: a
Reference: TS 3.1.4

*******************************END OF THE EXAM ********************************