August 29, 2014

Dr. Barry M. Klein, Reactor Director
5335 Price Avenue, Bldg. 258
McClellan AFB, CA 95652-2504

SUBJECT: EXAMINATION REPORT NO. 50-607/OL-14-01, UNIVERSITY OF CALIFORNIA-DAVIS

Dear Dr. Klein:

During the week of July 28, 2014, the U.S. Nuclear Regulatory Commission (NRC) administered operator licensing examinations at your University Of California-Davis TRIGA Reactor. The examinations were conducted according to NUREG-1478, "Operator Licensing Examiner Standards for Research and Test Reactors," Revision 2. Examination questions and preliminary findings were discussed at the conclusion of the examination with those members of your staff identified in the enclosed report.

In accordance with Section 2.390 of Title 10 of the *Code of Federal Regulations*, 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 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 Public Electronic Reading Room). The NRC is forwarding the individual grades to you in a separate letter which will not be released publicly. If you have any questions concerning this examination, please contact Mr. John T. Nguyen at (301) 415-4007 or via email John.Nguyen@nrc.gov.

Sincerely,

/RA/

Kevin Hsueh, Chief
Research and Test Reactors Oversight Branch
Division of Policy and Rulemaking
Office of Nuclear Reactor Regulation

Docket No. 50-607

Enclosures: 1. Examination Report No. 50-607/OL-14-01
2. Written examination

cc: Walter Steingass, University of California-Davis
cc w/o enclosures: See next page

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DISTRIBUTION w/ encls:
PUBLIC PROB r/f RidsNrrDprProb RidsNrrDprPrlb Facility File (CRevelle)

ADAMS Accession No: ML14219A632 **NRR-074**

OFFICE	PROB:CE	IOLB:LA	PROB:BC
NAME	JNguyen	CRevelle	KHsueh
DATE	08/12/2014	08/28/2014	08/29/2014

OFFICIAL RECORD COPY

cc:

Dr. Wesley Frey, Radiation Safety Officer
5335 Price Avenue, Bldg. 258
McClellan AFB, CA 95652-2504

California Energy Commission
1516 Ninth Street, MS-34
Sacramento, CA 95814

Radiological Health Branch
California Department of Public Health
P.O. Box 997414, MS 7610
Sacramento, CA 95899-7414

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

ENCLOSURE 1
U. S. NUCLEAR REGULATORY COMMISSION
OPERATOR LICENSING INITIAL EXAMINATION REPORT

REPORT NO.: 50-607/OL-14-01

FACILITY DOCKET NO.: 50-607

FACILITY LICENSE NO.: R-130

FACILITY: University Of California-Davis TRIGA Reactor

EXAMINATION DATES: July 28 – July 30, 2014

SUBMITTED BY: **/RA/** **08/12/2014**
John T. Nguyen, Chief Examiner Date

SUMMARY:

During the week of July 28, 2014, the NRC administered operator licensing examinations to one Reactor Operator (RO) and two Senior Reactor Operator (SRO) license candidates. One RO candidate failed the written examination and 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	0/1	2/0	2/1
Operating Tests	1/0	2/0	3/0
Overall	0/1	2/0	2/1

3. Exit Meeting:
John T. Nguyen, Chief Examiner, NRC
Walter Steingass, Reactor Supervisor, University of California-Davis

At the conclusion of the site visit, the examiner met with representative of the facility staff to discuss the results of the examinations. The facility licensee had no comments on the written examination.

ENCLOSURE 3
U. S. NUCLEAR REGULATORY COMMISSION
NON-POWER REACTOR LICENSE EXAMINATION

FACILITY: University Of California-Davis

REACTOR TYPE: TRIGA

DATE ADMINISTERED: July 29, 2014

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 ___

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 *****)

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 ___

B09 a b c d ___

B10 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 ___

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 ___

C06 a b c d ___

C07 a b c d ___

C08 a ___ b ___ c ___ d ___ (0.5 each)

C09 a b c d ___

C10 a b c d ___

C11 a b c d ___

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 ___ (0.5 each)

(***** 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

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

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

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

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

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

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

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

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

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

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

$$M = \frac{1}{1 - K_{eff}} = \frac{CR_2}{CR_1} \qquad P = P_0 \; 10^{SUR(t)}$$

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

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

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

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

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

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

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

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

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

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

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

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

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

1 Horsepower = 2.54 x 10^3 BTU/hr

1 BTU = 778 ft-lbf

1 gal (H_2O) ≈ 8 lbm

c_P = 1.0 BTU/hr/lbm/°F

1 kg = 2.21 lbm

1 Mw = 3.41 x 10^6 BTU/hr

°F = 9/5 °C + 32

°C = 5/9 (°F - 32)

c_p = 1 cal/sec/gm/°C

University Of California-Davis

Operator Licensing Examination

Week of July 28, 2014

ENCLOSURE 2

QUESTION A.1 [1.0 point]
A few 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_c is 200 kW power, what will it be five minutes later?

a. 0.2 kW

b. 4.7 kW

c. 163.0 kW

d. 213.0 kW

QUESTION A.2 [1.0 point]
Reactor is increasing power from 10 W to 250 KW in SQUARE WAVE mode. Which ONE of the following best describes the values of K_{eff} and ρ during the power increment?

a. $K_{eff} = 1$ and $\rho = 0$

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

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

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

QUESTION A.3 [1.0 point]
Which ONE statement below describes a NEGATIVE moderator temperature coefficient?

a. When moderator temperature increases, negative reactivity is added

b. When moderator temperature decreases, negative reactivity is added

c. When moderator temperature increases, positive reactivity is added

d. When moderator temperature increases, no change in reactivity

QUESTION A.4 [1.0 point]
A reactor with K_{eff} = 0.8 contributes 1000 neutrons in the first generation. Changing from the first generation to the THIRD generation, how many TOTAL neutrons are there after the third generation?

a. 1800

b. 2440

c. 3240

d. 6400

QUESTION A.5 [1.0 point]
Reactor A with a K_{eff} of 0.1 and reactor B with a K_{eff} of 0.8, K_{eff} is increased by 0.1 for each reactor. The amount of reactivity added in reactor A is _____ in reactor B for the same increment.

a. less than

b. same

c. eight times

d. thirty-six times

QUESTION A.6 [1.0 point]
In a just critical reactor, adding $0.50 worth of reactivity in the STEADY STATE MODE will cause:

a. The reactor period to be equal to 50 seconds

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.7 [1.0 point]
Which ONE of the following in the "six factor" formula is the MOST affected factor by the CONTROL RODS?

a. Fast fission factor

b. Reproduction factor

c. Thermal utilization factor

d. Resonance escape probability

QUESTION A.8 [1.0 point]
Which ONE of the following is the reason that Xenon peaks after a shutdown?

a. Iodine decays faster than Xenon decays

b. Samarium decays faster than Xenon decays

c. Xenon decays faster than Iodine decays

d. Xenon decays faster than Promethium

QUESTION A.9 [1.0 point]
Which ONE of the following is a number of neutrons in the tritium nucleus ($_1T^3$ or $_1H^3$)?

a. 1

b. 2

c. 3

d. 4

QUESTION A.10 [1.0 point]
Which ONE of the following is a correct statement of why delayed neutrons enhance the ability to control reactor power?

a. Delayed neutrons are born at higher energy levels than prompt neutrons

b. Delayed neutrons increase the average neutron lifetime that allows a reactor to be controlled

c. Prompt neutrons can cause fissions in both U-235 and U-238; whereas delayed neutrons can only cause fissions in U-235

d. The average number of delayed neutrons produced per fission is higher than the average number of prompt neutrons

QUESTION A.11 [1.0 point]
Using Figure 3.3 attached, calculate the effective delayed neutron fraction (β-effective). At birth energies, there are 65 delayed neutrons and 9935 prompt neutrons. In the process of slowing down, there are only 56 delayed neutrons and 7352 prompt neutrons at the thermal range. The resultant β-effective of Figure 3.3 is:

a. 0.00654

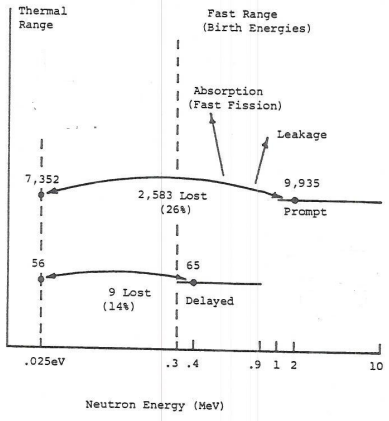
b. 0.00756

c. 0.00762

d. 0.00348

INTRODUCTION TO NUCLEAR REACTOR OPERATIONS
Nuclear Fission and Neutron Multiplication
Reed Robert Burn
December 1988

Figure 3.3 Delayed Neutron Fraction and Effective Delayed Neutron Fraction



Page 3-14

QUESTION A.12 [1.0 point]
Reactor power is increasing on a constant positive reactor period. Which ONE of the following power changes would finish in the shortest time?

a. 5% power from 1% to 6%

b. 10% power from 10% to 20%

c. 15% power from 20% to 35%

d. 20% power from 40% to 60%

QUESTION A.13 [1.0 point]
Which ONE of the following is the MAIN reason for operating reactor with thermal neutrons instead of fast neutrons?

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

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

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

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

QUESTION A.14 [1.0 point]
A reactor is subcritical with K_{eff} of 0.955. Which ONE of the following is the MINIMUM reactivity ($\rho K/K$) that must be added to produce PROMPT criticality? Given $\beta_{eff}=0.007$

a. 0.0052

b. 0.0070

c. 0.0540

d. 0.9620

QUESTION A.15 [1.0 point]
The reactor is critical. The reactor operator accidentally inserts a fuel element in the core and K_{eff} changes to 1.010. What is the period of the reactor? Given a prompt neutron lifetime (ℓ^*) of 1×10^{-5} seconds.

a. 0.001 sec

b. 0.01 sec

c. 0.10 sec

d. 1.0 sec

QUESTION A.16 [1.0 point]
Which ONE of the following nuclides will cause a fast neutron to lose its most energy per collision?

a. H_1

b. B_{10}

c. C_{12}

d. U_{238}

QUESTION A.17 [1.0 point]
In a subcritical reactor with K_{eff} of 0.931, a reactivity worth of 0.017 Δk is inserted into the reactor core. Which ONE of the following is the NEW K_{eff} ?

a. 0.925

b. 0.933

c. 0.946

d. 1.001

QUESTION A.18 [1.0 point]
Given a source strength of 300 neutrons per second (N/sec) and a multiplication factor of 0.7, which ONE of the following is the expected stable neutron count rate?

a. 210 N/sec

b. 1000 N/sec

c. 2100 N/sec

d. 2500 N/sec

QUESTION A.19 [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 neutron absorption in U-238

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.20 [1.0 point]
The effective target area in cm^2 presented by a single nucleus to an incident neutron beam is defined as:

a. a macroscopic cross section

b. a microscopic cross section

c. a mean free path

d. a neutron flux

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

QUESTION B.1 [1.0 point, 0.25 each]
Per UCD/MNRC Emergency Classification, a loss of all water in the reactor tank is an example of:

a. Personnel and Operational Events, Class 0

b. Notification of Unusual Events, Class 1

c. Alert, Class 2

d. Site Area Emergency, Class 3

QUESTION B.2 [1.0 point]
Assume that there is no leak from outside of the demineralizer bottle. You use a survey instrument with a window probe to measure the dose rate from the demineralizer bottle. 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.3 [1.0 point]
Per MNRC Technical Specification, the total inventory of iodine isotopes 131 through 135 in the experiment is no greater than _____.

a. 5 millicuries

b. 5 mg

c. 1.5 curies

d. 1.5 g

QUESTION B.4 [1.0 point]
Which ONE of the following conditions is NOT a violation of a Limiting Condition for Operations?

a. An earthquake affected the water tank wall, causing water level dropped below a depth of 20 feet in the reactor tank

b. Reactor was at full power. The pumps failed, causing the primary coolant core inlet temperature reached 55 °C

c. The minimum shutdown margin was found to be $1.0 in the reference core condition

d. Effluent concentration of Ar-41 released to the public exceeded 1 x 10^{-7} µCi/ml

QUESTION B.5 [1.0 point]
Per 10 CFR 20, a radiation worker can receive an annual limit of the shallow-dose equivalent of _____ to the **skin** of whole body.

a. 5 Rems

b. 15 Rems

c. 50 Rems

d. 500 Rems

QUESTION B.6 [1.0 point]
A radioactive source reads 2 Rem/hr on contact. Five hours later, the same source reads 1.0 Rem/hr. How long is the time for the source to decay from a reading of 2 Rem/hr to 20 mRem/hr?

a. 8 hours

b. 16 hours

c. 33 hours

d. 41 hours

QUESTION B.7 [1.0 point]
For the safe operation and maintenance of the facility, who does the UCD/MNRC Director report directly to?

a. U.S. NRC

b. UCD President

c. UCD Vice Chancellor for Research

d. UCD/MNRC Nuclear Safety Committee

QUESTION B.8 [1.0 point]
Assume an individual has received whole body occupational exposures of:

- 25 mrads of gamma
- 2 mrads of alpha
- 1 mrads of neutrons with **unknown** energy

What would be the cumulative dose equivalent (H_T) in **mrem** for this individual?

a. 28 mrem

b. 55 mrem

c. 66 mrem

d. 75 mrem

QUESTION B.9 [1.0 point]
According to MNRC Tech Spec, which ONE of the following would most likely be considered a Special Report (the Director shall report to the NRC within 24 hours)?

a. You receive a bomb threat directed toward the UC Davis

b. You did not pay attention while raising the control rods to power, which causes reactor scram

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

d. You load an unknown sample of $1.00 worth of reactivity. Reactor scrams due to your loading.

QUESTION B.10 [1 point]
During a reactor startup, which ONE of the following is a **MINIMUM** staffing requirement when the reactor is NOT shutdown? Note: staff member (warm body)

a. 1 Facility Director in the control room + 1 staff member

b. 2 SRO in the control room + 1 staff member

c. 1 RO in the control room +1 staff member + 1 SRO on call

d. 1 SRO in the control room + 1 RO in the control room

QUESTION B.11 [1.0 point]
Reactor is operated at full power. Half-way through a 3-hour operation, you discover that the reactor room exhaust system is OFF (no air flow) with OPEN dampers. Which ONE of the following actions should you take?

a. Immediately secure reactor operations. This event is a Technical Specification (TS) violation.

b. Immediately secure reactor. This event is NOT a TS violation because the dampers are still in opening positions.

c. Continue with reactor operation. Up to 48 hours is allowed to run reactor before repairing the ventilation systems.

d. Continue with reactor operations. The UCD/MNRC Technical Specifications requires the ventilation systems turn OFF during full power.

QUESTION B.12 [1.0 point]
The Fuel Handling Checklist is required to be completed _____ any reactor storage pit fuel manipulation.

a. at the end of

b. a week before

c. at the beginning of

d. prior to the commencement of, and each day of

QUESTION B.13 [1.0 point]
Which ONE of the following requires the NRC APPROVAL for changes?

a. Revise the UCD/MNRC Startup Checklist

b. Revise the requalification operator licensing examination

c. Replace a new picture, Figure 3.3, Triga Fuel, in SAR

d. Reduce a number of the Nuclear Safety Committee from seven (7) to five (5) members

QUESTION B.14 [1.0 point]
During a fuel element inspection, you identify corrosion in one of fuel elements. For this visual inspection, you will:

a. continue the fuel inspection because the specifications are required to be measured the transverse bend and elongation ONLY for identifying a fuel damage.

b. continue the fuel inspection because the corrosive fuel is NOT a damage fuel. A damage fuel has the conditions of bulges, gross pitting, and corrosion.

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

d. stop the fuel inspection, you immediately report the result to the U.S. NRC since it is a reportable occurrence

QUESTION B.15 [1.0 point]
Exposing a 2 mCi check source to the continuous air monitor (CAM) detector to verify whether it is operable is considered to be _____.

a. a channel calibration

b. a channel check

c. a channel test

d. a channel operation

QUESTION B.16 [1.0 point]
Which ONE of the following modifications would be considered a “50.59” and the UCD/MNRC Reactor Facility must file a request to NRC for change? The facility plans to:

a. Replace an identical NPP-1000, Safety Channel

b. Measure a SHIM 1 rod worth with new method

c. Replace a fission chamber with an uncompensated ion chamber for Wide-Range Log Channel

d. Perform a reactor power calibration with the new resistance temperature detector (RTD) probe

QUESTION B.17 [1.0 point]
Before entering to the experimental facility, you see a sign posted at the door “CAUTION, HIGH RADIATION AREA”. You would expect that radiation level in the facility could result in an individual receiving a dose equivalent of:

a. 10 mRem/hr at 30 cm from the source

b. 100 mRem/hr at 30 cm from the source

c. 100 mRem/hr at 1 m from the source

d. 500 Rads/hr at 1 m from the source

QUESTION B.18 [1.0 point]
For the Square Wave Mode of Operation, the MAXIMUM insertion of reactivity shall be _____.

a. $1.00

b. $0.90

c. $0.80

d. $0.70

QUESTION B.19 [1.0 point]
"A fuel followed control rods may contain either 8.5 wt% or 20 wt% fuel." This is an example of:

a. Design Features

b. Surveillance Requirements

c. Limiting Conditions for Operation (LCO)

d. Limiting Safety System Setting (LSSS)

QUESTION B.20 [1.0 point]
The MNRC reactor has been shutdown due to a fuel element leak. Which ONE of the following radioactive GASES poses the most significant hazard during the research for the leaking fuel element? (Assume the fuel element is leaking during the search)?

a. Argon

b. Iodine

c. Cesium

d. Nitrogen

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

QUESTION C.1 [1.0 point]
Which ONE of the following is the MAIN reason for not operating the coolant pumps in dry (no prime) for no longer than two minutes?

a. Increasing the amount of Ar-41 released to the reactor bay

b. Damaging the pump motor

c. Damaging the heat exchanger

d. Damaging the coolant pipes

QUESTION C.2 [1.0 point]
The MAIN purpose of the gadolinium painted in the internal surface of the aluminum container (beam tube) is to:

a. increase the thermal neutron flux for the beam tube

b. reduce the effects of secondary gamma radiation by minimizing fast neutron activation of the beam tube

c. increase the ratio of the neutron flux and gamma for the beam tube

d. prevent scattered neutrons from reentering the beam tube

QUESTION C.3 [1.0 point]
A purpose of the interlock to prevent withdrawal of more than one control rod at a time is to prevent:

a. inadvertently large reactivity insertion rate

b. damage of control rod drive system

c. initiation of a pulse while on a positive period

d. increment of prompt neutrons when reactor gets ready in Square Wave

QUESTION C.4 [1.0 point]
During performance of a reactor operation, you receive a message “Demand Power Not Reached” on the console. This message means:

a. Transient rod did not fire

b. Demand power not reached during Auto Mode Operations

c. Demand power not reached during Pulse Mode Operations

d. Demand power not reached during Square Wave Mode Operations

QUESTION C.5 [1.0 point]
Which ONE of the following is the actual design feature which prevents siphoning of tank water on a failure of the purification system?

a. A valve upstream of the primary pump will shut automatically

b. A valve downstream of the primary pump will shut automatically

c. The Emergency Coolant Fill System will automatically maintain pool level

d. Holes in the submerged section of the suction line acts like “Vacuum breaks”

QUESTION C.6 [1.0 point]
After a reactor room CAM alarm has been cleared, the reactor room ventilation system is restored to normal operation by:

a. restarting AC-2

b. restarting AC-1

c. calibrate the CAM to ensure it is operable

d. switching the reactor room ventilation from the RECIRC mode back to the NORMAL mode

QUESTION C.7 [1.0 point]
The SAFETY CHANNEL #1 (%PWR 1) scram signal comes from:

a. NPP-1000

b. Fuel Temperature

c. NM-1000

d. Action Pack, AP-1000

QUESTION C.8 [2.0 point, 0.5 each]
Reactor is in operation. Match the input signals listed in column A with their AUTOMATICALLY responses listed in column B. (Items in column B may be used more than once or not at all.)

Column A	Column B
a. Loss of NPP-1000 High Voltage	1. Normal Operation
b. CSC network disconnected (1 min)	2. Alarm ONLY
c. Reactor RAM =100 mR/hr	3. Interlock
d. Perform pulse at 2 kW	4. Scram

QUESTION C.9 [1.0 point]
The three-position switch for the first primary coolant pump on the motor controller in the equipment room is in the HAND position. As a result:

a. the second primary coolant pump will start without an eight-second time delay after the first pump is started.

b. after the first primary coolant pump is started from the temperature control panel, the second pump will start after an eight-second time delay.

c. the first primary coolant pump cannot be started from the temperature control panel.

d. the first primary coolant pump will automatically start at 1 minute time delay.

QUESTION C.10 [1.0 point]
Reactor is operated in the **AUTO mode** with the selected REG and SHIM 1 rods. Which ONE of the following describes the reactor power when you try to withdraw the SHIM 1 rod?

a. Reactor scrams

b. Reactor power increases

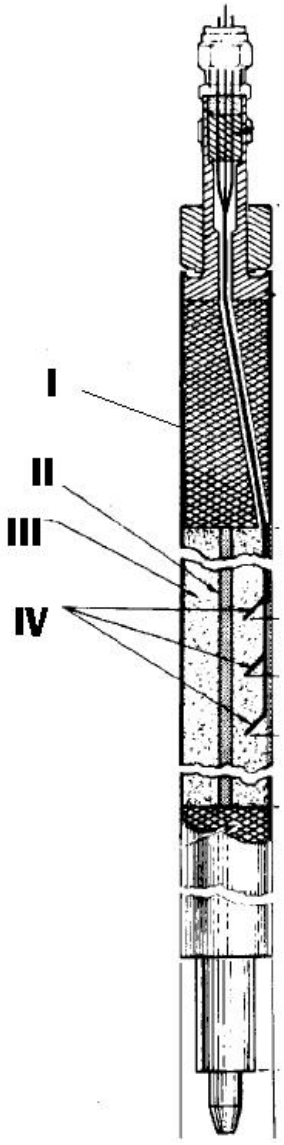
c. Reactor power decreases

d. Reactor power remains the same level

QUESTION C.11 [1.0 point]
Using the diagram of an instrumented fuel element, select the appropriate materials associated with its locator.

Column A
I
II
III
IV

Column B
A. Zirconium Hydride-Uranium
B. Stainless steel
C. Erbium Burnable Poison
D. Graphite Reflector
E. Zirconium Rod
F. Spacer
G. Thermocouples



a. I.A, II.E, III.C, IV.G

b. I.D, II.G, III.A, IV.F

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

d. I.C, II.A, III.B, IV.G

QUESTION C.12 [1.0 point]
For a control rod, the magnet up limit switch is open (OFF), the magnet down limit switch is open, and the rod down limit switch is open. The color of the rod as shown on the high-resolution screen will be:

a. black

b. magenta

c. green

d. yellow

QUESTION C.13 [1.0 point]
In the event of a loss of building power, the emergency backup power generator will provide power to:

a. CSC, DAC, and AUX Cabinet

b. RAMs, CAM, and Stack Gas Monitor

c. Emergency lights, reactor control room, and radiation control room

d. AMUWS demineralizer pump, EF-1 Fan Motor, and temperature control panel (TCP)

QUESTION C.14 [1.0 point]
During the annual calibration, you test a pulsing operation to collect the reading on the peak power channel (nv) and integrated power-time channel (nvt). The nv channel information comes from the _____ and the nvt channel information comes from the _____.

a. NPP 1000 channel, NM 1000 channel

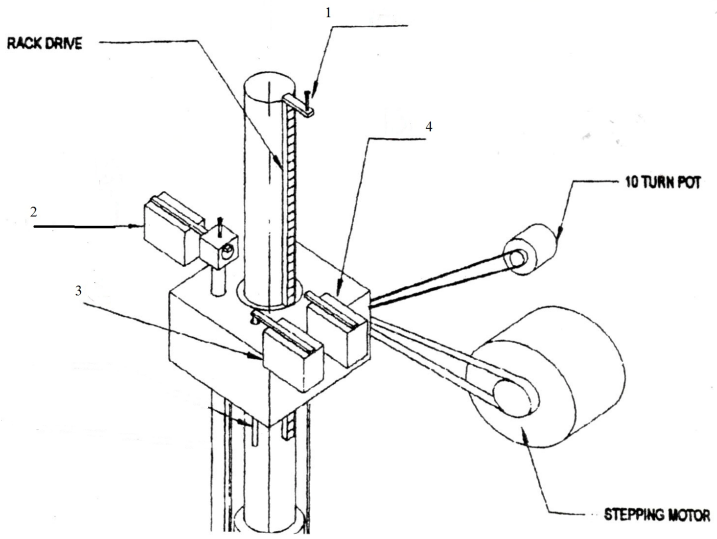
b. NM 1000 channel, NPP 1000 channel

c. NM 1000 channel, NM 1000 channel

d. NPP 1000 channel; NPP 1000 channel

QUESTION C.15 [1.0 point, 0.25 each]
Use the following diagram of the control rod; Match the Limit Switch (LS) components listed in Column A to the appropriate labels in Column B?

Column A	Column B
a. Control Rod Drive Down LS	1
b. Control Rod Drive UP LS	2
c. Control Rod Drive Down LS Actuator	3
d. Control Rod Down LS	4


1
RACK DRIVE
4
10 TURN POT
2
3
STEPPING MOTOR

QUESTION C.16 [1.0 point]
During normal operations, a leak develops in the SECONDARY to PRIMARY heat exchanger. Which ONE of the following correctly explains the reactor tank level?

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

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

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

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

QUESTION C.17 [1.0 point]
The scram time of each control rod shall be measured _____.

a. Monthly

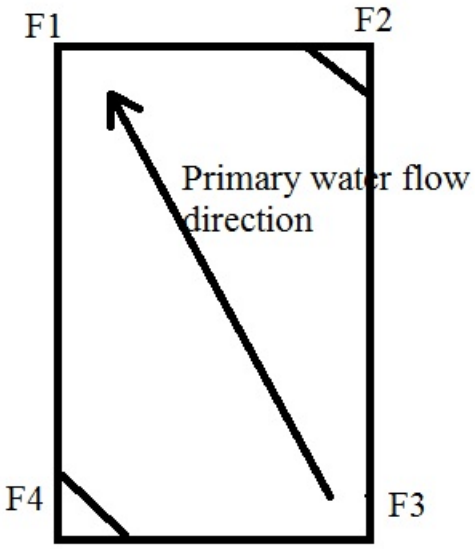
b. Quarterly

c. Semiannually

d. Annually

QUESTION C.18 [2.0 points, 0.5 each]
The figure below depicts the Primary Heat Transfer Plate with the primary water flow direction. Match the labels listed in Column A to the appropriate labels in Column B?

Column A	Column B
a. F1	1. Primary INPUT
b. F2	2. Primary OUTPUT
c. F3	3. Secondary INPUT
d. F4	4. Secondary OUTPUT



Primary Heat Transfer Plate of Heat exchanger

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

A.1
Answer: b
Reference: $P = P_0\, e^{-t/\omega} = 200\ kW \mid e^{(300sec/-80sec)} = 200\ kW \mid e^{-3.75} = 0.0235 \mid 200\ kW = 4.7\ KW$

A.2
Answer: c
Reference: Burn, R., *Introduction of Nuclear Reactor Operations*, © 1988, Sec 4.2

A.3
Answer a
Reference: Introduction to Nuclear Operation, Reed Burn, 1982, Sec 6.4

A.4
Answer: b
Reference: Burn, R., Introduction to Nuclear Reactor Operations, © 1982, § 5.3, p. 5.6
3-nd generation=n + K*n + K^2 *n=1000+800+640= 2440 neutrons

A.5
Answer: d
Reference: Burn, R., *Introduction to Nuclear Reactor Operations,* © 1982, Sec 3.3.3, page 3-21.
$\Delta\rho$ reactor A = $(Keff_1\text{-}Keff_2)/(Keff_1*Keff_2)$. (0.2-0.1)/(0.2*0.1) = 5 $\Delta k/k$
$\Delta\rho$ reactor B = $(Keff_1\text{-}Keff_2)/(Keff_1*Keff_2)$. (0.9-0.8)/(0.9*0.8) = 0.139 $\Delta k/k$
5/0.139 = 36

A.6
Answer b
Reference: Burn, R., *Introduction to Nuclear Reactor Operations,* © 1988, Sec 4.6, page 4-17

A.7
Answer: c
Reference: Burn, R., Introduction to Nuclear Reactor Operations, © 1982, Sec 3.2.2, page 3-18.

A.8
Answer: a
Reference: Introduction to Nuclear Operation, Reed Burn, 1982, Sec 8.4.2

A.9
Answer: b
Reference: Nuclides and Isotopes
N = A – Z 3-1 = 2

A.10
Answer: b
Reference: Burn, R., *Introduction of Nuclear Reactor Operations*, © 1982, Section 3.3.7, page 3-37

A.11
Answer: b
Reference: β-effective =56/(56+7352) =0.00756
Burn, R., *Introduction of Nuclear Reactor Operations*, © 1988, Figure 3.3

A.12
Answer: d
Reference: Burn, R., *Introduction of Nuclear Reactor Operations*, © 1988, Section 3.3

A.13
Answer: d
Reference: Burn, R., *Introduction of Nuclear Reactor Operations*, © 1982, Figure 2.6, page 2-39

A.14
Answer: c
Reference: from k=0.955 to criticality (k=1), □ρ = (k-1)/k = -0.047 □k/k or □ρ = 0.047 □k/k needed to reach criticality. From criticality to JUST prompt, □k/k = βeff required, so minimum reactivity added to produce prompt criticality will be: 0.047+0.007= 0.054

A.15
Answer: a
Reference: Using equations provided in the equation sheet:

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

ρ = (1.01-1)/1.01
ρ = 0.01
For prompt,

$$T = \frac{\ell^*}{\rho} = 0.00001/0.01 = 0.001 \text{ sec}$$

A.16
Answer: a
Reference: Burn, R., *Introduction of Nuclear Reactor Operations*, © 1988, Sec 2.4.5

A.17
Answer: c
Reference: Burn, R., *Introduction to Nuclear Reactor Operations,* © 1982, Sec 3.3.3, page 3-21.
$\Delta\rho = (Keff_1-Keff_2)/(Keff_1*Keff_2)$. 0.017 = (x-0.931)/(x*0.931); 0.017*0.931*x =x-0.931
0.01583x=x-0.931; 0.98417x =0.931; x=0.931/0.98417; x=0.946

A.18
Answer: b
Reference: CR = S/(1-K) → CR = 300/(1 - .7) = 1000

A.19
Answer: d
Reference: TRIGA Fuel Design

A.20
Answer: b
Reference: Burn, R., Introduction to Nuclear Reactor Operations, © 1988, Section 8.2

B.1
Answer: c
Reference: Emergency Plan, Table 5-1

B.2
Answer: d
Reference: BASIC Radiological Concept (Betas and alpha don't make through the demineralizer tank)

B.3
Answer: c
Reference: TS 3.8.2

B.4
Answer: c
Reference: TS 3.1, TS 3.3, and 10 CFR 20

B.5
Answer: c
Reference: 10 CFR 20

B.6
Answer: c
Reference: $DR = DR_{\circ} * e^{-\lambda t}$
$1 \text{ rem/hr} = 2 \text{ rem/hr} * e^{-\lambda(5hr)}$
$\ln(1.0/2) = -\lambda * 5 \rightarrow$ $\lambda = 0.1386$; solve for t: $\ln(.02/2) = -0.1386\ (t) \rightarrow t = 33$ hours

B.7
Answer: c
Reference: TS 6.1

B.8
Answer: d
Qualify factor(Q) - adjusts absorbed dose to dose equivalent
Q = 1 for x, gamma or beta
Q = 20 for alphas and other heavy particles
Q = 10 for neutrons of unknown energy; table 1004(b).2. is for known energies
Q = 10 for high-energy protons

Reference: 10 CFR 20

B.9
Answer: d
Reference: TS 6.7.2

B.10
Answer: d
Reference: TS 6.1.3

B.11
Answer: a
Reference: TS 3.4

B.12
Answer: d
Reference: SOP, Fuel Handling Tool, Section 2.2.1

B.13
Answer: d
Reference: TS 6.2.1 and 10 CFR 50.59 (TS change)

B.14
Answer: c
Reference: TS 3.2.4

B.15
Answer: c
Reference: TS, Definitions

B.16
Answer: c
Reference: 10 CFR 50.59

B.17
Answer: b
Reference: 10 CFR 20.1003

B.18
Answer: b
Reference: UCD/MNRC Operating Instruction, Section 4.6

B.19
Answer: a
Reference: TS 5.3

B.20
Answer: b
Reference: Standard NRC question, Cesium is a fission product, but not gas

C.1
Answer: b
Reference: OMM 5110, Section 2.1

C.2
Answer: d
Reference: SAR 10.2

C.3
Answer: a
Reference: TS 3.2.2

C.4
Answer: d
Reference: MNRC-0013-OMM-04, Section 2.2.3

C.5
Answer: d
Reference: SAR 5.3

C.6
Answer: d
Reference: SAR

C.7
Answer: c
Reference: SAR 7.1, Figure 7.1

C.8
Answer: a(4) b(4) c(2) d(3)
Reference: SAR 3.3 and TS 3.2

C.9
Answer: c
Reference: SAR

C.10
Answer: d
Reference: Operating Instruction, Section 4.3.
SHIM 1 rod cannot be controlled manually during Auto Mode, so power will remain the same.

C.11
Answer: c
Reference: Triga Fuel Element

C.12
Answer: c
Reference: SAR

C.13
Answer: d
Reference: MNRC-0053-OMM-01, Figure 1, Electrical Power Distribution

C.14
Answer: d
Reference: SAR 7.1

C.15
Answer: a(4) b(3) c(1) d(2)
Reference: SAR, Figure 7.11

C.16
Answer: b
Reference: MNRC-0020-OMM-04, Section 2.1.2

C.17
Answer: c
Reference: TS 4.2.1

C.18
Answer: F1 (2) F2(3) F3(1) F4(4)
Reference: OMM – 5110, Figure 2