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

April 28, 2022

Dr. Glenn E. Sjoden, Director
Utah Nuclear Engineering Program
Professor, Energy Solutions Presidential
Endowed Chair
Dept of Civil and Environmental Engineering
University of Utah
110 Central Campus Drive, Rm 2000
Salt Lake City, UT 84112

SUBJECT: EXAMINATION REPORT NO. 50-407/OL-22-01, UNIVERSITY OF UTAH

Dear Dr. Sjoden:

During the week of March 14, 2022, the U.S. Nuclear Regulatory Commission (NRC) administered operator licensing examinations at your University of Utah reactor. The examinations were conducted according to NUREG-1478, "Operator Licensing Examiner Standards for Research and Test Reactors," Revision 2. Examination questions and preliminary findings were discussed with those members of your staff identified in the enclosed report at the conclusion of the examination.

In accordance with Title 10 of the *Code of Federal Regulations,* Section 2.390, a copy of this letter and the enclosures will be available electronically for public inspection in the NRC Public Document Room or from the Publicly Available Records (PARS) component of NRC's Agencywide Documents Access and Management System (ADAMS). ADAMS is accessible from the NRC Web site at http://www.nrc.gov/reading-rm/adams.html. The NRC is forwarding the individual grades to you in a separate letter which will not be released publicly. Should you have any questions concerning this examination, please contact Mr. John T. Nguyen at (301) 415-4007 or via internet e-mail John.Nguyen@nrc.gov.

Sincerely,

Travis L. Tate
Digitally signed by Travis L. Tate
Date: 2022.04.28 14:22:58 -04'00'

Travis L. Tate, Chief
Non-Power Production and Utilization Facility
Oversight Branch
Division of Advanced Reactors and Non-Power
Production and Utilization Facilities
Office of Nuclear Reactor Regulation

Docket No. 50-407
Enclosures:
1. Examination Report No. 50-407/
OL-22-01
2. Written Examination

cc: w/o enclosures: See next page

SUBJECT: EXAMINATION REPORT NO. 50-407/OL-22-01, UNIVERSITY OF UTAH APRIL 28, 2022

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ADAMS Accession No.:ML22118A380 **NRR-079**

OFFICE	NRR/DANU/UNPO/CE	NRR/DANU/UNPO/OLA	NRR/DANU/UNPO/BC
NAME	JNguyen	ZTaru	TTate
DATE	04/01/2022	04/26/2022	04/28/2022

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cc:
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Test, Research and Training
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U.S. NUCLEAR REGULATORY COMMISSION
OPERATOR LICENSING INITIAL EXAMINATION REPORT

REPORT NO.: 50-407/OL-22-01

FACILITY DOCKET NO.: 50-407

FACILITY LICENSE NO.: R-126

FACILITY: University of Utah

EXAMINATION DATES: March 18, 2022

SUBMITTED BY: John Nguyen 04/01/2022
John T. Nguyen, Chief Examiner Date

SUMMARY:
During the week of March 14, 2022, the NRC administered a retake examination to one Reactor Operator (RO) and one Senior Reactor Operator Instant (SROI) candidates who previously failed the category B of the written examination in September 2021. Both candidates passed the retake examination.

REPORT DETAILS

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

2. Results:

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

3. Exit Meeting:
John T. Nguyen, Chief Examiner, NRC
Andrew Allison, Reactor Supervisor, UUTR

Facility comments were accepted prior to the administration of the written examination.
At the conclusion of the meeting, the NRC examiner thanked the facility for their support in the administration of the examinations.

ENCLOSURE 1

University of Utah

Operator Licensing Examination

Week of March 14, 2022

ENCLOSURE 2

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

FACILITY: University of Utah

REACTOR TYPE: TRIGA

DATE ADMINISTERED: 03/18/2022

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 one hour 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 COGE NTROLS
~~20.00~~	~~33.3~~	_____	_____	C.	~~FACILITY AND RADIATION MONITORING SYSTEMS~~
20.00		_____	_____	%	TOTALS
		FINAL GRADE			

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

_____
Candidate's Signature

Category B – Normal/Emergency Operating Procedures and Radiological Controls

A N S W E R S H E E T

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

B01 a b c d ___

B02 a b c d ___

B03 a b c d ___

B04 a b c d ___

B05 a b c d ___

B06 a b c d ___

B07 a _____ b _____ c _____ d _____ (0.25 each)

B08 a b c d ___

B09 a _____ b _____ c _____ d _____ (0.25 each)

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

B11 a b c d ___

B12 a b c d ___

B13 a b c d ___

B14 a _____ b _____ c _____ d _____ (0.25 each)

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

B16 a b c d ___

B17 a b c d ___

B18 a b c d ___

B19 a b c d ___

B20 a b c d ___

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

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 one (1) hour for completion of this examination.

EQUATION SHEET

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

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

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

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

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

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

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

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

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

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

$$CR_1(-\rho_1) = CR_2(-\rho_2)$$
$$CR_1(1 - K_{eff_1}) = CR_2(1 - K_{eff_2})$$

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

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

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

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

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

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

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

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

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

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

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

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-lb

1 gal (H_2O) ≈ 8 lb

c_P = 1.0 BTU/hr/lb/°F

1 kg = 2.21 lb

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

Category B: Normal/Emergency Operating Procedures and Radiological Controls

QUESTION B.01 [1.0 point]
Per UUTR Technical Specifications, which ONE of the following is the most correct statement regarding the basis of limiting 1000 °C temperature for stainless-steel clad?

a. It is temperature limit for the reactor to reduce the time of reactor scram, therefore it prevents exceeding the safety limit.

b. It is a temperature limit for a fuel cladding failure during Loss of Coolant Accident (LOCA).

c. It is the temperature limit to ensure that the cladding surface of fuel rod has the maximum heat transfer, therefore maintaining the safety margin.

d. It is the temperature limit to ensure that the stress in the cladding because of hydrogen pressure from the disassociation of zirconium hydride will remain below the ultimate stress.

QUESTION B.02 [1.0 point]
The exposure rate for a point source is 250 mR/hr at a distance of 1m. What is the exposure rate at a distance of 4m?

a. 150 mR/hr

b. 125 mR/hr

c. 62.5 mR/hr

d. 15.63 mR/hr

QUESTION B.03 [1.0 point]
What is a basis for the value of shutdown margin per UUTR Technical Specifications?

a. The value ensures that the reactor can be restarted from any operating condition with the highest control rod in the fully withdrawn position.

b. The value ensures that the reactor can be critical from any operating condition with the highest control rod in the fully withdrawn position.

c. The value ensures that the reactor can be operated from any operating condition with the control rod lowest withdraw position.

d. The value ensures that the reactor can be shut down from any permissible operating condition with the highest worth scrammable control rod in the fully withdrawn position.

Category B: Normal/Emergency Operating Procedures and Radiological Controls

QUESTION B.04 [1.0 point]
Which of the following events would be classified as Non-Reactor, Safety-Related Event?

a. Fire within the reactor facility that cannot be extinguished within 15 minutes.

b. Significant contamination of an individual of the UNEP or MEB facility.

c. Significant failure of a fuel element initiates all radiation monitor alarms.

d. A major leak in the primary system that cannot be made up with normal pool fill.

QUESTION B.05 [1.0 point]
Which ONE of the following will meet the MINIMUM staffing requirements during the reactor startup?

a. 2 ROs in the control room.

b. 1 RS or SRO – on call + 1 RO in the control room.

c. 1 RS or SRO in the control room + 1 designated person in the UNEF.

d. 1 RO in the control room + 1 designated person in the UNEF + 1 SRO or RS at Washington D.C.

QUESTION B.06 [1.0 point]
A two-curie source, emitted 90% of 200 keV gamma, is to be stored in the reactor building. What is the dose rate at 10 ft?

a. 21.6 mR/hr

b. 216 mR/hr

c. 2.16 R/hr

d. 21.6 R/hr

Category B: Normal/Emergency Operating Procedures and Radiological Controls

QUESTION B.07 [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 a startup, you depress a scram button to verify a reactor scram.

b. You insert a check source to the Radiation Area Monitor to verify an alarm set point.

c. You adjust Linear channel in accordance with recent data collected from a power channel calibration.

d. During a steady state power, you compare the readings of the pool water temperature.

QUESTION B.08 [1.0 point]
Per 10 CFR20, a radiation area is defined as:

a. Any area, accessible to personnel, in which there exists radiation at such levels that a major portion of the body could receive in excess of 100 mR/h.

b. Any accessible area, controlled by the licensee, where an individual could receive a dose in excess of 5 mR/hr.

c. Any area, accessible to personnel, in which there exists radiation at such levels that a major portion of the body could receive in 5 consecutive days a dose in excess of 100 mR.

d. Any area, accessible to personnel, in which there exists radiation in excess of 25 percent of the amounts specified in Appendix B, Table I, Column I of 10 CFR 20.

QUESTION B.09 [1.0 point]
In accordance with the UUTR Technical Specifications, select the allowable surveillance intervals defined by the TS.

a. Biennial interval not to exceed _____(24/26/30) months

b. Annual interval not to exceed _____(12/15/16) months

c. Semiannual interval not to exceed _____(7.0/7.5/8.0) months

d. Quarterly interval not to exceed _____ (3.0/3.5/4.0) months

Category B: Normal/Emergency Operating Procedures and Radiological Controls

QUESTION B.10 [1.0 point, 0.25 each]
Identify the PRIMARY source (irradiation of **air**, irradiation of **water**, irradiation of reactor **structure**, or **fission** product) of EACH of the following radioisotopes.

a. Al-28

b. Ar-41

c. N-16

d. Br-87

QUESTION B.11 [1.0 point]
Per UUTR Technical Specifications, when is the direct presence of a Reactor Supervisor (RS) required?

a. Control rod calibration.

b. First reactor startup for the day.

c. Movement of fuel within the reactor pool.

d. Relocation of any in-core experiment with a reactivity worth less than one dollar.

QUESTION B.12 [1.0 point]
The MAIN purpose to encapsulate a corrosive material irradiated in the reactor core is to prevent:

a. contamination in the pool water.

b. pressure build up in the sample holder.

c. release of corrosive gas to the reactor bay.

d. contamination to a reactor operator while handling it.

Category B: Normal/Emergency Operating Procedures and Radiological Controls

QUESTION B.13 [1.0 point]
Which ONE of the following types of radiation detectors does not have an output intensity proportional to the incident radiation energy (e.g., as incident energy increases, the output intensity increases)?

a. GM

b. Ion chamber

c. Scintillation

d. Proportional counter

QUESTION B.14 [1.0 point, 0.25 each]
Match the Federal Regulation number in Column A with the appropriate topic in Column B.

Column A	Column B
a. 10 CFR 20	1. Operator Licenses
b. 10 CFR 50	2. Facility Licenses
c. 10 CFR 55	3. Radiation Protection
d. 10 CFR 73	4. Special Nuclear Material

QUESTION B.15 [1.0 point, 0.25 each]
Fill out the blanks with correct value of the Limiting Conditions of Operation (LCO) listed in the UUTR Technical Specifications.

	Safety System	LCO
a.	Core Excess Reactivity	_____ $ (1.00/1.20/2.00)
b.	Transverse bend of fuel	_____ inches (0.055/0.0625/0.125)
c.	Reactor power	_____ kW (90/100/110)
d.	Scram time	_____ seconds (1/2/3)

Category B: Normal/Emergency Operating Procedures and Radiological Controls

QUESTION B.16 [1.0 point]
A 40-mm thick sheet of lead, placed at a certain location in a beam port, would reduce the gamma radiation level from 600 mR/hr to 150 mR/hr. How much **additional** lead would be needed to reduce the gamma radiation level to 75 mR/hr?

a. 20 mm

b. 40 mm

c. 60 mm

d. 80 mm

QUESTION B.17 [1.0 point]
Reactor Operator works in a high radiation area for eight (8) hours a day. The dose rate in the area is 80 mrem/hour. Which ONE of the following is the MAXIMUM number of days in which Reactor Operator may perform his duties WITHOUT exceeding 10 CFR 20 limits?

a. 6 days

b. 7 days

c. 8 days

d. 9 days

QUESTION B. 18 [1.0 point]
In case of Safety Limit violation, the reactor shall be shut down, and reactor operations shall not be resumed until authorized by _____.

a. Level 1, UUTR Vice President for Research

b. Level 2, UNEP Reactor Director

c. Level 3, UNEP Reactor Supervisor

d. U.S. NRC

Category B: Normal/Emergency Operating Procedures and Radiological Controls

QUESTION B.19 [1.0 point]
Radiation dose to emergency personnel is limited to _____ TEDE for the protection of large populations by volunteers fully aware of risk involved.

a. Up to 10 rem

b. Up to 25 rem

c. > 25 rem

d. Up to 5 rem

QUESTION B.20 [1.0 point]
Per UUTR Technical Specifications, the control rod movement speed requires to be measured _____ during control rod worth measurement.

a. Biennially

b. Annually

c. Biannually

d. Quarterly

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

((***** END OF EXAM *****))

Category B: Normal/Emergency Operating Procedures and Radiological Controls

B.01
Answer: d
Reference: UUTR TS 2.1

B.02
Answer: d
Reference: $I_2 = I_1 D_1^2 / d_2^2$
$I_2 = (250\ mR/hr)(1m)^2 / (4m)^2$
$I_2 = 15.63\ mR$

B.03
Answer: d
Reference: UUTR TS 3.1.2

B.04
Answer: b
Reference: UUTR EP 4.2

B.05
Answer: c
Reference: UUTR TS 6.1.3

B.06
Answer: a
Reference: 6CEN = R/hr @ 1 ft. -> 6 x 2 x 0.9 x 0.2 = 2.16 R/hr at 1ft.
$I_2 = I_1 D_1^2 / d_2^2$
$I_2 = (2.16\ R/hr)(1m)^2 / (10m)^2$
$I_2 = 2.16\ R/hr\ ?100 = 0.0216\ R/hr = 21.6\ mR/hr$

B.07
Answer: a, TEST b, TEST c, CAL d, CHECK
Reference: UUTR TS 1.3

B.08
Answer: b
Reference: 10 CFR 20

B.09
Answer: a, 30 b, 15 c, 7.5 d. 4.0
Reference: UUTR TS 1.3

B.10
Answer: a. = Structure; b. = Air; c. = Water, d. = Fission (0.25 each)
Reference: NRC standard question

B.11
Answer: b
Reference: UUTR Technical Specifications, Section 6.1.3

Category B: Normal/Emergency Operating Procedures and Radiological Controls

B.12
Answer: a
Reference: NRC standard question

B.13
Answer: a
Reference: NRC standard question

B.14
Answer: a. = 3; b. = 2; c. = 1; d. = 4. (0.25 each)
Reference: Title 10 of the *Code of Federal Regulations.*

B.15
Answer: a. = $1.20; b. = 0.0625 ins; c. = 100 kW; d. = 2 sec (0.25 each)
Reference: UUTR TS 3.1.1, TS 3.1.3, TS 3.1.6, TS 3.2.1

B.16
Answer: a
Reference: $DR = DR^{*}e^{-\mu X}$
Find μ
$150 = 600^{*} e^{-\mu^{*}40}$; μ = 0.0346
If insertion of an HVL (thickness of lead), the original intensity will be reduced by half.

Find X: $1 = 2^{*} e^{-0.0346^{*}X}$; X= 20 mm

Find HVL by shortcut:
600mR- 300 mR is the 1st HVL
300 mR – 150 mR is the 2nd HVL
150- mR – 75 mR is the 3rd HVL

B.17
Answer: b
Reference: 10CFR20.1201(a)(1)

$$\frac{5000 \text{ mr} \times 1 \text{ hr} \times \text{day}}{80 \text{ mr} * 8 \text{ hr}} = 7.8 \text{ days}$$

You cannot round off to 8 days that will exceed 10CFR20 limits

B.18
Answer: d
Reference: UUTR TS 6.1.2

B.19
Answer: b
Reference: UUTR EP 3.5

B.20
Answer: b
Reference: UUTR TS 4.2