February 9, 2000

Dr. David M. Slaughter
2202 MEB
University of Utah
Salt Lake City, UT 84112

SUBJECT: INITIAL EXAMINATION REPORT NO. 50-407/OL-00-01

Dear Dr. Slaughter:

During the week of January 17, 2000, the NRC administered examinations to employees of your facility who had applied for a license to operate your University of Utah Reactor. The examinations were conducted in accordance with NUREG-1478, "Non-Power Reactor Operator Licensing Examiner Standards," Revision 1. At the conclusion of the examinations, the examination questions and preliminary findings were discussed with those members of your staff identified in the enclosed report.

In accordance with 10 CFR 2.790 of the Commission's regulations, a copy of this letter and the enclosures will be placed in the NRC Public Document Room.

Should you have any questions concerning this examination, please contact me at (301) 415-1168.

Sincerely,

/RA/

Ledyard B. Marsh, Chief
Events Assessment, Generic Communications
and Non-Power Reactors Branch
Division of Regulatory Improvement Programs
Office of Nuclear Reactor Regulation

Docket No. 50-407

Enclosures: 1. Initial Examination Report
No. 50-407/OL-00-01
2. Facility comments with NRC resolution
3. Examination and answer key (RO/SRO)

cc w/encl.: Please see next page

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Dr. Melinda Krahenbuhl
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University of Utah
Salt Lake City, UT 84112

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

REPORT NO.: 50-407/OL-00-01

FACILITY DOCKET NO.: 50-407

FACILITY LICENSE NO.: R-126

FACILITY: University of Utah

EXAMINATION DATES: January 18 and 19, 2000

EXAMINER: Paul Doyle, Chief Examiner

SUBMITTED BY: _____ _____
Paul Doyle, Chief Examiner Date

SUMMARY:

During the week of January 17, 2000, the NRC administered Operator Licensing Examinations to three Senior Reactor Operator Candidates. One candidate failed section B only, one candidate failed section C only and the third candidate failed both sections B and C of the written examination.

REPORT DETAILS

1. Examiners: Paul Doyle, Chief Examiner

2. Results:

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

3. Exit Meeting:
Paul Doyle, NRC, Examiner
Melinda Krahenbuhl, Reactor Supervisor, University of Utah
David M. Slaughter, CENTER Director, University of Utah

The examiner held an exit meeting with the facility staff on January 20, 2000. The examiner thanked the facility staff for their support in the administration of the examinations, and discussed some minor weaknesses noted on the operating tests. The Reactor Supervisor provided a copy of the facility comments on the written examination to the examiner.

FACILITY COMMENTS ON NRC WRITTEN EXAMINATION
AND NRC RESOLUTIONS

ENCLOSURE 2

Center for Excellence in
Nuclear Technology, Engineering, and Research

Jan. 20, 2000

Paul Doyle
U.S. Nuclear Regulatory Commission
Non-Power Reactors and Decommissioning Project Directorate, HQ
Division of Reactor Program Management
Washington, DC 20555-0001

Dear Mr. Doyle

This exam was well written and represents a reasonable exam for the SRO candidates. I appreciate the time and effort you and the NRC support staff put forth. I have identified three questions in the written exam which I feel should be amended or omitted. The question, specific concern and support information are provided below.

Section A
All questions are acceptable. The answer key for problem A.3 is incorrect. The correct response is d.

Section B
We have identified two questions from part B which are confusing

Question B.2 This question concerns the requirements for maintaining an active operator license. We agree that 10 CFR 55 clearly identifies 6 years to renew, two year medical exams and annual operating exam. The confusion lies in the time interval for the written requalification exam. The Requal program at the CENTER requires a written exam on a yearly basis. The 10 CFR 55.59 states

(1) "Successfully complete a requalification program developed by the facility licensee that has been approved by the Commission"

(2) "pass a comprehensive requalification written examination and annual operating test"

We contend the language requires fulfillment of our NRC accepted requalification program which is a annual written exam.

Action: the answer should be changed to a.6 b. 2 c. 1 d. 1

B.12 This question is confusing. The TS4.3.1 is describing the surveillance of the control rods to determine reactivity worth. This procedure is required annually and would be late after fifteen months. The language "annual maintenance" was thought to describe the control rod inspection and maintenance performed biennially. Therefor none of the answers would be correct.

Action: omit question B.12

CENTER
University of Utah
122 S. Central Campus Dr. Rm. 104
Salt Lake City, Utah 84112-0561
(801) 581-8499

Section C
C.9 This question is confusing. The emphasized word "automatic" suggests that we currently have an automatic control system attached to the regulating rod. This is not the case. The safety shim and reg. rods are operated manually.

Action: Omit question C.9

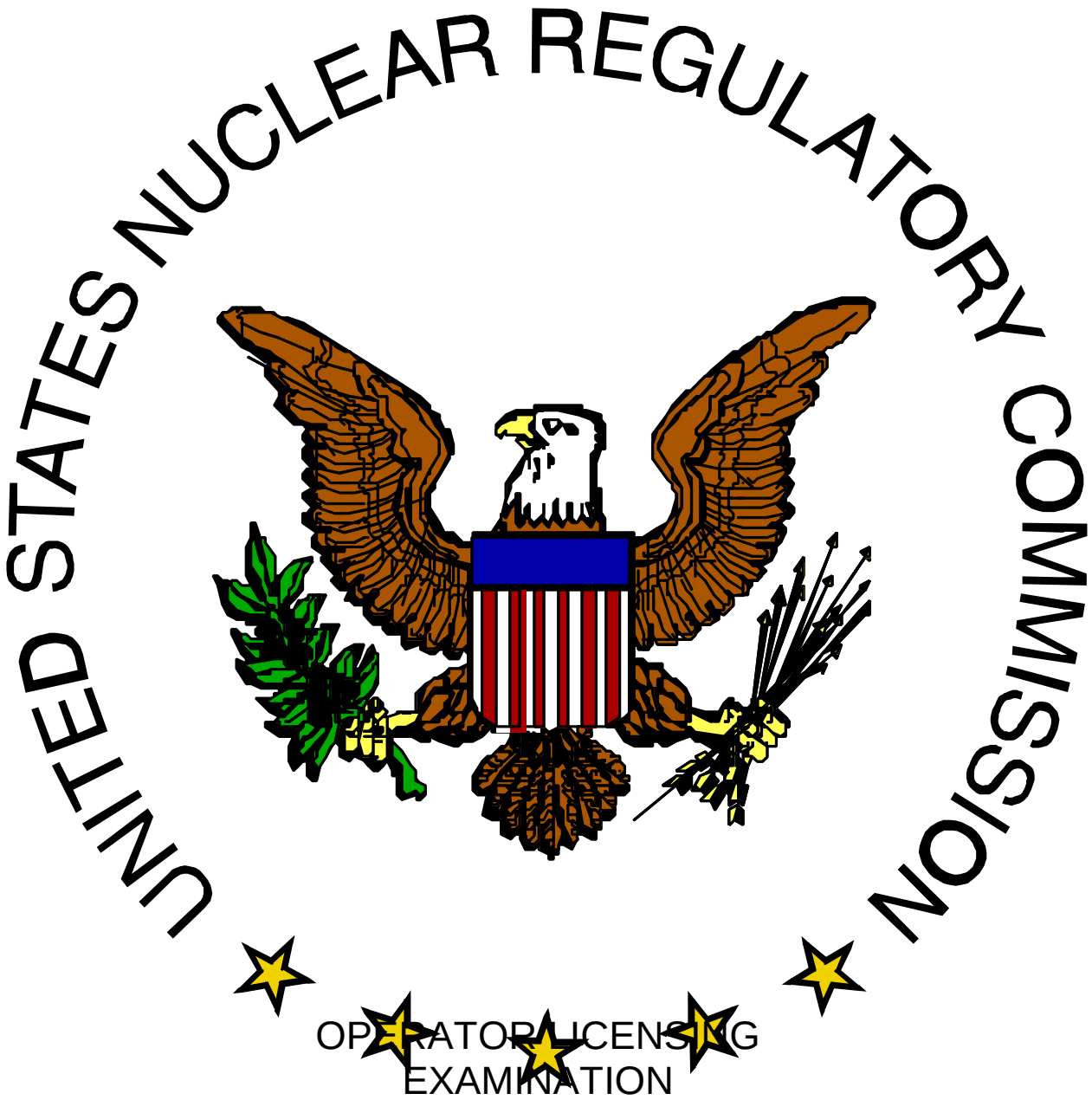
Respectfully,

Melinda P. Krahenbuhl, Ph.D.
Reactor Supervisor

NRC RESOLUTION TO UNIVERSITY OF UTAH COMMENTS:

All comments accepted as written.

University of Utah
With Answer Key



OPERATOR LICENSING EXAMINATION

January 17, 2000

ENCLOSURE 3

Question A.1 [1.0 point]

Core excess reactivity changes with…

a. Fuel burnup

b. Control Rod Height

c. Neutron Level

d. Reactor Power Level

Question A.2 [1.0 point]

Control Rod withdrawal predominantly changes K_{eff} by changing the …

a. fast fission factor (ε).

b. thermal utilization factor (f).

c. neutron reproduction factor (η).

d. resonance escape probability (p).

Question A.3 [1.0 point]

Reactor power increases from 30 watts to 60 watts in one minute. Reactor period is …

a. 30 seconds

b. 42 seconds

c. 60 seconds

d. 87 seconds

Question A.4 [1.0 point]

Which ONE of the following is an example of alpha decay?

a. $_{35}Br^{87} \rightarrow {}_{33}As^{83}$

b. $_{35}Br^{87} \rightarrow {}_{35}Br^{87}$

c. $_{35}Br^{87} \rightarrow {}_{34}Se^{86}$

d. $_{35}Br^{87} \rightarrow {}_{36}Kr^{87}$

Question A.5 [1.0 point]

When compared to β, β_{eff} is …

a. smaller, because delayed neutrons are born at lower energies than prompt neutrons.

b. larger, because delayed neutrons are born at lower energies than prompt neutrons.

c. smaller, because delayed neutrons are born at higher energies than prompt neutrons.

d. larger, because delayed neutrons are born at higher energies than prompt neutrons.

Question A.6 [1.0 point]

Five minutes following shutdown, reactor power is 3×10^6 counts per minute. Which ONE of the following is the count rate you would expect to see three minutes later?

a. 10^6

b. 8×10^5

c. 5×10^5

d. 3×10^5

Question A.7 [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.8 [1.0 point]

The reactor supervisor tells you the reactor is shutdown with a shutdown margin of 12%. An experimenter inserts an experiment in the core and nuclear instrumentation increases form 100 counts per minute to 200 counts per minute. What is the new K_{eff} of the reactor?

a. 0.920

b. 0.946

c. 0.973

d. 1.000

Question A.9 [1.0 point]

The term $\mathbf{K_{eff}}$ is defined as …

a. absorption/(production + leakage)

b. (production + leakage)/absorption

c. (absorption + leakage)/production

d. production/(absorption + leakage)

Question A.10 [1.0 point]

INELASTIC SCATTERING is the process by which a neutron collides with a nucleus and …

a. recoils with the same kinetic energy it had prior to the collision.

b. recoils with a lower kinetic energy than it had prior to the collision with the nucleus emitting a gamma ray.

c. is absorbed, with the nucleus emitting a gamma ray.

d. recoils with a higher kinetic energy than it had prior to the collision with the nucleus emitting a gamma ray.

Question A.11 [2.0 points]

Match each of the terms in column A with the correct definition from column B.

Column A	Column B
a. Fast neutrons	1. Neutrons released directly from fission.
b. Prompt neutrons	2. High energy neutrons.
c. Slow neutrons	3. Neutrons releases from decay of fission products.
d. Delayed neutrons	4. Low energy neutrons.

Question A.12 [1.0 point]

WHICH ONE of the following nuclei will cause a neutron to lose the MOST energy while slowing down? (Assume elastic collision.)

a. H^{1}

b. H^{2}

c. C^{12}

d. U^{238}

Question A.13 [1.0 point]

WHICH ONE of the following is the **MAJOR** source of energy released during fission?

a. Kinetic energy of the fission neutrons.

b. Kinetic energy of the fission fragments.

c. Decay of the fission fragments.

d. Prompt gamma rays.

Question A.14 [1.0 point]

WHICH ONE of the following describes the **MAJOR** contributions to the production and depletion of xenon in the reactor?

a. Produced from radioactive decay of iodine and depletes by neutron absorption only.

b. Produced from radioactive decay of iodine and depletes by radioactive decay and neutron absorption.

c. Produced directly from fission and depletes by neutron absorption only.

d. Produced directly from fission and depletes by radioactive decay and neutron absorption.

Question A.15 [1.0 point]

An experimenter makes an error loading a rabbit sample. Injection of the sample results in a 100 millisecond period. If the scram setpoint is 125 kW and the scram delay time is 0.1 seconds, **WHICH ONE** of the following is the peak power of the reactor at shutdown.

a. 125 kW

b. 250 kW

c. 340 kW

d. 125 kW

Question A.16 [1.0 point]

The **PRIMARY** reason that a neutron source is installed in the reactor is to …

a. allow for testing and irradiation of experiments when the core is shutdown.

b. supply the neutrons required to start the chain reaction for subsequent reactor startups.

c. provide a neutron level high enough to be monitored for a controlled reactor startup.

d. increase the excess reactivity of the reactor which reduces the frequency for refueling.

Question A.17 [1.0 point]

Which ONE of the following describes the response of a SUBCRITICAL reactor to EQUAL insertions of positive reactivity as the reactor approaches criticality? Each reactivity insertion causes …

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

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

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

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

Question A.18 [1.0 point]

The neutron microscopic cross-section for absorption σ_a generally …

a. increases as neutron energy increases

b. decreases as neutron energy increases

c. increases as target nucleus mass increases

d. decreases as target nucleus mass increases

Question A.19 [1.0 point]

By definition, an exactly critical reactor can be made prompt critical by adding positive reactivity equal to …

a. the shutdown margin

b. the K_{excess} margin

c. the β_{eff} value

d. 1.0 $\%\Delta K/K$.

Question B.1 [1.0 point]

Two sheets of ¼ inch thick lead shielding reduces a radiation beam from 200 mR/hr to 100 mR/hr at 1 foot. What will the radiation read at 1 foot if you add another ¼ inch thick lead sheet (for a total of 3 sheets)?

e. 71 mR/hr

f. 50 mR/hr

g. 35 mR/hr

h. 17 mR/hr

Question B.2 [2.0 points, ½ each]

Match the 10CFR55 requirements for maintaining an active operator license in column A with the corresponding time period from column B.

	Column A	Column B
a.	Renew License	1 year
b.	Medical Exam	2 years
c.	Pass Requalification Written Examination	4 years
d.	Pass Requalification Operating Test	6 years

Question B.3 [2.0 points, ½ each]

Identify each of the following actions as either a ***CHANNEL CHECK***, ***CHANNEL TEST*** or a ***CHANNEL CALIBRATION***.

a. Verifying overlap between Nuclear Instrumentation channels.

b. Replacing a Resistance Temperature Detector (RTD) with a precision resistance decade box, to verify proper channel output for a given resistance.

c. Performing a calorimetric (heat balance) calculation on the primary system, then adjusting the Nuclear Instrumentation to agree.

d. During reactor shutdown you verify the period meter reads -80 seconds.

Question B.4 [2.0 points, ½ each]

Match the type of radiation in column A with its associated Quality Factor (10CFR20) from column B.

	Column A	Column B
a.	alpha	1
b.	beta	2
c.	gamma	5
d.	neutron (unknown energy)	10
		20

Question B.5 [1.0 point]

Following an evacuation of the facility during an emergency. Who by title, may authorize reentry (according to the Emergency Plan)?

a. CENTER Director

b. Reactor Supervisor, with advice of Radiation Safety Officer

c. Any Senior Operator, with advice of Radiation Safety Officer

d. Any NRC licensed Operator, with advice of any health physics technician.

Question B.6 [1.0 point]

Which ONE of the following correctly identify the Technical Specification experiment reactivity limits for single unsecured and secured experiments respectively?

a. 57¢ and $1.00

b. $1.00 and $1.80

c. $1.00 and $2.80

d. $2.00 and $3.80

Question B.7 [1.0 point]

Who, may authorize reactor restart following an accident which causes a Safety Limit to be exceeded.

a. Licensed Senior Operator on call.

b. Reactor Supervisor

c. CENTER Director

d. U.S. NRC

Question B.8 [1.0 point]

Per Technical Specifications the maximum amount of time the ventilation system may be out of service (with the reactor running) is …

a. 2 hours

b. a day

c. 2 days

d. a week

Question B.9 [1.0 point]

Per the Emergency Plan, Emergency Action Level(s) is (are) …

a. the person or persons appointed by the Emergency Coordinator to ensure that all personnel have evacuated the facility or a specific part of the facility.

b. Projected radiological dose or dose commitment values to individuals that warrant protective action following a release of radioactive material.

c. A condition that requires immediate action, beyond the scope of normal operating procedures, to avoid or mitigate an accident or event and its consequences.

d. Radiological dose rates; specific contamination levels of airborne, waterborne, or surface deposited concentrations of radioactive materials; or specific instrument readings that may be used as thresholds for initiating specific emergency measures.

Question B.10 [1.0 point]

CAM alarms are set at …

a. 10% of MPC

b. 50% of MPC

c. 100% of MPC

d. 5 times MPC

Question B.11 [1.0 point, ¼ each]

Match the Federal Regulation chapter in column A with the requirements covered 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.12 [1.0 point]

Annual maintenance was last performed on the control rods on October 31, 1998. The last date annual maintenance may be performed on the system without being late is…

a. October 31, 1999

b. December 31, 1999

c. January 31, 2000

d. March 31, 2000

Question B.13 [2.0 points, ½ each]

Identify each of the following as either a Safety Limit (SL), Limiting Safety System Setting (LSSS) or a Limiting Condition for Operation (LCO)

a. The rate of reactivity insertion shall not exceed 30¢ per second.

b. The temperature in an aluminum-clad low hydride fuel element located in the B-hexagonal ring shall not exceed 460°C.

c. The temperature in a stainless-steel-clad high hydride fuel element shall not exceed 1000°C.

d. During steady-state operation a minimum of two reactor power level channels shall be operable.

Question B.14 [1.0 point]

The facility accepts a brilliant 14 year old as a student in the Nuclear Engineering Department. As part of his curriculum, he must perform reactor startups. Because he is under 18, his maximum 10 CFR 20 Total Effective dose Equivalent (TEDE) limit is

a. the same as everyone else because he is a radiation worker.

b. ½ the limit for other radiation workers.

c. ¼ the limit for other radiation workers

d. $^{1}/_{10}$ the limit for other radiation workers.

Question B.15 [1.0 point]

The ***CURIE*** content of a radioactive source is a measure of

a. the number of radioactive atoms in the source.

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

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

d. the number of nuclear disintegrations per unit time.

Question B.16 [1.0 point]

Which ONE of the following scrams built in to the Mark III console is **NOT** required by Technical Specifications?

a. Fuel Temperature

b. Reactor Power Level (Nuclear Instrumentation)

c. Reactor Tank Water Level

d. Reactor Period

Question C.1 [2.0 points, ½ each]

Match the reactor power instrumentation listed in column A with its corresponding detector type from column B. (Choices from column b may be used more than once or not at all.)

Column A	Column B
e. Source Range Channel	1. Boron Lined Uncompensated Ion Chamber
f. Linear Channel	2. Boron Lined Compensated Ion Chamber
g. Log-N Channel	3. Unlined Ion Chamber
h. Percent Power Channel	4. Fission Chamber
	e. Proportional Counter

Question C.2 [1.0 point]

WHICH ONE of the following components is primarily responsible for maintain pool water conductivity?

a. Water Filter

b. Demineralizer

c. Skimmer

d. Water Softener

Question C.3 [1.0 point]

WHICH ONE of the following detectors is used primarily to measure N^{16} release to the environment?

a. NONE, N^{16} has too short a half-life to require environmental monitoring.

b. TA BAM-3H Continuous Air Monitor Particulate Channel

c. TA BAM-3H Continuous Air Monitor Gaseous Channel

d. TA BAM-3H Continuous Air Monitor Iodine Channel

Question C.4 [1.0 point]

WHICH ONE of the following gases is used to propel the rabbit in the pneumatic tube system?

a. air

b. CO_2

c. N_2

d. He

Question C.5 [1.0 point]

Fuel temperature must be limited in the aluminum clad, low hydride fuel elements in order to avoid fuel element failure due to which of the following mechanisms?

a. Distortion of the fuel element due to a phase change of the zirconium hydride.

b. Melting the aluminum cladding due to high temperature.

c. Damage to fuel cladding due to excessive pressure from expansion of fission product gasses.

d. Damage to fuel cladding due to excessive pressure from hydrogen produced by disassociation of the zirconium and hydrogen.

Question C.6 [1.0 point]

How long with the single phase backup generator operate, before it must be refueled?

a. 2 hours

b. 2 days

c. 2 weeks

d. 2 months

Question C.7 [1.0 point]

A pipe flange fails just downstream of the primary pump. What design feature of the primary system prevents draining of the pool?

a. Signal from a float switch shuts a valve in the pump suction line.

b. Signal from a float switch shuts off the primary pump.

c. Level in the pool drops below the Net Positive Suction Head pressure minimum required to operate the pump.

d. Level in the pool drops below siphon break holes in the primary suction pipe.

Question C.8 [1.0 point]

Which **ONE** of the following heat transfer mechanisms provides cooling for the core?

a. Forced Convection

b. Natural Convection

c. Conduction

d. Radiation

Question C.9 [1.0 point]

Which ONE of the following is NOT a input signal into the AUTOMATIC circuit for the regulating rod?

a. Linear Power

b. Log-N Period

c. Power Demand Level

d. Count Rate

Question C.10 [1.0 point]

Which ONE of the following would result in a LESS CONSERVATIVE calculation of reactor power during the Semi-Annual Thermal Power Calibration?

a. Initial Temperature readings were recorded lower than actual

b. Initial Pool level reading was lower than actual level.

c. Recorded time for the power run was less than actual.

d. Water is drained from the pool during the power run.

Question C.11 [2.0 points, ½ each]

For each of the gasses listed in column A identify its primary source (i.e. neutron irradiation of air, neutron irradiation of water or fission product).

a. H^3

b. N^{16}

c. Ar^{41}

d. Xe^{138}

Question C.12 [1.0 point]

Which ONE of the following contaminants is most efficiently removed by the demineralizer.

a. Ar^{41}

b. I^{135}

c. mosquito larvae

d. Oil

Question C.13 [1.0 point]

Which ONE of the following may be used for the storage of **UNIRRADIATED** Fuel, but NOT used for the storage of **IRRADIATED** Fuel?

a. Secured Storage Pits

b. Reactor Tank

c. Cf^{252} room (room 1205B)

d. Radio Chem Lab (room 1205K)

Question C.14 [1.0 point]

Under normal conditions, the CENTER reactor is **RADIALLY** reflected by …

a. Pool Water

b. Heavy Water

c. Beryllium

d. Carbon

Question C.15 [1.0 point]

Which ONE of the following is the reason that the ventilation system maintains a negative pressure in the reactor room?

a. To facilitate opening of the door between the control room and the reactor room.

b. To ensure that any radioactive contaminants go through the stack, vice through any cracks in the room.

c. To reduce pressure on the reactor tank.

d. To ensure proper operation of the Continuous Air Monitor.

Question C.16 [1.0 point]

Which ONE of the following is the design feature which limits the diffusion of any radioactive gasses from the pneumatic tube system into Reactor Laboratory?

a. None, this is not a problem at the CENTER.

b. The exhaust of the pneumatic system has it's own HEPA filter.

c. The exhaust of the pneumatic system is tied directly into the exhaust stack plenum.

d. the exhaust of the pneumatic system is vented to its own stack 25 feet above ground level.

Question C.17 [1.0 point]

On a signal requiring isolation of the reactor room the …

a. supply damper automatically closes, and automatically reopens when the signal clears.

b. supply damper automatically closes, and is opened by an operator, using a switch on the control console.

c. supply damper automatically closes, and is manually opened using a pull cord at the damper.

d. supply damper is manually closed and opened at the damper.

Question C.18 [1.0 point]

CENTER-015, specifies equipment required to be on-hand for an emergency. It requires a Radiation-Exposure survey meter to be in the control room. This meter is a

a. Geiger-Muller radiation detector

b. Ion Chamber radiation detector

c. Personnel Dosimeter

d. Scintillation radiation detector

Answer Key

A.1 a
REF:

A.2 b
REF:

A.3 ~~b~~ d Answer changed per facility comment.

REF: $\ln\left(\frac{P}{P_0}\right)=\frac{t}{t}\quad t=\frac{60\text{sec}}{\ln(2)}=86.56$

also

A.4 a
REF:

A.5 b
REF:

A.6 d
REF:

A.7 c
REF: Time is related to ratio of final power to initial power. 2:1 is the largest ratio.

A.8 b

REF:
$$K_{eff_1}=\frac{1}{1+SDM}=\frac{1}{1+0.12}=0.892857$$
$$CR_1(1-K_{eff_1})=CR_2(1-K_{eff_2});$$
$$1-K_{eff_2}=\frac{100}{200}(1-0.892857)=(0.0535715)$$
$$K_{eff_2}=0.9464285$$

Also,

A.9 d
REF:

A.10 b
REF:

A.11 a, 2; b, 1; c, 4; d, 3
REF:

A.12 a
REF:

A.13 b
REF:

A.14 b
REF:

A.15 c
REF: $P = P_0 e^{t/\tau}$, P = 125 kwatt × $e^{0.1/0.1}$ = 125 × e = 339.79

A.16 c
REF:

A.17 b
REF:

A.18 b
REF:

A.19 c
REF:

Answer Key

B.1 a
REF: From the stem 2 sheets equal 1 half thickness $I = I_0 (½)^{1.5} = 200 \times 0.3535 = 70.71$

B.2 a, 6; b, 2; c, 2 or 1; d, 1 Second correct answer added per facility comment.
REF: 10CFR55.

B.3 a, CHECK; b, TEST; c, CAL; d, CHECK
REF: T.S. DEFINITIONS

B.4 a, 20; b, 1; c, 1; d, 10
REF: 10CFR20.100x

B.5 b
REF: Emergency Plan, § 3.4

B.6 c
REF: Technical Specification 3.1(3) and (5)

B.7 d
REF: Technical Specification 6.7

B.8 c
REF: Technical Specification 3.5

B.9 x
REF: Technical Specifications

B.10 b
REF: VI Auxiliary Surveillance Equipment, § II.A p. 97.

B.11 b
REF: Code of Federal Regulations

~~B.12 c~~
~~REF: Technical Specification 4.3.1~~ Question deleted per facility comment.

B.13 a, LCO; b, LSSS; c, SL; d, LCO
REF: R

B.14 d
REF: 10CFR20.1207

B.15 d
REF: Basic Radiation principles

B.16 d
REF: Modification Authorization MA-2, and Technical Specifications, § 3.3.3 Table.

Answer Key

C.1 a, 4; b, 2; c, 2; d, 1
REF: Modification MA-2, Reactor Control System 3rd ¶.

C.2 b
REF: III, Maintenance and Surveillance, § I.B.7.d.ii 2nd ¶, p. 42

C.3 a
REF: Chart of the Nuclides.

C.4 a
REF: IV Experiment Methods § C.1 p. 2

C.5 a.
REF: Technical Specifications Section 2.1 bases.

C.6 b
REF: VI, Auxiliary Surveillance Equipment, § III. Auxiliary Power System, 3rd ¶.

C.7 d
REF: III, Maintenance and Surveillance, § I.B.7.d 1st ¶, p. 41

C.8 b
REF: SER § 5 p. 5-1 (NOTE: SER not provided by facility. This question is form an examination administered in June 1994.)

~~C.9 d~~
~~REF: Modification Authorization MA-1, figure 6.~~ Question deleted per facility comment.

C.10 b
REF: FORM NEL-012, Semi-Annual Thermal Power Calibration

C.11 a, Water; b, Water; c, Air; d, Fission Product
REF: Standard NRC Question

C.12 b
REF: III. Maintenance and Surveillance, § I.B.7.d,ii Demineralizer Beds.

C.13 c
REF: II, Reactor Operations, § F.3

C.14 b
REF: Modification Authorization MA-1, Figure 3.

C.15 b
REF: III, Maintenance and Surveillance, § I.B.7.c, 1st ¶

C.16 c
REF: IV, Experiment Methods, § C.1, 1st ¶.

C.17 b
REF: Modification Authorization MA-4, Changes to the Ventilation System, Description of Proposed Modifications, 4th ¶.

C.18 b
REF: Standard NRC question

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

FACILITY: University of Utah

REACTOR TYPE: TRIGA Mark I

DATE ADMINISTERED: 2000/01/18

REGION: IV

CANDIDATE: _____

_

INSTRUCTIONS TO CANDIDATE:
Answers are to be written on the answer sheet provided. Attach the answer sheets to the examination. Points for each question are indicated in brackets for each question. A 70% in each section is required to pass the examination. Examinations will be picked up three (3) hours after the examination starts.

Category Value	% of Total	% of Candidates Score	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. Facillity and Radiation Monitoring Systems
60.00		_____	____%	TOTALS
			FINAL GRADE	

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 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.

13. When you have completed and turned in you examination, leave the examination area. If you are observed in this area while the examination is still in progress, your license may be denied or revoked.

EQUATION SHEET

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

$$T_{½} = \frac{0.693}{\lambda}$$

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

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

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

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

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

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

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

1 kg = 2.21 lbm

1 Horsepower = 2.54 x 10^3 BTU/hr

1 Mw = 3.41 x 10^6 BTU/hr

1 BTU = 778 ft-lbf

°F = 9/5 °C + 32

1 gal (H_2O) ≈ 8 lbm

°C = 5/9 (°F - 32)

c_P = 1.0 BTU/hr/lbm/°F

c_p = 1 cal/sec/gm/°C

A.1 a b c d ___

A.2 a b c d ___

A.3 a b c d ___

A.4 a b c d ___

A.5 a b c d ___

A.6 a b c d ___

A.7 a b c d ___

A.8 a b c d ___

A.9 a b c d ___

A.10 a b c d ___

A.11a 1 2 3 4 ___

A.11b 1 2 3 4 ___

A.11c 1 2 3 4 ___

A.11d 1 2 3 4 ___

A.12 a b c d ___

A.13 a b c d ___

A.14 a b c d ___

A.15 a b c d ___

A.16 a b c d ___

A.17 a b c d ___

A.18 a b c d ___

A.19 a b c d ___

B.1 a b c d ___

YEARS
B.2a 1 2 4 6 ___

YEARS
B2b 1 2 4 6 ___

YEARS
B.2c 1 2 4 6 ___

YEARS
B.2d 1 2 4 6 ___

B.3a Check Test Cal ___

B.3b Check Test Cal ___

B.3c Check Test Cal ___

B.3d Check Test Cal ___

B.4a 1 2 5 10 20 ___

B.4b 1 2 5 10 20 ___

B.4c 1 2 5 10 20 ___

B.4d 1 2 5 10 20 ___

B.5 a b c d ___

B.6 a b c d ___

B.7a air water fission ___

B.7b air water fission ___

B.7c air water fission ___

B.7d air water fission ___

B.8 a b c d ___

B.9a 1 2 3 ___

B.9b 1 2 3 ___

B.9c 1 2 3 ___

B.9d 1 2 3 ___

B.9e 1 2 3 ___

B.10 a b c d ___

B.11a 1 2 3 4 ___

B.11b 1 2 3 4 ___

B.11c 1 2 3 4 ___

B.11d 1 2 3 4 ___

B.12 a b c d ___

B.13a SL LSSS LCO ___

B.13b SL LSSS LCO ___

B.13c SL LSSS LCO ___

B.13d SL LSSS LCO ___

B.14 a b c d ___

B.15 a b c d ___

C.1a 1 2 3 4 5 ___

C.1b 1 2 3 4 5 ___

C.1c 1 2 3 4 5 ___

C.1d 1 2 3 4 5 ___

C.2 a b c d ___

C.3 a b c d ___

C.4 a b c d ___

C.5 a b c d ___

C.6 a b c d ___

C.7 a b c d ___

C.8 a b c d ___

C.9a 1 2 3 4 ___

C.9b 1 2 3 4 ___

C.9c 1 2 3 4 ___

C.9d 1 2 3 4 ___

C.10 a b c d ___

C.11a I IA II III ___

C.11b I IA II III ___

C.11c I IA II III ___

C.11d I IA II III ___

C.12 a b c d ___

C.13a S O ___

C.13b S O ___

C.13c S O ___

C.13d S O ___

C.14 a b c d ___

C.15 a b c d ___

C.16 a b c d ___

C.17 a b c d ___