June 15, 2001

Mr. Richard Cashwell
Reactor Director
Nuclear Engineering Laboratory
1513 University Avenue, Room 141ME
University of Wisconsin
Madison, WI 53706

SUBJECT: INITIAL EXAMINATION REPORT NO. 50-156/OL-01-01

Dear Mr. Cashwell:

During the week of May 21, 2001, the NRC administered initial examinations to employees of your facility who had applied for a license to operate your University of Wisconsin Reactor. The examination was conducted in accordance with NUREG-1478, "Non-Power Reactor Operator Licensing Examiner Standards," Revision 1. At the conclusion of the examination, 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 available electronically for public inspection in the NRC Public Document Room or from the Publicly Available Records (PARS) component of NRC's document system (ADAMS). ADAMS is accessible from the NRC Web site at (the Public Electronic Reading Room) http://www.nrc.gov/NRC/ADAMS/indesx.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. Warren Eresian at 301-415-1833, or Internet e-mail wje@nrc.gov.

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. 50-156

Enclosures: 1. Initial Examination Report
No. 50-156/OL-01-01
2. Examination and answer key

cc w/encls:
Please see next page

cc:

Mayor of Madison
City Hall
Madison, WI 53705

Chairman, Public Service
Commission of Wisconsin
Hill Farms State Office Building
Madison, WI 53702

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DATE	06/ 11 /2001		06/ 14 /2001		06/ 15 /2001	

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

REPORT NO.: 50-156/OL-01-01

FACILITY DOCKET NO.: 50-156

FACILITY LICENSE NO.: R-74

FACILITY: University of Wisconsin

EXAMINATION DATES: May 22 – 24, 2001

SUBMITTED BY: ____________/RA/____________________ 6/11/01________
Warren Eresian, Chief Examiner Date

SUMMARY:

During the week of May 21, 2001, the NRC administered operator licensing examinations to six Reactor Operator (RO) initial candidates, and one RO retake candidate. The RO retake candidate took section A of the written and passed it. All six RO initial candidates passed the written examination. One RO initial candidate failed the operating test.

REPORT DETAILS

1. Examiners:
   Warren Eresian, Chief Examiner
   Paul Doyle, Examiner

2. Results:

	RO PASS/FAIL	SRO PASS/FAIL	TOTAL PASS/FAIL
Written	7/0	N/A	7/0
Operating Tests	5/1	N/A	5/1
Overall	6/1	N/A	6/1

3. Exit Meeting:
   Warren Eresian, NRC
   Paul Doyle, NRC
   Richard Cashwell, Univ. of Wisconsin
   Steven Matusewik, Univ. of Wisconsin
   Robert Agasie, Univ. of Wisconsin

   The facility staff presented their comments on the written examination, and the NRC discussed weaknesses noted during the operating tests. The written examination has been modified per facility comments.

ENCLOSURE 1

UNIVERSITY OF WISCONSIN

WITH ANSWER KEY

UNITED STATES NUCLEAR REGULATORY COMMISSION

OPERATOR LICENSING
EXAMINATION
May, 2001

ENCLOSURE 2

in column A with the correct definition in column B.

	Column A		Column B
a.	Prompt Neutron	1.	A neutron in equilibrium with its surroundings.
b.	Fast Neutron	2.	A neutron born directly from fission.
c.	Thermal Neutron	3.	A neutron born due to decay of a fission product.
d.	Delayed Neutron	4.	A neutron at an energy level greater than its surroundings.

QUESTION A.2 [1.0 point]
You enter the control room and note that all nuclear instrumentation show a steady neutron level, and no rods are in motion. Which ONE of the following conditions **CANNOT** be true?

a. The reactor is critical.

b. The reactor is subcritical.

c. The reactor is supercritical.

d. The neutron source has been removed from the core.

QUESTION A.3 [1.0 point]
Which ONE of the following describes the **MAJOR** contributor to the production and depletion of Xenon respectively in a **STEADY-STATE** OPERATING reactor?

	Production	Depletion
a.	Radioactive decay of Iodine and Tellurium	Radioactive Decay
b.	Radioactive decay of Iodine and Tellurium	Neutron Absorption
c.	Directly from fission	Radioactive Decay
d.	Directly from fission	Neutron Absorption

QUESTION A.4 [1.0 point]
Which factor of the Six Factor formula is most easily varied by the reactor operator?

a. Thermal Utilization Factor (f)

b. Reproduction Factor (η)

c. Fast Fission Factor (ε)

d. Fast Non-Leakage Factor ($\mathcal{L}_f$)

QUESTION A.5 [1.0 point]
Which ONE of the following is an example of neutron decay?

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

b. $_{35}Br^{87} \rightarrow {}_{35}Br^{86}$

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

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

QUESTION A.6 [1.0 point]
In order to compensate for the reduction in U^{238} atoms in FLIP fuel, General Atomics added ______ to compensate to the fuel.

a. Hydrogen

b. Erbium

c. Hafnium

d. Carbon

QUESTION A.7 [1.0 point]
Several processes occur that may increase or decrease the available number of neutrons. SELECT from the following the six-factor formula term that describes an **INCREASE** in the number of neutrons during the cycle.

a. Thermal utilization factor (f).

b. Resonance escape probability (p).

c. Thermal non-leakage probability ($\mathcal{L}_{th}$).

d. Reproduction factor (η).

QUESTION A.8 [1.0 point]
Which ONE of the following isotopes will cause a neutron to lose the most energy in an elastic collision?

a. $Uranium^{238}$

b. $Carbon^{12}$

c. $Hydrogen^{2}$

d. $Hydrogen^{1}$

QUESTION A.9 [1.0 point]
K_{eff} for the reactor is 0.98. If you place an experiment worth **+$1.00** into the core, what will the new K_{eff} be?

a. 0.982

b. 0.987

c. 1.013

d. 1.018

QUESTION A.10 [1.0 point]
About two minutes following a reactor scram, period has stabilized, and is decreasing at a CONSTANT rate. If reactor power is 10^{-5}% full power what will the power be in three minutes.

a. 5×10^{-6}% full power

b. 2×10^{-6}% full power

c. 10^{-6}% full power

d. 5×10^{-7}% full power

QUESTION A.11 [1.0 point]
You perform two initial startups a week apart. Each of the startups has the same starting conditions, (core burnup, pool and fuel temperature, and count rate are the same). The only difference between the two startups is that during the **SECOND** one you stop for 10 minutes to answer the phone. For the second startup compare the critical rod height and count rate to the first startup.

	Rod Height	Count Rate
a.	Higher	Same
b.	Lower	Same
c.	Same	Lower
d.	Same	Higher

QUESTION A.12 [1.0 point]
The term "prompt jump" refers to:

a. the instantaneous change in power due to raising a control rod.

b. a reactor which has attained criticality on prompt neutrons alone.

c. a reactor which is critical using both prompt and delayed neutrons.

d. a negative reactivity insertion which is less than β_{eff}.

QUESTION A.13 [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 slightly higher energy than it had prior to the collision with the nucleus emitting a gamma ray.

QUESTION A.14 [1.0 point]
Which one of the following is the definition of the FAST FISSION FACTOR?

a. The ratio of the number of neutrons produced by fast fission to the number produced by thermal fission

b. The ratio of the number of neutrons produced by thermal fission to the number produced by fast fission

c. The ratio of the number of neutrons produced by fast and thermal fission to the number produced by thermal fission

d. The ratio of the number of neutrons produced by fast fission to the number produced by fast and thermal fission

QUESTION A.15 [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.16 [1.0 point]
A characteristic peculiar to TRIGA fuel is that it has a relatively large (and quickly acting) …

a. pressure coefficient.

b. void coefficient.

c. bath temperature coefficient.

d. fuel temperature coefficient.

QUESTION A.17 [1.0 point]
Which **ONE** of the following is the **MAJOR** source of energy released during fission?

a. Kinetic Energy of fission neutrons

b. Kinetic Energy of fission fragments

c. Decay of the fission fragments

d. Prompt gamma rays

QUESTION A.18 [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 1.25 MW and the scram delay time is 0.1 seconds, **WHICH ONE** of the following is the peak power of the reactor at shutdown. (Assume Rabbit system is operational for this question.)

a. 1.25 MW

b. 2.5 MW

c. 3.4 MW

d. 12.5 MW

QUESTION A.19 [1.0 point]
Which ONE of the following is the correct reason that delayed neutrons enhance control of the reactor?

a. There are more delayed neutrons than prompt neutrons.

b. Delayed neutrons increase the average neutron generation time.

c. Delayed neutrons are born at higher energies than prompt neutrons and therefore have a greater effect.

d. Delayed neutrons take longer to reach thermal equilibrium.

QUESTION (B.1) [2.0 points, ⅔ point each]
Match each of the Technical Specification Limits in column A with its corresponding value in column B. (Each limit has only one answer, values in Column B may be used once, more than once or not at all.)

Column A		Column B
a. Minimum Shutdown Margin	1	1.4% ΔK/K
b. Each secured Experiment	2	$0.4% ΔK/K
c. Each Unsecured Experiment	3	0.2% ΔK/K

QUESTION (B.2) [1.0 point]
A Channel calibration of the power level monitoring channels by the calorimetric method was last performed on July 31, 2000. Which one of the following dates is the latest the maintenance may be performed again without exceeding a Technical Specifications requirement?

a. February 28, 2001

b. March 15, 2001

c. July 31, 2001

d. August 31, 2001

QUESTION (B.3) [1.0 point]
Which ONE of the following is the minimum number of fixed radiation monitors required to be operable per Technical Specifications?

a. Four (4) Area Radiation Monitors and the Continuous Air Monitor

b. Four (4) Area Radiation Monitors and the Stack Air Monitor

c. Three (3) Area Radiation Monitors and the Continuous Air Monitor

d. Three (3) Area Radiation Monitors and the Stack Air Monitor

QUESTION (B.4) [2.0 points, ½ point 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 reactivity to be inserted for pulse operation shall be determined and mechanically limited such that the reactivity insertion will not exceed 1.4% ΔK/K.

b. … 400°C as measured in an instrumented fuel element.

c. The maximum temperature in a FLIP-type TRIGA fuel rod shall not exceed 1150°C under any conditions of operation.

d. The Reactor shall not be operated with damaged fuel.

QUESTION B.5 [2.0 points, ½ point each]
Identify each of the following actions as either a channel **CHECK**, a channel **TEST**, or a channel **CAL**ibration.

a. Prior to startup you place a known radioactive source near a radiation detector, noting meter movement and alarm function operation.

b. During startup you compare all of your nuclear instrumentation channels ensuring they track together.

c. At power, you perform a heat balance (calorimetric) and determine you must adjust Nuclear Instrumentation readings.

d. During a reactor shutdown you note a -80 second period on Nuclear Instrumentation.

QUESTION (B.6) [1.0 points]
Which ONE of the following is the 10 CFR 20 definition of **TOTAL EFFECTIVE DOSE EQUIVALENT (TEDE)**?

a. The sum of the deep does equivalent and the committed effective dose equivalent.

b. The dose that your whole body receives from sources outside the body.

c. The sum of the external deep dose and the organ dose.

d. The dose to a specific organ or tissue resulting from an intake of radioactive material.

QUESTION (B.7) [2.0 points, ½ point each]
Match the radiation reading from column A with its corresponding radiation area classification (per 10 CFR 20) listed in column B.

COLUMN A	COLUMN B
a. 10 mRem/hr	1. Unrestricted Area
b. 150 mRem/hr	2. Radiation Area
c. 10 Rem/hr	3. High Radiation Area
d. 550 Rem/hr	4. Very High Radiation Area

QUESTION (B.8) [1.0]
Which ONE of the following evolutions **DOES NOT** require the presence of a licensed **SENIOR** reactor operator?

a. Recovery from an unplanned shutdown.

b. An unlicensed individual operating the reactor for training.

c. An unlicensed individual moving fuel within the core.

d. An initial startup.

QUESTION (B.9) [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. 8

d. 12

QUESTION (B.10) [1.0 point]
Which ONE of the following locations is the normal (no evacuation required) Emergency Support Center per the Emergency Plan?

a. Reactor Control Room

b. Reactor Shop

c. Reactor Director's Office

d. Lobby of the Mechanical Engineering Building.

QUESTION (B.11) [1.0 point]
Which ONE of the following Measuring Channels is required to be operable in ALL modes of operation per Technical Specifications?

a. Fuel Temperature

b. Log Power

c. Linear Power

d. Startup Count Rate

QUESTION (B.12) [1.0 point]
10CFR50.54(x) states: *"A licensee may take reasonable action that departs from a license condition or a technical specification (contained in a license issued under this part) in an emergency when this action is immediately needed to protect the public health and safety and no action consistent with license conditions and technical specifications that can provide adequate or equivalent protection is immediately apparent.* 10CFR50.54(y) states that the minimum level of management which may authorize this action is …

a. any Reactor Operator licensed at facility

b. any Senior Reactor Operator licensed at facility

c. Reactor Supervisor (or equivalent name at facility).

d. U.S. NRC Project Manager

QUESTION (B.13) [1.0 point]
The ***Quality Factor*** is used to convert …

a. dose in rads to dose equivalent in rems.

b. dose in rems to dose equivalent in rads.

c. contamination in rads to contamination equivalent in rems

d. contamination in rems to contamination equivalent in rads.

QUESTION (B.14) [1.0 point]
Two inches of shielding reduce the gamma exposure in a beam of radiation from 400 mR/hr to 200 mR/hr. If you add an additional four inches of shielding what will be the new radiation level? (Assume all reading are the same distance from the source.)

a. 25 mR/hr

b. 50 mR/hr

c. 75 mr/hr

d. 100 mr/hr

QUESTION (B.15) [1.0 point]
Which ONE of the listed emergency classifications is the ONLY applicable at University of Wisconsin?

a. Notification of Unusual Event

b. General Emergency

c. Site Emergency

d. Alert

QUESTION B.16 [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.17 [1.0 point]
According to Technical Specifications, which ONE of the following situations is NOT PERMISSIBLE during reactor operations?

a. Scram time for a control element = 1 second

b. A pulse reactivity insertion of 1.4% $\Delta K/K$

c. The ventilation system is inoperable for 24 hours.

d. A single experiment reactivity worth of 1.4% $\Delta K/K$.

QUESTION C.1 [2.0 points, $^1/_6$ each]
Using the figure provided identify components A through L.

1. Beam Port #1
2. Beam Port #2
3. Beam Port #3
4. Beam Port #4
5. CIC #1
6. CIC #2
7. Fission Counter
8. Log N
9. Regulating Blade
10. Safety Blade #1
11. Safety Blade #2
12. Safety Blade #3

QUESTION C.2 [1.0 point]
The gas used to move pneumatic tube "rabbit" samples into and out of the reactor is …

a. H_2

b. Air

c. CO_2

d. N_2

QUESTION C.3 [1.0 point]
On a Building Evacuation Alarm, the Ventilation system will

a. The room exhaust fan will continue to operate, and the reactor operator must start the emergency exhaust fan manually.

b. The room exhaust fan will secure automatically, and the emergency exhaust fan will start automatically taking a suction on the reactor laboratory.

c. The room exhaust fan will secure automatically, and the emergency exhaust fan will start automatically taking a suction on outside are air to dilute the stack exhaust.

d. The room exhaust fan will secure automatically, but the reactor operator must start the emergency exhaust fan manually.

QUESTION C.4 [2.0 points, ½each]
Match the purification system functions in column A with the purification component listed in column B

Column A	Column B
a. remove floating dust, bug larvae, etc.	1. Demineralizer (Ion Exchanger)
b. remove dissolved impurities	2. Skimmer
c. remove suspended solids	3. Filter
d. maintain pH	

QUESTION C.5 [2.0 points, ½each]
When filling the pool, you have 4 options as listed below. Identify each of the options as either normal, abnormal or emergency methods for filling the reactor.

a. Distilled Water

b. Softened Water

c. Raw (city) water.

d. Raw (city) water, via nozzle at pool top.

QUESTION C.6 [1.0 point]
Which ONE of the following is the method used to minimize mechanical shock to the safety blades on a scram?

a. A small spring located at the bottom of the rod.

b. A piston enters a special dashpot as the rod reaches five inches of the fully inserted position.

c. An electrical-mechanical brake energizes when the rod down limit switch is energized.

d. An electromagnet energizes as the blade approaches the last few inches of travel slowing the decent of the blade.

QUESTION C.7 [1.0 point]
During reactor shutdown, you attempt to drive the fission chamber in, but it will not move. Which ONE of the following is the probable reason?

a. Count Rate < 120 cpm

b. Interlock switch in “Defeat” position.

c. Count Rate $> 1 \times 10^9$ cpm

d. Any one of the control elements is in motion.

QUESTION C.8 [1.0 point]
Which ONE of the following is the actual design feature which prevents siphoning of pool 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. “Vacuum breaks” are located in the system which prevent draining the pool below about 1 foot below the “full” line.

d. The Emergency Fill system will automatically maintain pool level.

QUESTION C.9 [1.0 point]
Which ONE of the following is the correct ranking of rod speed from fastest to slowest for the Transient Rod (T), Regulating Blade (R), and Blades 1, 2 & 3, (B).

a. R T B

b. T R B

c. R B T

d. T B R

QUESTION C.10 [1.0 point]
An experimenter drops and breaks open a sample vial in a laboratory room. He immediately runs out of the room and closes the door. You are called in to assist in the cleanup. Prior to opening the door you would take a reading using a(n)

a. Ion Chamber portable radiation detector to determine the radiation field strength.

b. Geiger-Müller portable radiation detector to determine the radiation field strength.

c. Ion Chamber portable radiation detector to determine whether contamination is present.

d. Geiger-Müller portable radiation detector to determine whether contamination is present.

QUESTION C.11 [1.0 point]
Each shim/safety blades consists of a grooved,

a. stainless steel sheet.

b. boron-carbide sheet.

c. boral (boron and aluminum alloy) sheet.

d. aluminum sheet.

QUESTION C.12 [1.0 point]
Which ONE of the following control elements can NOT be used for automatic control of the reactor?

a. #2 Shim Blade

b. Transient Rod

c. Regulating Blade

d. #3 Shim Blade

QUESTION C.13 [1.0 point]
Given: Period and power level trips are bypassed, control element withdrawal is prohibited, HPVS current is limited and servo control is bypassed. Which ONE of the following is the MODE switch position?

a. Manual

b. Automatic

c. Pulse

d. Square Wave

QUESTION C.14 [1.0 point]
Which ONE of the following is the actual method used to determine safety blade position?

a. A logic circuit receives input from two sensors which count 100 pulses per revolution along with detecting direction, converting these signals to rod position.

b. A potentiometer, driven by the rod drive motor, generates a signal proportional to rod position.

c. As the rod moves up and down, the magnet opens and closes a series of over 1000 limits switches which generate a signal which is converted to rod position.

d. As the rod moves, it move into or out of a coil, generating a signal proportional to rod position.

QUESTION C.15 [1.0 point
Which ONE of the following radiation monitors will energize the evacuation alarm?

a. Pneumatic Tube Area Radiation Monitor

b. Stack Air Monitor (Gaseous)

c. Beam Port 1 Area Radiation Monitor

d. Continuous Air Monitor (Particulate)

QUESTION C.16 [1.0 point]
Which ONE of the following methods is used to compensate for gamma radiation in a Compensated Ion Chamber?

a. Pulses smaller than a pre-set height (voltage) are stopped by a pulse-height discriminator circuit from entering the instrument channel's log diode pump circuit.

b. The chamber contains concentric tubes one of which detects both neutrons and gammas the other only gammas, are wired electronically to subtract the gamma signal, leaving only the signal due to neutrons.

c. The signal travels through a Resistance-Capacitance (RC) circuit, converting the signal to a power change per time period effectively deleting the signal due to gammas.

d. A compensating voltage equal to a predetermined "source gamma level" is fed into the pre-amplifier electronically removing source gammas from the signal. Fission gammas are proportional to reactor power and therefore not compensated for.

QUESTION C.17 [1.0 point]
The high count rate alarm on the startup channel is provided to …

a. prevent control element withdrawal when count rate is too high.

b. prevent detector damage from high neutron fluxes.

c. provide warning of high power level before the scram point is reached.

d. provide automatic withdrawal of the drive when count rate is off range.

A.1 a, 2; b, 4; c, 1; d, 3
REF: NEEP 234, p. 87.

A.2 c
REF: Standard NRC question

A.3 b
REF: NEEP 234, p. 93

A.4 a
REF: NEEP 234, p. 89.

A.5 b
REF: NEEP 234, p. ??

A.6 b
REF: NEEP 234, p. 112

A.7 d
REF: NEEP 234, p. 88.

A.8 d
REF: NEEP 234, p. 87.

A.9 b
REF:
SDM = $(1-k_{eff})/k_{eff}$ = (1-0.98)/0.98 = 0.02/0.99 = 0.02041 or 0.02041/.0075 = \$2.72, or a reactivity worth (ρ) of -\$2.72. Adding +\$1.00 reactivity will result in a SDM of \$2.72 - \$1.00 = \$1.72, or .0129081 ΔK/K
K_{eff} = 1/(1+SDM) = 1/(1 + 0.0129081) = 0.987

A.10 c
REF: $P = P_0\, e^{-T/\tau} = 10^{-5} \times e^{(-180sec/80sec)} = 10^{-5} \times e^{-2.25} = 0.1054 \times 10^{-5} = 1.054 \times 10^{-6}$

A.11 d
REF: NEEP 234, pp. 121–126.

A.12 a
REF:

A.13 b
REF: NEEP 234, p. ??.

A.14 c
REF: NEEP 234, p. 89.

A.15 d
REF: $\ln\left(\frac{P}{P_0}\right) = \frac{t}{t}\ t = \frac{60sec}{\ln(2)} = 86.56$

A.16 d
REF: NEEP 234, pp. 112–114.

A.17 b
REF: NEEP 234, p ??

A.18 A.15 c
REF: $P = P_0\ e^{t/\tau}$, $P = 1.25$ Mwatt × $e^{0.1/0.1} = 1.25 \times e = 3.3979$.

A.19 b
REF: NEEP 234, p. 101.

B.1 a, 3; b, 1; Part c of question deleted per facility comment (SRO level), value for each of remaining increase to 1 (2 point question)
REF: Technical Specifications §§ 3.1, 3.6, (a) & (b)

B.2 Question deleted per facility comment (no correct answer)
REFERENCE

B.3 d
REF: Facility supplied question B.56

B.4 a, LCO; b, LSSS; c, SL; d, LCO
REF: T.S. a: § 3.2; b: § 2.2.a; c: § 2.1.a; d § 3.7

B.5 a, Test; b, Check; c, Cal; d, Check
REF: Technical Specification 1.3 Definitions, p. 2.

B.6 a
REF: 10 CFR 20.1003 *Definititions*

B.7 a, 2; b, 3; c, 3; d, 4
REF: 10 CFR 20.1003, Definitions

B.8 b
REFERENCE Facility supplied question B.109

B.9 b
REF: 10CFR55.53(e).

B.10 c
REF: Emergency Plan, § 8.0 1st ¶.

B.11 a
REF: Facility supplied question B.114.

B.12 Question deleted per facility comment
REF:

B.13 a
REF: 10CFR20.1004.

B.14 b
REF: Standard NRC Question re: "Half-Thickness and Tenth-Thickness"

B.15 a
REF: Emergency Plan, Table 2

B.16 a, 3; b, 2; c, 1; d, 4
REFERENCE Facility License and 10 CFR Parts 20, 50, 55 and 73

B.15 d
REF: Facility Supplied question B.126

B.16 a, 3; b, 2; c, 1; d, 4
REF:

B.17 d
REF:

C.1 a, 5; b, 6; c, 7; d, 4 e, 12; f, 9; g, 3; h, 11; i, 10; j, 8; k, 2; l, 1
REF: Safety Analysis Report (SAR), (April, 1973), Figure 11, pg. 2-17.

C.2 c
REF: SAR § 2.4.4, 1st ¶, p. 2-41

C.3 a
REF: Facility supplied question C.16.

C.4 a, 2; b, 1; c, 3; d, 1
REF: University of Wisconsin Nuclear Reactor Operating Training Manual (Training Manual), Reactor Water Systems I, Makeup and Recirculation Systems pp. 152 – 154 of 281.

C.4 a, 2; b, 1; c, 3; d, 1
REF: Safety Analysis Report (SAR), (April, 1973), Figure 11, pg. 2-17.

C.5 a, n; b, a; c, a; d, e
REF: Training Manual, Reactor Water Systems I, Makeup and Recirculation Systems, p. 153 of 281.

C.6 b
REF: SAR § 2.2.1, pp. 2-16 – 2-19.

C.7 c
REF: Training Manual, Controls & Instrumentation I & II, pp. 171

C.8 c
REF: Training Manual, Water Systems

C.9 b
REF: SAR, p. 2-19, also rewrite of facility supplied question C.80.

C.10 a or b 2nd answer added per facility comment
REF: Standard NRC question.

C.11 c
REF: SAR § 2.1.5, p. 2-9.

C.12 d
REF: Rewrite of facility supplied question C.76.

C.13 c
REF: Rewrite of Facility supplied question C.61.

C.14 b
REF: SAR § 2.2.1, pp. 2-16 – 2-19.

C.15 Question deleted per facility comment (no correct answer)
REF:

C.16 b
REF: Training Manual, Controls & Instrumentation I & II, Nuclear Instrumentation, Discriminator, p. 170.

C.17 b
REF: Facility supplied question B.96

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

FACILITY: University of Wisconsin

REACTOR TYPE: TRIGA (Pulsing)

DATE ADMINISTERED: 2001/05/22

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	34.5	______	____	A.	Reactor Theory, Thermodynamics and Facility Operating Characteristics
19.00	32.8	______	____	B.	Normal and Emergency Operating Procedures and Radiological Controls
19.00	32.8	______	____	C.	Facility and Radiation Monitoring Systems
58.00		______	____% 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 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.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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 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

A.1a 1 2 3 4 ___

A.1b 1 2 3 4 ___

A 1c 1 2 3 4 ___

A.1d 1 2 3 4 ___

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.11 a b c d ___

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.1a 1 2 3 ___

B.1b 1 2 3 ___

B.1c 1 2 3 ___

B.2 a b c d ___

B.3 a b c d ___

B.4a SL LSSS LCO ___

B.4b SL LSSS LCO ___

B.4c SL LSSS LCO ___

B.4d SL LSSS LCO ___

B.5a Check Test CAL ___

B.5b Check Test CAL ___

B.5c Check Test CAL ___

B.5d Check Test CAL ___

B.6 a b c d ___

B.7a 1 2 3 4 ___

B.7b 1 2 3 4 ___

B.7c 1 2 3 4 ___

B.7d 1 2 3 4 ___

B.8 a b c d ___

B.9 a b c d ___

B.10 a b c d ___

B.11 a b c d ___

B.12 a b c d ___

B.13 a b c d ___

B.14 a b c d ___

B.15 a b c d ___

B.16a 1 2 3 4 ___

B.16b 1 2 3 4 ___

B.16c 1 2 3 4 ___

B.16d 1 2 3 4 ___

B.17 a b c d ___

C.1a 1 2 3 4 5 6 7 8 9 10 11 12 ___

C.1b 1 2 3 4 5 6 7 8 9 10 11 12 ___

C.1c 1 2 3 4 5 6 7 8 9 10 11 12 ___

C.1d 1 2 3 4 5 6 7 8 9 10 11 12 ___

C.1e 1 2 3 4 5 6 7 8 9 10 11 12 ___

C.1f 1 2 3 4 5 6 7 8 9 10 11 12 ___

C.1g 1 2 3 4 5 6 7 8 9 10 11 12 ___

C.1h 1 2 3 4 5 6 7 8 9 10 11 12 ___

C.1i 1 2 3 4 5 6 7 8 9 10 11 12 ___

C.1j 1 2 3 4 5 6 7 8 9 10 11 12 ___

C.1k 1 2 3 4 5 6 7 8 9 10 11 12 ___

C.1ℓ 1 2 3 4 5 6 7 8 9 10 11 12 ___

C.2 a b c d ___

C.3 a b c d ___

C.4a 1 2 3 ___

C.4b 1 2 3 ___

C.4c 1 2 3 ___

C.4d 1 2 3 ___

C.5a N A E ___

C.5c N A E ___

C.5c N A E ___

C.5d N A E ___

C.6 a b c d ___

C.7 a b c d ___

C.8 a b c d ___

C.9 a b c d ___

C.10 a b c d ___

C.11 a b c d ___

C.12 a b c d ___

C.13 a b c d ___

C.14 a b c d ___

C.15 a b c d ___

C.16 a b c d ___

C.17 a b c d ___

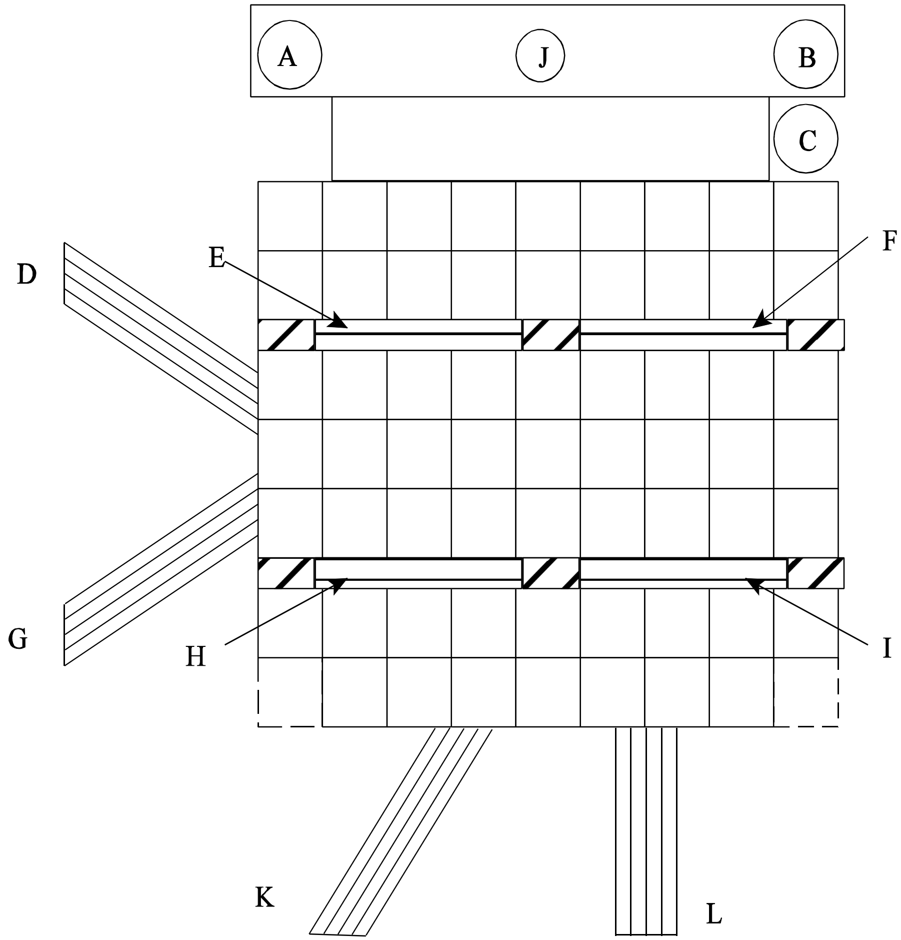

Figure 1