June 28, 2006

Mr. Stephen LaFlamme, Director
Nuclear Reactor Facility
Worcester Polytechnic Institute
100 Institute Road.
Worcester, MA 01609-2280

SUBJECT: INITIAL EXAMINATION REPORT NO. 50-134/OL-06-01, WORCESTER POLYTECHNIC INSTITUTE

Dear Mr. LaFlamme:

During the week of April 24, 2006, the NRC administered an operator licensing examination at your Worcester Polytechnic Institute Reactor. The examination was conducted according to NUREG-1478, "Non-Power Reactor Operator Licensing Examiner Standards," Revision 1. 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 10 CFR 2.390 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 Agencywide Documents Access and Management System (ADAMS). ADAMS is accessible from the NRC Web site at (the Public Electronic Reading Room) 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. Paul V. Doyle Jr. at (301) 415-1058 or via internet e-mail pvd@nrc.gov.

Sincerely,

/RA/

Johnny Eads, Chief
Research and Test Reactors Branch B
Division of Policy and Rulemaking
Office of Nuclear Reactor Regulation

Docket No. 50-134

Enclosures: 1. Initial Examination Report No. 50-134/OL-06-01
2. Examination and answer key

cc w/encls:
Please see next page

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OFFICE	PRTB:CE	IOLB:LA	PRTB:BC
NAME	PDoyle*	EBarnhill:tls*	JEads:tls*
DATE	06 /14/2006	06/28/2006	06/28/2006

OFFICIAL RECORD COPY

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

REPORT NO.: 50-134/OL-04-01

FACILITY DOCKET NO.: 50-134

FACILITY LICENSE NO.: R-61

FACILITY: Worcester Polytechnic Institute

EXAMINATION DATES: April 24 through 27, 2006

SUBMITTED BY: ______________________________ ____________
Paul V. Doyle Jr., Chief Examiner Date

SUMMARY:

During the week of April 24, 2006, the NRC administered examinations to 6 Reactor Operator (RO) and one Senior Reactor Operator Upgrade (SRO-U) operator licensing candidates. One RO candidate failed sections A and B of the Written examination and the operating test, and one RO candidate failed section A of the written only. The other four RO candidates and the SRO-U candidate passed all portions of their examinations.

REPORT DETAILS

1. Examiners: Paul V. Doyle Jr., Chief Examiner

2. Results:

	RO PASS/FAIL	SRO PASS/FAIL	TOTAL PASS/FAIL
Written	4/2	0/0	4/2
Operating Tests	6/0	1/0	7/0
Overall	4/2	1/0	5/2

3. Exit Meeting:
Paul V. Doyle Jr., NRC, Examiner
Stephen LaFlamme, WPI, Facility Director

Mr. Doyle thanked Mr. LaFlamme for his support in the administration of the examinations. Mr. LaFlamme reported that he had no comments on the written examination. Mr. Doyle reported that the candidates were weak in general, not limited to any one system.

ENCLOSURE 1

U. S. NUCLEAR REGULATORY COMMISSION
RESEARCH AND TEST REACTOR LICENSE EXAMINATION

FACILITY:	Worcester Polytechnic Institute
REACTOR TYPE:	Pool
DATE ADMINISTERED:	04/24/2006
REGION:	1
CANDIDATE:___________________________	

INSTRUCTIONS TO CANDIDATE:

Answers are to be written on the exam page itself, or the answer sheet provided. Write answers one side ONLY. Attach any answer sheets to the examination. Points for each question 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	34	______	____	A. REACTOR THEORY, THERMODYNAMICS, AND FACILITY OPERATING CHARACTERISTICS
20	34	______	____	B. NORMAL AND EMERGENCY OPERATING PROCEDURES AND RADIOLOGICAL CONTROLS
18	32	______	____	C. FACILITY AND RADIATION MONITORING SYSTEMS
58		______	_____% 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 not received or 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.

6. Print your name in the upper right-hand corner of the answer sheets.

7. The point value for each question is indicated in parentheses after the question.

8. Partial credit may be given. Therefore, ANSWER ALL PARTS OF THE QUESTION AND DO NOT LEAVE ANY ANSWER BLANK. NOTE: partial credit will NOT be given on multiple choice questions.

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

10. When turning in your examination, assemble the completed examination with examination questions, examination aids and answer sheets. In addition, turn in all scrap paper.

11. When you are done and have turned in your examination, leave the examination area as defined by the examiner. If you are found in this area while the examination is still in progress, your license may be denied or revoked.

QUESTION: 001 (1.00)

Which ONE of the following describes the term prompt jump?

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

b. A reactor that has attained criticality on prompt neutrons alone.

c. A reactor that is critical using both prompt and delayed neutrons.

d. A negativity reactivity insertion that is less than β_{eff}.

QUESTION: 002 (1.00)

The effective neutron multiplication factor, K_{eff}, is defined as:

a. production/(absorption + leakage).

b. (production + leakage)/absorption.

c. (absorption + leakage)/production.

d. absorption/(production + leakage).

QUESTION: 003 (1.00)

As the moderator temperature increases, the resonance escape probability:

a. increases, since the moderator becomes less dense.

b. decreases, since the time required for a neutron to reach thermal energy increases.

c. remains constant, since the effect of moderator temperature change is relatively small.

d. increases, since the moderator-to-fuel ratio increases.

(***** CATEGORY A CONTINUED ON NEXT PAGE *****)

QUESTION: 004 (1.00)

A 1/M curve is being generated as fuel is loaded into the core. After some fuel elements have been loaded, the count rate existing at that time is taken to be the new initial count rate, C_0. Additional elements ate then loaded and the inverse count rate ratio continues to decrease. As a result of changing the initial count rate:

a. criticality will occur earlier (i.e., with fewer elements loaded.)

b. criticality will occur later (i.e., with more fuel elements loaded.)

c. criticality will occur with the same number of elements loaded as if there were no cange in the initial count rate.

d. criticality will be completely unpredictable.

QUESTION: 005 (1.00)

A reactor is subcritical with a K_{eff} of 0.955. A positive reactivity of 3.5% delta k/k is inserted into the core. At this point, the reactor is:

a. supercritical.

b. exactly critical.

c. prompt critical.

d. subcritical.

QUESTION: 006 (1.00)

During the minutes following a reactor scram, reactor power decreases on a negative 80-second period, corresponding to the half-life of the longest-lived delayed neutron precursors, which is approximately:

a. 20 seconds.

b. 40 seconds.

c. 55 seconds.

d. 80 seconds.

QUESTION: 007 (1.00)

A critical reactor with an initial population of $1x10^8$ neutrons changes to one with a K_{eff} = 1.001. Considering only the increase in neutron population, how many neutrons (of the increase) will be prompt when the reactor population changes from the initial generation to the next? Assume β_{eff} = 0.007.

a. 700.

b. 7,000

c. 99,300.

d. 100,000.

QUESTION: 008 (1.00)

A critical reactor is operating at a steady-state power level of 1.000 kW. Reactor power is increased to a new steady-state power level of 1.004 kW. Neglecting any temperature effects, what reactivity insertion is required to accomplish this?

a. 0.004 delta k/k.

b. 0.4% delta k/k.

c. 1.004% delta k/k.

d. Indeterminate, since any amount of positive reactivity could be used.

QUESTION: 009 (1.00)

Which factor in the six-factor formula is represented by the ratio:

$$\frac{\text{number of neutrons that reach thermal energy}}{\text{number of neutrons that start to slow down}}$$

a. fast non-leakage probability.

b. resonance escape probability.

c. reproduction factor.

d. thermal utilization factor.

(***** CATEGORY A CONTINUED ON NEXT PAGE *****)

QUESTION: 010 (1.00)

During the neutron cycle from one generation to the next, several processes occur that may increase or decrease the available number of neutrons. Which ONE of the following factors describes an increase in the number of neutrons during the cycle?

a. Thermal utilization factor.

b. Resonance escape probability.

c. Thermal non-leakage probability.

d. Fast fission factor.

QUESTION: 011 (1.00)

Which ONE of the following elements will slow down fast neutrons most quickly, i.e., produces the greatest energy loss per collision?

a. Oxygen-16.

b. Uranium-238.

c. Hydrogen-1.

d. Boron-10.

QUESTION: 012 (1.00)

Which ONE statement below describes a negative fuel temperature coefficient?

a. When fuel temperature decreases, negative reactivity is added.

b. When fuel temperature increases, positive reactivity is added.

c. When fuel temperature decreases, reactor power decreases.

d. When fuel temperature decreases, positive reactivity is added.

(***** CATEGORY A CONTINUED ON NEXT PAGE *****)

QUESTION: 013 (1.00)

A reactor is operating at criticality. Instantaneously, all of the delayed neutrons are suddenly removed from the reactor. The K_{eff} of the reactor in this state would be approximately:

a. 1.007

b. 1.000

c. 0.000

d. 0.993

QUESTION: 014 (1.00)

For the same constant reactor period, which ONE of the following transients requires the longest to occur? A power increase of:

a. 5% of rated power - increasing from 1% to 6% of rated power.

b. 10% of rated power - increasing from 10% to 20% of rated power.

c. 15% of rated power - increasing from 10% to 25% of rated power.

d. 20% of rated power - increasing from 15% to 35% of rated power.

QUESTION: 015 (1.00)

Which ONE of the following is the description of a thermal neutron?

a. A neutron that possesses thermal rather than kinetic energy.

b. The primary source of thermal energy increase in the reactor coolant during reactor operation.

c. A neutron that has been produced in a significant time (on the order of seconds) after its initiating fission took place.

d. A neutron that experiences no net change in kinetic energy after several collisions with atoms of the diffusing medium.

(***** CATEGORY A CONTINUED ON NEXT PAGE *****)

QUESTION: 016 (1.00)

Which ONE of the reactions below is an example of a photoneutron source?

a. $_1H^2 + \gamma \rightarrow {}_1H^1 + n$

b. $_{92}U^{238} \rightarrow {}_{35}Br^{87} + {}_{57}La^{148} + 3n + \gamma$

c. $_{51}Sb^{123} + n \rightarrow {}_{51}Sb^{124} + \gamma$

d. $_4Be^9 + \alpha \rightarrow {}_6C^{12} + n$

QUESTION: 017 (1.00)

The moderator temperature coefficient of reactivity is -1.25×10^{-3} delta k/k/deg.C. When a control rod with an average rod worth of 0.1% delta k/k/inch is withdrawn 10 inches, reactor power increases and becomes stable at a higher power level. At this point, the moderator temperature has:

a. increases by 8 degrees C.

b. decreased by 8 degrees C.

c. increased by 0.8 degrees C.

d. decreased by 0.8 degrees C.

QUESTION: 018 (1.00)

Fuel is being loaded into the core. The operator is using a 1/M plot to monitor core loading. Which ONE of the following conditions would result in a non-conservative prediction of core critical mass, i.e., the reactor would reach criticality prior to the predicted critical mass?

a. The detector is too far away from the source and the fuel.

b. The detector is too close to the source and the fuel.

c. Excessive time is allowed between fuel elements being loaded.

d. A fuel element is placed between the source and the detector.

(***** CATEGORY A CONTINUED ON NEXT PAGE *****)

QUESTION: 019 (1.00)

It has been determined that the excess reactivity of a core is 0.50% delta k/k. The most recent rod worth data show that:

Control Rod	Reactivity Worth
#1	3.8% delta k/k
#2	3.5% delta k/k
#3	3.7% delta k/k

The <u>actual</u> shutdown margin (NOT the Tech. Spec. minimum) for this reactor is:

a. 7.2% delta k/k

b. 10.5% delta k/k

c. 11.0% delta k/k

d. 11.5% delta k/k

QUESTION: 020

Which ONE of the following factors in the six-factor formula can be varied by the reactor operator?

a. Fast fission factor.

b. Reproduction factor.

c. Fast non-leakage factor.

d. Thermal utilization factor.

(***** END OF CATEGORY A *****)

QUESTION: 001 (1.00)

Match the 10CFR Part 55 requirements listed in Column A for an actively licensed operator with the correct time period in Column B. Column B answers may be used once, more than once, or not at all.

	Column A		Column B
a.	License Expiration	1.	1 year
b.	Medical Examination	2.	2 years
c.	Requalification Written Examination	3.	3 years
d.	Requalification Operating Test	4.	6 years

QUESTION: 002 (1.00)

In the event of an area evacuation, personnel should proceed to the emergency assembly area, located:

a. in the operations boundary.

b. at Freeman Plaza.

c. at the Campus Police building.

d. in Stratton Hall.

QUESTION: 003 (1.00)

In accordance with 10 CFR 20, the "Annual Limit on Intake (ALI)" refers to:

a. the amount of radioactive material taken into the body by inhalation or ingestion in one (1) year which would result in a committed effective dose equivalent of five (5) rems.

b. the dose equivalent to organs that will be received from an intake of radioactive material by an individual during the 50-year period following the intake.

c. limits on the release of effluents to an unrestricted environment.

d. the concentration of a given radionuclide in air which, if breathed for a working year of 2,000 hours, would result in a committed effective dose equivalent of five (5) rems.

(***** CATEGORY B CONTINUED ON NEXT PAGE *****)

QUESTION: 004 (1.00)

A survey instrument with a window probe is used to measure the beta-gamma dose rate from an irradiated experiment. The dose rate with the window open is 100 mrem/hour, and the dose rate with the window closed is 60 mrem/hour. The gamma dose rate is:

a. 40 mrem/hour.

b. 60 mrem/hour.

c. 100 mrem/hour.

d. 160 mrem/hour.

QUESTION: 005 (1.00)

The area radiation monitor at the pool level is out of service. As a result:

a. the reactor cannot be operated.

b. the reactor can continue to operate.

c. the reactor can continue to operate only if the alarm setpoints of the remaining radiation monitors are lowered.

d. the reactor can continue to operate only if the monitor is replaced by an alarming unit capable of detecting gamma radiation.

QUESTION: 006 (1.00)

Two different gamma point sources have the same curie strength. The gammas from Source A have an energy of 1 Mev, and the gammas from Source B have an energy of 2 Mev. The dose rate from each source is measured at a distance of 10 feet using a G-M tube. Which ONE of the following statements is correct?

a. The measured dose rate of Source B is four times that of Source A.

b. The measured dose rate of Source B is two times that of Source A.

c. Both measured dose rates are the same.

d. The measured dose rate of Source B is half that of Source A.

(***** CATEGORY B CONTINUED ON NEXT PAGE *****)

QUESTION: 007 (1.00)

In order to maintain an active reactor or senior reactor operator license, the license-holder must perform the functions of his/her position for at least:

a. four hours per calendar quarter.

b. three hours per calendar quarter.

c. one hour per month.

d. sixteen hours per year.

QUESTION: 008 (1.00)

Two centimeters of lead placed in a beam of gamma rays reduce the radiation level from 400 mR/hour to 200 mR/hour. Which ONE of the following is the total thickness of lead that would reduce the gamma radiation level from 400 mR/hour to 50 mR/hour?

a. 3 cm.

b. 4 cm.

c. 6 cm.

d. 8 cm.

QUESTION: 009 (1.00)

In accordance with the Power Level Calibration Procedure, in order to give the proper indication after power level is determined:

a. the pointers in the linear power meters are adjusted.

b. the compensating voltages of the compensated ion chambers are adjusted.

c. the high voltages to the compensated ion chambers are adjusted.

d. the positions of the compensated ion chambers are adjusted.

(***** CATEGORY B CONTINUED ON NEXT PAGE *****)

QUESTION: 010 (1.00)

In accordance with the Technical Specifications, which ONE situation below is permissible?

a. An experiment that has a moving component having a reactivity worth of $0.50.

b. Storage of a fuel element outside the reactor pool with a radiation level of 90 mRem/hour at the storage container surface.

c. A depth of water in the reactor pool nine (9) feet above the top of the end box of the fuel elements.

d. A safety blade withdrawal rate of 8 inches/minute.

QUESTION: 011 (1.00)

A radiation survey of an area reveals a general radiation reading of 1 mrem/hour, but there is a small section of pipe (point source) that reads 10 mrem/hour at one (1) meter. Which ONE of the following defines the posting requirements for the area in accordance with 10 CFR 20?

a. "CAUTION RADIATION AREA"

b. CAUTION RADIOACTIVE MATERIAL"

c. CAUTION HIGH RADIATION AREA"

d. GRAVE DANGER, VERY HIGH RADIATION AREA"

QUESTION: 012 (1.00)

In accordance with the Technical Specifications, the reactor will be in a <u>shutdown</u> condition if:

a. the shutdown margin with the highest worth control blade fully withdrawn is greater than 1% delta k/k.

b. there is no indication of neutron level on any measuring channel.

c. there are less than 12 fuel elements loaded on the grid plate.

d. the three control blades are fully inserted.

(***** CATEGORY B CONTINUED ON NEXT PAGE *****)

QUESTION: 013 (1.00)

Each of the five Emergency Operating Procedures require that the Emergency Director be informed. The Emergency Director is normally:

a. the Senior Reactor Operator with the most seniority.

b. the Radiation Safety Officer.

c. the Reactor Facility Director.

d. The Director of the WPI Nuclear Engineering Program.

QUESTION: 014 (1.00)

In accordance with the Technical Specifications, which ONE situation below is NOT permissible?

a. Reactor critical with the regulating blade fully inserted.

b. Total cold, clean excess reactivity, including experiments = 0.4% delta k/k.

c. Temperature coefficient of reactivity = $-5x10^{-5}$ delta k/k/deg. F with an average core water temperature of 100 degrees F.

d. Reactor operation with SRO not in the reactor facility.

QUESTION: 015 (1.00)

The facility ventilation system is required to be operating whenever:

a. reactor power exceeds 1 kW.

b. the Ar-41 monitor is inoperable.

c. the thermal column and beam port exhaust fans are inoperable.

d. the reactor is operating.

(***** CATEGORY B CONTINUED ON NEXT PAGE *****)

QUESTION: 016 (1.00)

The "Shutdown Checklist" requires that "watt-hours" be calculated following each reactor shutdown. Watt-hours provide a measure of:

a. the peak power reached during operation.

b. fuel burnup during operation.

c. the average power generated during operation.

d. shutdown margin.

QUESTION: 017 (1.00)

In accordance with the Checkout and Operation Procedure, the B-10 detector may be fully removed from the neutron flux when:

a. the Log N channel is on scale.

b. one Percent Power channel and the Log N channel are on scale.

c. both Percent Power channels are on scale.

d. both Percent Power channels and the Log N channel are on scale.

QUESTION: 018 (1.00)

During critical operation of the reactor, the safety system functions that are required to be operable at all times are:

a. reactor period, reactor power, pool radiation monitor.

b. reactor period, reactor power, manual scram.

c. reactor power, neutron count rate, pool water level.

d. reactor power, manual scram, pool water level.

(***** CATEGORY B CONTINUED ON NEXT PAGE *****)

QUESTION: 019 (1.00)

As part of the reactor checkout procedure prior to operation, the regulating blade is withdrawn from beyond its "in" limit, and then it is checked that no control blade can be withdrawn. The purpose of this check is to:

a. ensure that the reactor can only be taken critical using the regulating blade.

b. verify that a control blade cannot be moved if the Startup count rate meter shows less than 50 counts per second.

c. verify that the regulating blade will scram when the source bottle is used to obtain a period of about six seconds.

d. verify that the regulating blade position indicator is operating properly.

QUESTION: 020 (1.00)

In accordance with the Emergency Plan, the term "on-site" means:

a. within the operations boundary.

b. within the Emergency Planning Zone.

c. the area within the site boundary.

d. the WPI campus.

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

QUESTION: 001 (1.00)

Upon the receipt of a scram signal, the regulating blade:

a. magnet is de-energized, and the blade falls into the core.

b. remains where it is, and must be manually driven into the core.

c. automatically drives into the core.

d. magnet and drive both fall into the core.

QUESTION: 002 (1.00)

The Beam Port design protects personnel against radiation from the port by:

a. a shutter in the pipe and a plug.

b. portable shielding around the beam port.

c. alternately stacked graphite logs and a stepped closure door.

d. graphite filler plugs.

QUESTION: 003 (1.00)

Which ONE of the safety blade withdrawal interlocks below may be bypassed?

a. 5 second time delay.

b. Regulating blade withdrawn from its lowest position.

c. Reactor in scram condition.

d. Log count rate below 3000 CPM.

(***** CATEGORY C CONTINUED ON NEXT PAGE *****)

QUESTION: 004 (1.00)

Which ONE of the following is the approximate rate at which the ventilation system is designed to completely change the reactor compartment air?

a. 1 change per hour.

b. >2 changes per hour.

c. >3 changes per hour.

d. >4 changes per hour.

QUESTION: 005 (1.00)

Which ONE of the following demineralizer regeneration processes will remove radioactive particulates from the resin bed?

a. Resin mixing.

b. Caustic soda treatment.

c. Acid solution treatment.

d. Backwash.

QUESTION: 006 (1.00)

Which alarm(s) provide indication of abnormal conditions at Campus Security Headquarters?

a. Area radiation monitors only.

b. Area radiation monitors and reactor pool low water level.

c. Loss of electrical power.

d. Reactor pool low water level only.

(***** CATEGORY C CONTINUED ON NEXT PAGE *****)

QUESTION: 007 (2.00)

Match the instrument channel listed in Column A with the correct detector listed in Column B. Items listed in Column B may be used more than once or not at all.

Column A	Column B
a. Log N/Linear Channel	1. Proportional counter
b. Startup Channel	2. Fission chamber
c. Safety Channel	3. Na-I scintillation detector
d. Area radiation monitor	4. GM detector
	5. Compensated ion chamber
	6. Uncompensated ion chamber

QUESTION: 008 (1.00)

Which ONE of the following is the normal flow rate for the cleanup system circulation pump?

a. 5 gpm.

b. 10 gpm.

c. 15 gpm.

d. 20 gpm.

QUESTION: 009 (1.00)

The evacuation alarm setpoints for the area radiation monitors are:

a.	Pool - 50 mrem/hr	Beam Tube - 50 mrem/hr	Thermal Column - 20 mrem/hr
b.	Pool - 50 mrem/hr	Beam Tube - 20 mrem/hr	Thermal Column - 20 mrem/hr
c.	Pool - 20 mrem/hr	Beam Tube - 20 mrem/hr	Thermal Column - 50 mrem/hr
d.	Pool - 20 mrem/hr	Beam Tube - 50 mrem/hr	Thermal Column - 50 mrem/hr

(***** CATEGORY C CONTINUED ON NEXT PAGE *****)

QUESTION: 010 (1.00)

Control blades are withdrawn from the core at a nominal speed of:

a. 4.0 inches/minute.

b. 7.5 inches/minute.

c. 24.0 inches/minute.

d. 32.0 inches/minute.

QUESTION: 011 (1.00)

Which ONE of the following describes how control blade position indication is generated when the blade is between the full in and full out positions? As the blade moves,

a. the impedance of a pick-up coil changes, generating a change in voltage proportional to position.

b. a chain driven optical pulse generator produces pulses whose number is proportion to blade travel.

c. a series of limit switches open and close as the blade passes.

d. a ten-turn potentiometer generates a signal proportional to position.

QUESTION: 012 (1.00)

An abnormal condition is indicated by the lighting of a box on the annunciator panel and the sounding of

an alarm horn. Pressing the “Acknowledge” on the annunciator panel or control console will always:

a. silence the horn and extinguish the light.

b. silence the horn only if the condition has returned to normal.

c. silence the horn.

d. extinguish the light.

(***** CATEGORY C CONTINUED ON NEXT PAGE *****)

QUESTION: 013 (1.00)

Which ONE of the following systems does NOT receive emergency power from the battery backup system following a loss of normal power?

a. Area radiation monitoring system.

b. Evacuation alarms.

c. Emergency lighting system.

d. Safety instrumentation system.

QUESTION: 014 (1.00)

During periodic leak testing of the neutron source, filter paper wipes are counted for the detection of:

a. alpha radiation.

b. beta radiation.

c. gamma radiation.

d. neutrons.

QUESTION: 015 (1.00)

Which ONE of the following will cause a building evacuation alarm?

a. Loss of electrical power.

b. High pool temperature.

c. High radiation level at fuel storage container surface.

d. Low pool water level.

(***** CATEGORY C CONTINUED ON NEXT PAGE *****)

QUESTION: 016 (1.00)

During full power operation, the proportional counter is fully withdrawn to its uppermost position so that the:

a. scalar does not become saturated.

b. counter is not damaged by radiation.

c. “Startup channel full-in” annunciator will not alarm.

d. high count rate will not initiate a reactor scram.

QUESTION: 017 (1.00)

Which ONE of the following control blade withdrawal interlocks provides protection against an abnormally high excess reactivity?

a. Log N count below 3000 cpm.

b. 5-second delay subsequent to reactor startup.

c. Regulating blade is withdrawn from its lowest position.

d. Flux rises above a preset level before the safety blades are completely withdrawn.

QUESTION: 018 (1.00)

When the Master Switch is in the "TEST" position:

a. all blade withdrawal interlocks are bypassed.

b. the blade drives may be moved without withdrawing the blades.

c. electronic scrams are bypassed.

d. electronic and relay scrams are bypassed.

(***** END OF CATEGORY C *****)
(***** END OF EXAMINATION *****)

A. REACTOR THEORY, THERMODYNAMICS & FACILITY OPERATING CHARACTERISTICS

ANSWER: 001 (1.00)
A.
REFERENCE:
Lamarsh, Introduction to Nuclear Engineering, 2nd. Edition, page 286.

ANSWER: 002 (1.00)
A.
REFERENCE:
Lamarsh, Introduction to Nuclear Engineering, 2nd. Edition, page 103

ANSWER: 003 (1.00)
B.
REFERENCE:
Lamarsh, Introduction to Nuclear Engineering, 2nd. Edition, page 313

ANSWER: 004 (1.00)
C.
REFERENCE:
Experiment No. 3, Critical Mass Determination.

ANSWER: 005 (1.00)
D.
REFERENCE:
Lamarsh, Introduction to Nuclear Engineering, 2nd. Edition, page 282.
Reactivity = (K-1)/K = -4.7% delta K/K. If + 3.5% delta K/K is added, the new reactivity will be -1.2%, i.e., subcritical.

ANSWER: 006 (1.00)
C.
REFERENCE:
Lamarsh, Introduction to Nuclear Engineering, 2nd. Edition, page 76.

ANSWER: 007 (1.00)

C.
REFERENCE:
Increase = $1.001 \times 10^8 - 1 \times 10^8 = 1 \times 10^5$. Prompt neutron population = $0.993 \times 1 \times 10^5$ = 99,300.

ANSWER: 008 (1.00)
D.
REFERENCE:
Lamarsh, Introduction to Nuclear Engineering, 2nd. Edition, page 285.

ANSWER: 009 (1.00)
B.
REFERENCE:
Lamarsh, Introduction to Nuclear Engineering, 2nd. Edition, page 266.

ANSWER: 010 (1.00)
D.
REFERENCE:
Lamarsh, Introduction to Nuclear Engineering, 2nd. Edition, page 267.

ANSWER: 011 (1.00)
C.
REFERENCE:
Lamarsh, Introduction to Nuclear Engineering, 2nd. Edition, page 60.

ANSWER: 012 (1.00)
D.
REFERENCE:
Lamarsh, Introduction to Nuclear Engineering, 2nd. Edition, page 307.

ANSWER: 013 (1.00)
D.
REFERENCE:
Lamarsh, Introduction to Nuclear Engineering, 2nd. Edition, page 286.

ANSWER: 014 (1.00)
A.
REFERENCE:
Lamarsh, Introduction to Nuclear Engineering, 2nd. Edition, page 284.

ANSWER: 015 (1.00)
D.
REFERENCE:
Glasstone, Nuclear Reactor Engineering, 3rd. Edition, Section 1.39.

ANSWER: 016 (1.00)
A.
REFERENCE:
Glasstone, Nuclear Reactor Engineering, 3rd. Edition, Section 2.73.

ANSWER: 017 (1.00)
A.
REFERENCE:
Lamarsh, Introduction to Nuclear Engineering, 2nd. Edition, page 307.
Reactivity added by control rod = 0.001 delta k/k/inch x 10 inches = 0.01 delta k/k
(0.01 delta k/k)/1.25x10^{-3} delta k/k/deg.C = 8 degrees C.

ANSWER: 018 (1.00)
A.
REFERENCE:
A detector that is too far from the source and fuel will underestimate the effects of adding fuel, since the measured counts will not appreciably increase with each fuel element addition.

ANSWER: 019 (1.00)
B.
REFERENCE:
Shutdown Margin = Total Rod Worth - Excess Reactivity
Shutdown Margin = 11.0% - 0.5% = 10.5% delta k/k

ANSWER: 020 (1.00)
D.
REFERENCE:
Lamarsh, Introduction to Nuclear Engineering, 2nd. Edition, page 222.

B. NORMAL/EMERGENCY OPERATING PROCEDURES AND RADIOLOGICAL CONTROLS

ANSWER: 001 (1.00)
A, 4; B, 2; C, 2; D, 1.
REFERENCE:
WPI Requalification Program.

ANSWER: 002 (1.00)
B.
REFERENCE:
Emergency Plan, page 9.

ANSWER: 003 (1.00)
A.
REFERENCE:
10 CFR 20.

ANSWER: 004 (1.00)
B.
REFERENCE:
With the window closed, no betas are measured. The gamma dose rate is 60 mrem/hour.

ANSWER: 005 (1.00)
D.
REFERENCE:
WPI Technical Specifications, Section 3.3.

ANSWER: 006 (1.00)
C.
REFERENCE:
G-M tubes are not sensitive to energy.

ANSWER: 007 (1.00)
A.
REFERENCE:
WPI Requalification Program.

ANSWER: 008 (1.00)
C.
REFERENCE:
Each 2 cm. of lead reduces the radiation level by a factor of 2. Therefore 6 cm. reduces it by a factor of 8.

ANSWER: 009 (1.00)
D.
REFERENCE:
OP-6, Power Level Calibration Procedure.

ANSWER: 010 (1.00)
B.
REFERENCE:
WPI Technical Specifications, Section 5.9.

ANSWER: 011 (1.00)
C.
REFERENCE:
10 CFR 20; 10 mrem/hour at one meter = 111 mrem/hour at 30 centimeters.

ANSWER: 012 (1.00)
C.
REFERENCE:
WPI Technical Specifications, Definitions.

ANSWER: 013 (1.00)
C.
REFERENCE:
Emergency Plan, 3.1.1.

ANSWER: 014 (1.00)
A.
REFERENCE:
WPI Technical Specifications, Section 2.1.

ANSWER: 015 (1.00)
D.
REFERENCE:
WPI Technical Specifications, Section 4.3.

ANSWER: 016 (1.00)
B.
REFERENCE:
Watt-hours is a unit of energy, therefore measures fuel burnup.

ANSWER: 017 (1.00)
D.
REFERENCE:
OP-1, Reactor Startup, Section II.7.

ANSWER: 018 (1.00)
B.
REFERENCE:
WPI Technical Specifications, Table 4.1.

ANSWER: 019 (1.00)
A.
REFERENCE:
OP-1, Reactor Startup, Section I.12.

ANSWER: 020 (1.00)
C.
REFERENCE:
Emergency Plan, Definitions.

C. FACILITY AND RADIATION MONITORING SYSTEMS

ANSWER: 001 (1.00)
C.
REFERENCE:
SAR, Section 4.2.2.2.

ANSWER: 002 (1.00)
A.
REFERENCE:
SAR, Section 1.3.

ANSWER: 003 (1.00)
D.
REFERENCE:
WPI Technical Specifications, Table 4.1.

ANSWER: 004 (1.00)
B.
REFERENCE:
SAR, Section 9.1.

ANSWER: 005 (1.00)
D.
REFERENCE:
Demineralizer Regeneration Procedure.

ANSWER: 006 (1.00)
B.
REFERENCE:
Emergency Plan, Section 7.1.

ANSWER: 007 (1.00)
A,5; B,1; C,5; D,4.
REFERENCE:
SAR Sections 7.4, 7.5, 7.6.

ANSWER: 008 (1.00)
B.
REFERENCE:
SAR, Section 5.3.

ANSWER: 009 (1.00)
B.
REFERENCE:
OP-1, Section 5.2.

ANSWER: 010 (1.00)
B.
REFERENCE:
SAR, Section 7.7.

ANSWER: 011 (1.00)
B.
REFERENCE:
SAR, Section 7.7.

ANSWER: 012 (1.00)
C.
REFERENCE:
SAR, Section 7.3.

ANSWER: 013 (1.00)
D.
REFERENCE:
SAR, Section 8.2.

ANSWER: 014 (1.00)
A.
REFERENCE:
SAR, Section 4.2.4.

ANSWER: 015 (1.00)
D.
REFERENCE:
Technical Specifications, Table 4.1.

ANSWER: 016 (1.00)
B.
REFERENCE:
SAR, Section 7.4.

ANSWER: 017 (1.00)
D.
REFERENCE:
SAR, Section 7.7.

ANSWER: 018 (1.00)
B.
REFERENCE:
SAR, Section 8.1.

A. REACTOR THEORY, THERMODYNAMICS AND FACILITY OPERATING CHARACTERISTICS

ANSWER SHEET

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

001	a	b	c	d ______
002	a	b	c	d ______
003	a	b	c	d ______
004	a	b	c	d ______
005	a	b	c	d ______
006	a	b	c	d ______
007	a	b	c	d ______
008	a	b	c	d ______
009	a	b	c	d ______
010	a	b	c	d ______
011	a	b	c	d ______
012	a	b	c	d ______
013	a	b	c	d ______
014	a	b	c	d ______
015	a	b	c	d ______
016	a	b	c	d ______
017	a	b	c	d ______
018	a	b	c	d ______
019	a	b	c	d ______
020	a	b	c	d ______

(***** END OF CATEGORY A *****)

B. NORMAL/EMERGENCY OPERATING PROCEDURES AND RADIOLOGICAL CONTROLS

ANSWER SHEET

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

001 a_____ b_____ c_____ d _____

002 a b c d _____

003 a b c d _____

004 a b c d _____

005 a b c d _____

006 a b c d _____

007 a b c d _____

008 a b c d _____

009 a b c d _____

010 a b c d _____

011 a b c d _____

012 a b c d _____

013 a b c d _____

014 a b c d _____

015 a b c d _____

016 a b c d _____

017 a b c d _____

018 a b c d _____

019 a b c d _____

020 a b c d _____

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

C. FACILITY AND RADIATION MONITORING SYSTEMS

ANSWER SHEET

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

001	a	b	c	d _____
002	a	b	c	d _____
003	a	b	c	d _____
004	a	b	c	d _____
005	a	b	c	d _____
006	a	b	c	d _____
007	a_____	b_____	c_____	d _____
008	a	b	c	d _____
009	a	b	c	d _____
010	a	b	c	d _____
011	a	b	c	d _____
012	a	b	c	d _____
013	a	b	c	d _____
014	a	b	c	d _____
015	a	b	c	d _____
016	a	b	c	d _____
017	a	b	c	d _____
018	a	b	c	d _____

(***** END OF CATEGORY C *****)

EQUATION SHEET

$Q = m\ c_p\ \Delta T$

$SUR = 26.06/\tau$

$P = P_0\ e^{(t/\tau)}$

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

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

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

1 Curie = $3.7x10^{10}$ dps

1 Btu = 778 ft-lbf

1 Mw = $3.41x10^{6}$ BTU/hr

$CR_1\ (1-K_{eff})_1 = CR_2\ (1-K_{eff})_2$

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

$\tau = (\ell^*/\rho) + [(\beta-\rho)/\lambda_{eff}\rho]$

$DR_1 D_1^2 = DR_2 D_2^2$

$DR = 6CiE/D^2$

1 eV = $1.6x10^{-19}$ watt-sec.

1 gallon water = 8.34 pounds

EF = 9/5EC + 32

EC = 5/9 (EF - 32)