January 31, 2002

Mr. Stephan LaFlamme, Director
Nuclear Reactor Facility
Worcester Polytechnic Institute
Worcester, MA 01609-2280

SUBJECT: INITIAL EXAMINATION REPORT NO. 50-134/OL-02-01

Dear Mr. LaFlamme:

During the week of December 10, 2001, the NRC administered initial examinations to employees of your facility who had applied for a license to operate your Worcester Polytechnic Institute 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 Warren Eresian at 301-415-1833 or Internet e-mail wje@nrc.gov.

Sincerely,

/RA/

William D. Beckner, Program Director
Operating Reactor Improvement Program
Division of Regulatory Improvement Programs
Office of Nuclear Reactor Regulation

Docket No. 50-134

Enclosures: 1. Initial Examination Report No. 50-134/OL-02-01
2. Examination and answer key

cc w/encls:
Please see next page

cc:

Francis J. McGrath
City Manager
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WBeckner

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NAME	**WEresian:rdr**		**EBarnhill**		**PMadden**		**WBeckner**	
DATE	**01/ 17 /2002**		**01/ 23 /2002**		**01/ 24 /2002**		**01/ 25 /2002**	

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

REPORT NO.: 50-134/OL-02-01

FACILITY DOCKET NO.: 50-134

FACILITY LICENSE NO.: R-61

FACILITY: Worcester Polytechnic Institute

EXAMINATION DATES: December 11-13, 2001

SUBMITTED BY: ***/RA/*** 01/07/2002
Warren Eresian, Chief Examiner Date

SUMMARY:

During the week of December 10, 2001, the NRC administered operator licensing examinations to seven Reactor Operator (RO) initial candidates. All candidates passed the written examination. Five candidates passed the operating test and two candidates failed the operating test.

REPORT DETAILS

1. Examiners:

   Warren Eresian, Chief Examiner

2. Results:

	RO PASS/FAIL	SRO PASS/FAIL	TOTAL PASS/FAIL
Written	7/0	N/A	7/0
Operating Tests	5/2	N/A	5/2
Overall	5/2	N/A	5/2

3. Exit Meeting:
   Warren Eresian, NRC
   Stephen LaFlamme, Director

   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:

   Question C001: Two correct answers, both will be accepted.

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

FACILITY: Worcester Tech

REACTOR TYPE: Pool

DATE ADMINISTERED: 12/11/01

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	33	______	____	A. REACTOR THEORY, THERMODYNAMICS, AND FACILITY OPERATING CHARACTERISTICS
20	33	______	____	B. NORMAL AND EMERGENCY OPERATING PROCEDURES AND RADIOLOGICAL CONTROLS
20	33	______	____	C. FACILITY AND RADIATION MONITORING SYSTEMS
60	____	______% FINAL GRADE		

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

____
Candidate's Signature

ENCLOSURE 2

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)

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

a. K_{eff} = production/(absorption + leakage).

b. K_{eff} = (production + leakage)/absorption.

c. K_{eff} = (absorption + leakage)/production.

d. K_{eff} = absorption/(production + leakage).

QUESTION: 002 (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.

QUESTION: 003 (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_o. Additional elements are then loaded and the inverse count rate ratio continues to decrease. As a result of changing the initial count rate:

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

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

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

d. criticality will be completely unpredictable.

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

QUESTION: 004 (1.00)

Two reactors are identical except that Reactor 1 has a beta fraction of 0.0072 and Reactor 2 has a beta fraction of 0.0060. An equal amount of positive reactivity is inserted into both reactors. Which ONE of the following will be the response of Reactor 2 compared to Reactor 1?

a. The resulting power level is lower.

b. The resulting power level is higher.

c. The period of the power increase is shorter.

d. The period of the power increase is longer.

QUESTION: 005 (1.00)

During a reactor startup, the count rate is increasing linearly with time, with no rod motion. This means that:

a. the reactor is subcritical and the count rate increase is due to the buildup of delayed neutron precursors.

b. the reactor is critical and the count rate increase is due to source neutrons.

c. the reactor is subcritical and the count rate increase is due to source neutrons.

d. the reactor is critical and the count rate increase is due to the buildup of delayed neutron precursors.

QUESTION: 006 (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 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}.

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

QUESTION: 007 (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 precursor, which is approximately:

a. 20 seconds.

b. 40 seconds.

c. 55 seconds.

d. 80 seconds.

QUESTION: 008 (1.00)

A reactor with an initial population of 1×10^8 neutrons is operating with $K_{eff} = 1.001$. Considering only the increase in neutron population, how many neutrons (of the increase) will be prompt when the neutron population changes from the current generation to the next? Assume $\beta_{eff} = 0.007$.

a. 700.

b. 7,000.

c. 99,300.

d. 100,000.

QUESTION: 009 (1.00)

Starting with a critical reactor at low power, a control rod is withdrawn from position X and reactor power starts to increase. Neglecting any temperature effects, in order to terminate the increase with the reactor again critical but at a higher power, the control rod must be:

a. inserted deeper than position X.

b. inserted, but not as far as position X.

c. inserted back to position X.

d. inserted, but exact position depends on power level.

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

QUESTION: 010 (1.00)

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

a. A neutron which 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 media.

QUESTION: 011 (1.00)

In a subcritical reactor with K_{eff} = 0.861, +0.104 delta k/k reactivity is added. As a result, the new K_{eff} is:

a. 0.899

b. 0.946

c. 0.989

d. 1.0574

QUESTION: 012 (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.

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

QUESTION: 013 (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. increased by 8 deg C.

b. decreased by 8 deg C.

c. increased by 0.8 deg C.

d. decreased by 0.8 deg C.

QUESTION: 014 (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.

QUESTION: 015 (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.

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

QUESTION: 016 (1.00)

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

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

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

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

d. $_{4}Be^{9} + \alpha \rightarrow {_{6}C^{12}} + n$

QUESTION: 017 (1.00)

Which ONE of the following is responsible for the constant rate of power change several minutes after a reactor scram from full power?

a. The decay of the longest-lived delayed neutron precursors.

b. The decay of the shortest-lived delayed neutron precursors.

c. The mean average decay of the delayed neutron precursors.

d. The decay of fission product gammas producing photoneutrons.

QUESTION: 018 (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: 019 (1.00)

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

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

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

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

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

QUESTION: 020 (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
Safety Blade #1	3.80 % delta k/k
Safety Blade #2	3.50 % delta k/k
Safety Blade #3	3.70 % delta k/k

The ACTUAL shutdown margin (NOT the Tech. Spec. minimum) for this reactor is:

a. 7.20 % delta k/k

b. 10.50 % delta k/k

c. 11.00 % delta k/k

d. 11.50 % delta k/k

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

QUESTION: 001 (2.00)

Match the 10 CFR Part 55 requirements listed in Column A for an actively licensed operator with the correct time period from 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 accordance with the "Power Level Calibration" procedure, after power level is determined:

a. The pointers on the linear power meters are adjusted to give the proper indication.

b. The compensating voltages of the compensated ion chambers are adjusted to give the proper indication.

c. The high voltages to the compensated ion chambers are adjusted to give the proper indication.

d. The positions of the compensated ion chambers are adjusted to give the proper indication.

QUESTION: 003 (1.00)

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

a. An experiment which 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 9 feet above the top of the end box of the fuel elements.

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

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

QUESTION: 004 (1.00)

A radiation survey of an area reveals a general radiation reading of 1 mrem/hr. There is, however, a small section of pipe (point source) which reads 10 mrem/hr at one (1) meter. Which ONE of the following defines the posting requirements for the area in accordance with 10CFR20?

a. "CAUTION RADIATION AREA."

b. "CAUTION RADIOACTIVE MATERIAL."

c. "GRAVE DANGER, VERY HIGH RADIATION AREA."

d. "CAUTION HIGH RADIATION AREA."

QUESTION: 005 (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 (SRO) with the most seniority.

b. the Radiation Safety Officer.

c. the Reactor Facility Director.

d. the Director of the WPI Nuclear Engineering Program.

QUESTION: 006 (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.

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

QUESTION: 007 (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: 008 (1.00)

In accordance with the “Check-out 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: 009 (1.00)

Technical Specifications require that reactor power level be calibrated at least semiannually. If the mass of the gold foil used in the calculation of power is greater than the actual mass, the calculated power level will be:

a. higher than actual power.

b. lower than actual power.

c. the same as actual power.

d. higher than actual power if calibrated at low power, but lower than actual power if calibrated at high power.

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

QUESTION: 010 (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: 011 (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 2000 hours, would result in a committed effective dose equivalent of five (5) rems.

QUESTION: 012 (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.

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

QUESTION: 013 (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 area 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: 014 (1.00)

A sample has been removed from the core and measures 110 mR/hour at 6 inches. In accordance with the "Routine Experiments and Samples Irradiation" procedure:

a. the sample must be reinserted in the pool until it measures less than 100 mR/hour.

b. the sample must be doubly encapsulated.

c. the sample may only be handled by a reactor staff member.

d. the area must be posted as a "Caution-High Radiation" area.

QUESTION: 015 (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: 016 (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: 017 (1.00)

The actual cold, clean core excess reactivity is 0.3% delta k/k. An unsecured (moving) experiment with a reactivity worth of +0.15%Δk/k is being irradiated in the reactor. It is desired to add another experiment, also having positive reactivity. The reactivity of the additional experiment cannot exceed:

a. +0.05%Δk/k

b. +0.15%Δk/k

c. +0.35%Δk/k

d. +0.50%Δk/k

QUESTION: 018 (1.00)

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

a. 3 cm.

b. 4 cm.

c. 6 cm

d. 8 cm.

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

QUESTION: 019 (1.00)

Which ONE of the following activities may be performed by a licensed operator without the permission or supervision of a senior licensed operator?

a. Maintenance of the regulating rod drive.

b. Movement of fuel from the core to a fuel rack.

c. Placing the pool water level safety switch in the BYPASS position.

d. Measurement of rod drop times.

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

QUESTION: 001 (1.00)

Which ONE instrument channel below can generate an alarm and a scram?

a. Reactor period.

b. CIC High Voltahe Monitor.

c. Low pool level.

d. High ARM.

QUESTION: 002 (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: 003 (1.00)

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

a. a shutter and concrete shield plugs.

b. portable shielding around the beamport.

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

d. graphite filler plugs.

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

QUESTION: 004 (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.

QUESTION: 005 (1.00)

The shrouds which surround each safety blade have small holes at the bottom. The purpose of these holes is to:

a. minimize the effect of viscous damping on scram times.

b. provide a cooling water path through the shrouds.

c. provide points where a shroud lifting tool can be attached.

d. smooth out the thermal neutron flux distribution at the bottom of the core.

QUESTION: 006 (1.00)

When normal electrical power is lost, emergency power is provided by batteries to:

a. area radiation monitors, evacuation alarms, and facility emergency lighting.

b. area radiation monitors, control rod drive system, and evacuation alarms.

c. neutron detectors, evacuation alarms, and facility emergency lighting.

d. neutron detectors, control rod drive system, and evacuation alarms.

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

QUESTION: 007 (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: 008 (1.00)

Which ONE of the following is the approximate reactor power at which the Log N and Safety Channel indications overlap with the Startup Channel indication?

a. 0.2 watts.

b. 2.0 watts.

c. 20.0 watts.

d. 200.0 watts.

QUESTION: 009 (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.

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

QUESTION: 010 (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. Area radiation monitors and Argon-41.

d. Reactor Pool low water level and Argon-41.

QUESTION: 011 (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	1. Proportional counter
b. Startup	2. Fission chamber
c. Linear power	3. Na-I scintillation detector
d. Area radiation monitor	4. GM detector
	5. Compensated ion chamber
	6. Uncompensated ion chamber

QUESTION: 012 (1.00)

Which ONE of the following does NOT use a neutron source check to verify operability?

a. Scram circuits.

b. Console amplifiers.

c. Area radiation monitors.

d. Rod permissive interlocks.

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

QUESTION: 013 (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: 014 (1.00)

Pool water purity is measured by a resistivity probe located at:

a. the outlet of the demineralizer.

b. the inlet to the demineralizer.

c. the outlet of the purification pump.

d. the outlet of the reactor pool.

QUESTION: 015 (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: 016 (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: 017 (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: 018 (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: 019 (1.00)

When reactor power is raised above 1 kW, the thermal column and beamport exhaust fans:

a. will automatically start.

b. will automatically start and will automatically stop when power is reduced below 1 kW.

c. will automatically start, but must be manually stopped when power is reduced below 1 kW.

d. must be manually started and manually stopped when power is reduced below 1 kW.

(***** 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, pg. 103.

ANSWER: 002 (1.00)
B.
REFERENCE:
Lamarsh, Introduction to Nuclear Engineering, 2nd Edition, pg. 313.

ANSWER: 003 (1.00)
A.
REFERENCE:
Experiment No. 3, Critical Mass Determination

ANSWER: 004 (1.00)
C.
REFERENCE:
$\tau = (\ell^*/\rho) + [(\beta-\rho)/\lambda_{eff}\rho]$. The reactor with the smaller beta fraction will have the shortest period.

ANSWER: 005 (1.00)
B.
REFERENCE:
A linear increase means that a constant number of neutrons are being added each generation, which can only be due to source neutrons.

ANSWER: 006 (1.00)
A.
REFERENCE:
Lamarsh, Introduction to Nuclear Engineering, 2nd Edition, pg. 287.

ANSWER: 007 (1.00)
C.
REFERENCE:
Lamarsh, Introduction to Nuclear Engineering, 2nd. Edition, page 76.

ANSWER: 008 (1.00)
C.
REFERENCE:
Increase = $1.001\times10^8 - 1\times10^8 = 1\times10^5$. Prompt neutron population = $0.993\times1\times10^5$ = 99,300.

ANSWER: 009 (1.00)
C.
REFERENCE:
In the absence of any temperature effects, core reactivity returns to zero when the rods are returned to their original positions.

ANSWER: 010 (1.00)
D.
REFERENCE:
Glasstone, Nuclear Reactor Engineering, 3rd. Edition, Section 1.39.

ANSWER: 011 (1.00)
B.
REFERENCE:
Initial reactivity = (K - 1)/K = (0.861 - 1)/0.861 = -0.1614 delta k/k.
Final reactivity = -0.1614 + 0.104 = -0.0574 delta k/k
K = 1/(1 + 0.0574) = 0.946

ANSWER: 012 (1.00)
D.
REFERENCE:
Lamarsh, Introduction to Nuclear Engineering, 2nd. Edition, page 267.

ANSWER: 013 (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 deg. C.

ANSWER: 014 (1.00)
D.
REFERENCE:
Lamarsh, Introduction to Nuclear Engineering, 2nd. Edition, page 307.

ANSWER: 015 (1.00)
C.
REFERENCE:
Lamarsh, Introduction to Nuclear Engineering, 2nd. Edition, page 60.

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 289.

ANSWER: 018 (1.00)
B.
REFERENCE:
Lamarsh, Introduction to Nuclear Engineering, 2nd. Edition, page 266.

ANSWER: 019 (1.00)
A.
REFERENCE:
Lamarsh, Introduction to Nuclear Engineering, 2nd. Edition, page 284.

ANSWER: 020 (1.00)
B.
REFERENCE:
Shutdown Margin = Total Rod Worth - Excess Reactivity
Shutdown Margin = 11.00% delta k/k - 0.50% delta k/k = 10.50% delta k/k.

B. NORMAL/EMERGENCY PROCEDURES & RADIOLOGICAL CONTROLS

ANSWER: 001 (2.00)
A, 4; B,2; C,2; D,1
REFERENCE:
WPI Requalification Program

ANSWER: 002 (1.00)
D.
REFERENCE:
SP-02, Power Level Calibration.

ANSWER: 003 (1.00)
B.
REFERENCE:
Technical Specifications, Section 5.9.

ANSWER: 004 (1.00)
D.
REFERENCE:
10CFR20.
10 mrem/hr at 1 meter = 111 mrem/hr at 30 centimeters.

ANSWER: 005 (1.00)
C.
REFERENCE:
Emergency Plan, 3.1.1.

ANSWER: 006 (1.00)
A.
REFERENCE:
Technical Specifications, Section 2.1.

ANSWER: 007 (1.00)
B.
REFERENCE:
"Watt-hours" is a unit of energy, therefore measures fuel burnup.

ANSWER: 008 (1.00)
D.
REFERENCE:
OP-01, Check-out and Operation, Section 6.9.

ANSWER: 009 (1.00)
B.
REFERENCE:
SP-02, Power Level Calibration.
Calculated power level is inversely proportional to the mass of the foil.

ANSWER: 010 (1.00)
B.
REFERENCE:
Emergency Plan, page 9.

ANSWER: 011 (1.00)
A.
REFERENCE:
10 CFR 20.

ANSWER: 012 (1.00)
B.
REFERENCE:
With the window closed, no betas are measured. The gamma dose rate is 60 mrem/hour.

ANSWER: 013 (1.00)
D.
REFERENCE:
Technical Specifications, Section 3.3.

ANSWER: 014 (1.00)
C.
REFERENCE:
OP-02, Routine Experiments and Samples Irradiation, section 5.7.

ANSWER: 015 (1.00)
C.
REFERENCE:
G-M tubes are not sensitive to energy.

ANSWER: 016 (1.00)
A.
REFERENCE:
WPI Requalification Program.

ANSWER: 017 (1.00)
A.
REFERENCE:
Technical Specifications, Section 2.3(4).

ANSWER: 018 (1.00)
C.
REFERENCE:
Each 2 cm. of lead reduces the radiation level by a factor of 2. 6 cm reduces it by a factor of 8.

ANSWER: 019 (1.00)
D.
REFERENCE:
SP-03, Rod Drop-Time Measurement

C. FACILITY AND RADIATION MONITORING SYSTEMS

ANSWER: 001 (1.00)
A and B.
REFERENCE:
WPI Instrument Setpoint Summary

ANSWER: 002 (1.00)
C.
REFERENCE:
OP-01.

ANSWER: 003 (1.00)
A.
REFERENCE:
WPI SAR, Section 4.2.2.

ANSWER: 004 (1.00)
D.
REFERENCE:
WPI Technical Specifications, Table 4.1.

ANSWER: 005 (1.00)
A.
REFERENCE:
SAR Section 4.1.2

ANSWER: 006 (1.00)
A.
REFERENCE:
WPI SAR, Section 4.3.4.

ANSWER: 007 (1.00)
B.
REFERENCE:
WPI SAR, Section 3.2.2

ANSWER: 008 (1.00)
A.
REFERENCE:
WPI Technical Specifications, Section 4.5.1.

ANSWER: 009 (1.00)
D.
REFERENCE:
Demineralizer Regeneration Procedure

ANSWER: 010 (1.00)
B.
REFERENCE:
WPI SAR, Section 6.5.2.

ANSWER: 011 (2.00)
A,5; B,1; C,5; D,4
REFERENCE:
WPI SAR, Sections 4.3.5, 4.3.6, 4.3.7, 4.3.8.

ANSWER: 012 (1.00)
C.
REFERENCE:
OP-01.

ANSWER: 013 (1.00)
B.
REFERENCE:
WPI SAR, Section 4.1.10

ANSWER: 014 (1.00)
A.
REFERENCE:
MP-01.

ANSWER: 015 (1.00)
B.
REFERENCE:
WPI Instrument Setpoint Summary

ANSWER: 016 (1.00)
B.
REFERENCE:
OP-01.

ANSWER: 017 (1.00)
B.
REFERENCE:
WPI SAR, Section 4.3.9

ANSWER: 018 (1.00)
C.
REFERENCE:
WPI SAR, Section 4.3.12.

ANSWER: 019 (1.00)
D.
REFERENCE:
OP-01.

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 ______

B. NORMAL/EMERGENCY PROCEDURES & 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 _____

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 _____

019 a b c d _____

EQUATION SHEET

$Q = m\, c_p\, \Delta T$	$CR_1\,(1\text{-Keff})_1 = CR_2\,(1\text{-Keff})_2$
$SUR = 26.06/\tau$	$P = P_0\, 10^{SUR(t)}$
$P = P_0\, e^{(t/\tau)}$	$\tau = (\ell^*/\rho) + [(\beta-\rho)/\lambda_{eff}\rho]$
$\lambda_{eff} = 0.1$ seconds^{-1}	$DR_1 D_1^2 = DR_2 D_2^2$
$DR = DR_o e^{-\lambda t}$	$DR = 6CiE/D^2$
$\rho = (\text{Keff}-1)/\text{Keff}$	
1 Curie = $3.7\text{x}10^{10}$ dps	1 gallon water = 8.34 pounds
1 Btu = 778 ft-lbf	$^\circ F = 9/5\, ^\circ C + 32$
1 Mw = $3.41\text{x}10^{6}$ BTU/hr	$^\circ C = 5/9\, (^\circ F - 32)$