March 19, 2007

Mr. Glenn Winters, Director
Reactor Critical Facility
Nuclear Engineering and Science Bldg.
Rensselaer Polytechnic Institute
Troy, NY 12181

SUBJECT: INITIAL EXAMINATION REPORT NO. 50-225/OL-07-01, RENSSELAER POLYTECHNIC INSTITUTE

Dear Mr. Winters:

During the week of February 19, 2006, the NRC administered initial examinations to employees of your facility who had applied for a license to operate your Rensselaer 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 2.390 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 document 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. Phillip T. Young at 301-415-4094 or internet e-mail pty@nrc.gov.

Sincerely,
/RA/ M. Voth for

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

Docket No. 50-225

Enclosures: 1. Initial Examination Report No. 50-225/OL-07-01
2. Facility Comments with NRC Resolution
3. Examination and answer key

cc w/encls: Please see next page

cc:

Mayor of the City of Schenectady
Schenectady, NY 12305

Barbara Youngberg
Chief, Radiation Section
Division of Hazardous Waste and Radiation Management
NY State Dept. of Environmental Conservation
625 Broadway
Albany, NY 12233-7255

John P. Spath, State Liaison Officer Designee
Program Manager
Radioactive Waste Policy and Nuclear Coordination
New York State Energy Research & Development Authority
17 Columbia Circle
Albany, NY 12203-6399

Test, Research, and Training
Reactor Newsletter
University of Florida
202 Nuclear Sciences Center
Gainesville, FL 32611

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Office of Nuclear Reactor Regulation

Docket No. 50-225
Enclosures: 1. Initial Examination Report No. 50-225/OL-06-01
2. Facility Comments with NRC Resolution
3. Examination and answer key
cc w/encls: Please see next page
DISTRIBUTION:

PUBLIC	PRTB r/f	JEads
Facility File (EBarnhill) O-6 F-2	PYoung	DHughes

EXAMINATION PACKAGE NO.: ML063490118
CORPORATE NOTIFICATION LETTER ACCESSION NO.: ML063490131
INITIAL EXAMINATION REPORT NO.:ML070730055
INITIAL EXAMINATION RESULTS LETTER NO.: ML070730062 **TEMPLATE #: NRR-079**

OFFICE:	PRTB:CE	DIRS/IOLB:LA	PRTB:BC
NAME:	PYoung:cah	EBarnhill	JEads
DATE:	3/16/2007	3/19/2007	3/19/2007

OFFICIAL RECORD COPY

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

REPORT NO.: 50-225/OL-07-01

FACILITY DOCKET NO.: 50-225

FACILITY LICENSE NO.: CX-22

FACILITY: Rensselaer Polytechnic Institute

EXAMINATION DATES: February 22, 2007

EXAMINERS: Phillip T. Young, Chief Examiner

SUBMITTED BY: ***/RA/*** 03/16/2007
Phillip T. Young, Chief Examiner Date

SUMMARY:

During the week of February 19, 2007, the NRC administered operator licensing examinations to two Senior Reactor Operator (Instant) candidates. One candidate passed the examination and one candidate failed Section B of the written examination.

ENCLOSURE 1

REPORT DETAILS

1. Examiners: Phillip T.Young, Chief Examiner

2. Results:

	RO PASS/FAIL	SRO PASS/FAIL	TOTAL PASS/FAIL
Written	**N/A**	**1/1**	**1/1**
Operating Tests	**N/A**	**2/0**	**2/0**
Overall	**N/A**	**1/1**	**1/1**

3. Exit Meeting:

Phillip T. Young, NRC Chief Examiner
Timothy Trumbull, Operations Supervisor

The NRC thanked the facility staff for their cooperation during the examination. No generic concerns were noted.

Facility Comments with NRC Resolution

Facility Comment:
Question C.003
1) C-3, change the correct answer to (a) G/M tubes. We replaced our old scintillators a few years ago.

NRC Resolution:
Comments accepted, correct answer changed to (a) G/M tubes

Facility Comment:
Question C.005
2) C-5, the correct answer, (d) was confusing. The DC current flows through two coils that are in parallel, it is the relay contacts that are in series. I think Glenn and Jason might have chosen this anyway but consider tossing it out.

NRC Resolution:
Reviewed facility comment, this question will be rewritten prior to next use.

Facility Comment:
Question C.009
3) C-9, no 400 Hz MG set anymore - consider tossing these.

NRC Resolution:
Comments accepted

Facility Comment:
Question C.020
4) C-20, no 400 Hz MG set anymore - consider tossing these.

NRC Resolution:
Comments accepted

Facility Comment:
Question C.013
5) C13, the question identifies a GANG/SINGLE switch and when we re-wired the panel we changed it to GANG/OFF and removed the individual shim switches - consider tossing this one.

NRC Resolution:
Comments accepted

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

FACILITY: Rensselaer Polytechnic Institute

REACTOR TYPE: Critical Facility

DATE ADMINISTERED: 02/22/2007

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	35	_____	____	A. REACTOR THEORY, THERMODYNAMICS, AND FACILITY OPERATING CHARACTERISTICS
20	35	_____	____	B. NORMAL AND EMERGENCY OPERATING PROCEDURES AND RADIOLOGICAL CONTROLS
17 ~~20~~	30	_____	____	C. FACILITY AND RADIATION MONITORING SYSTEMS
57		_____	_____% FINAL GRADE	

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

_____
Candidate's Signature

ENCLOSURE 3

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.

A. Rx THEORY, THERMO & FACILITY OPERATING CHARACTERISTICS

QUESTION A.001 [1.0 point] (1.0)
Core excess reactivity changes with…

a Fuel burnup

b Control Rod Height

c Neutron Level

d Reactor Power Level

Answer: A.001 a.
REF: Burn, R., *Introduction to Nuclear Reactor Operations*, © 1982, § 6.2 p. 6-1 — 6-4.

QUESTION A.002 [1.0 point] (2.0)
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

Answer: A.002 c.
Ref: Lamarsh, Introduction to Nuclear Engineering, 2nd Edition, page 289.
$P = P_0 e^{-T/\tau} = 10^{-5} \times e^{(-180sec/80sec)} = 10^{-5} \times e^{-2.25} = 0.1054 \times 10^{-5} = 1.054 \times 10^{-6}$

QUESTION A.003 [1.0 point] (3.0)
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

Answer: A.003 d
Ref: Burn, R., *Introduction to Nuclear Reactor Operations*, © 1982, § 5.7, pp. 5-28 — 5-38.

A. Rx THEORY, THERMO & FACILITY OPERATING CHARACTERISTICS

QUESTION A.004 [2.0 points, 0.5 each] (5.0)
Match each term 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.

Answer: A.004 a. = 2; b. = 4; c. = 1; d. = 3
REF: Burn, R., *Introduction to Nuclear Reactor Operations,* © 1982, § 2.5, p. 2-36.

QUESTION A.005 [1.0 point] (6.0)
Which condition below describes a reactor which is exactly critical.

a. k = 1; delta k/k = 1
b. k = 1; delta k/k = 0
c. k = 0; delta k/k = 1
d. k = 0; delta k/k = 0

Answer: A.005 b.
Ref: Standard NRC Question

QUESTION A.006 [1.0 point] (7.0)
Thermalization of neutrons is accomplished most efficiently when the moderator has a:

a. LOW atomic mass number and HIGH scattering cross-section
b. HIGH atomic mass number and HIGH scattering cross-section
c. LOW neutron absorption cross-section and LOW scattering cross-section
d. LOW neutron absorption cross-section and HIGH atomic mass number

Answer: A.006 a.
Ref: Burn, R., *Introduction to Nuclear Reactor Operations,* © 1982

A. Rx THEORY, THERMO & FACILITY OPERATING CHARACTERISTICS

QUESTION A.007 [1.0 point] (8.0)
As a result of beta decay:

a. The atomic mass number decreases by 1, and the number of protons remains constant.
b. The atomic mass number remains constant, and the number of protons increases by 1.
c. The atomic mass number decreases by 1, and the number of protons decreases by 1.
d. The atomic mass number remains constant, and the number of protons remains constant.

Answer: A.007 b.
Ref: Lamarsh, Introduction to Nuclear Engineering, 2nd Edition, page 71.

QUESTION A.008 [1.0 point] (9.0)
Which of the following elements has the highest neutron absorption cross section?

a. Uranium 235
b. Samarium 149
c. Boron 10
d. Xenon 135

Answer: A.008 d.
Ref: Burn, Introduction to Nuclear Reactor Operations

QUESTION A.009 [1.0 point] (10.0)
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.

Answer: A.009 d.
Ref: Burn, Introduction to Nuclear Reactor Operations, page 3-15.

A. Rx THEORY, THERMO & FACILITY OPERATING CHARACTERISTICS

QUESTION A.010 [1.0 point] (11.0)
As a reactor continues to operate over time, for a constant power level, the average neutron flux:

a. decreases, due to the increase in fission product poisons.
b. decreases, because fuel is being depleted.
c. increases, in order to compensate for fuel depletion.
d. remains the same.

Answer: A.010 c.
Ref: Burn, Introduction to Nuclear Reactor Operations, page 2-50.

QUESTION A.011 [1.0 point] (12.0)
A reactor is subcritical with a K_{eff} of 0.955. Seven dollars ($7.00) of positive reactivity is inserted into the core ($\beta = 0.007$). At this point, the reactor is:

a. subcritical.
b. exactly critical.
c. supercritical.
d. prompt critical.

Answer: A.011 c.
Ref: Burn, Introduction to Nuclear Reactor Operations, page 3-21.
When $k_{eff} = 0.955$, $\rho = -0.047$ delta k/k; $7.00 = 7(0.0070) = + 0.049$ delta k/k
$- 0.047 + 0.049$ delta k/k = + 0.002 delta k/k, therefore reactor is supercritical.

QUESTION A.012 [1.0 point] (13.0)
A reactor with an initial population of $1x10^8$ 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 $\beta = 0.007$.

a. 700.
b. 7,000.
c. 99,300.
d. 100,000.

Answer: A.012 c.
Ref: Burn, Introduction to Nuclear Reactor Operations, page 3-11. $(1.001 - 1.000)x1x10^8$ = 100,000 increase. Number of delayed = 0.007x100,000 = 700. Prompt = 99,300.

A. Rx THEORY, THERMO & FACILITY OPERATING CHARACTERISTICS

QUESTION A.013 [1.0 point] (14.0)
The neutron microscopic cross section for absorption, σ_a , generally:

a. increases as neutron energy increases.

b. decreases as neutron energy increases.

c. increases as the mass of the target nucleus increases.

d. decreases as the mass of the target nucleus increases.

Answer: A.013 b.
Ref: Burn, Introduction to Nuclear Reactor Operations, page 2-36.

QUESTION A.014 [1.0 point] (15.0)
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 become critical before the predicted number of fuel elements are loaded)?

a. The detector is too far from the source.

b. The detector is too close to the source.

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

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

Answer: A.014 b.
Ref: Manual of Experiments, Core Loading by Subcritical Multiplication, page 27.

QUESTION A.015 [1.0 point] (16.0)
The moderator-to-fuel ratio describes the relationship between the number of moderator atoms in a volume of core to the number of fuel atoms. A reactor which is:

a. undermoderated will have a positive moderator temperature coefficient.

b. undermoderated will have a negative moderator temperature coefficient.

c. overmoderated will have a constant moderator temperature coefficient.

d. overmoderated will have a negative moderator temperature coefficient.

Answer: A.015 b.
Ref: Burn, Introduction to Nuclear Reactor Operations, page 6-7.

A. Rx THEORY, THERMO & FACILITY OPERATING CHARACTERISTICS

QUESTION A.016 [1.0 point] (17.0)
A reactor is critical at 18.1 inches on a controlling rod. The controlling rod is withdrawn to 18.4 inches. The reactivity inserted is 14.4 cents. What is the differential rod worth?

a. 14.4 cents/inch at 18.25 inches.
b. 14.4 cents/inch only between 18.1 and 18.4 inches.
c. 48 cents/inch at 18.4 inches.
d. 48 cents/inch at 18.25 inches.

Answer: A.014 d.
Ref: Burn, Introduction to Nuclear Reactor Operations, page 7-2. $\Delta\rho = 14.4$ cents; $\Delta x = 18.4 - 18.1 = 0.3$ inches; $\Delta\rho/\Delta x = 48$ cents/inch at the midpoint (18.25 inches).

QUESTION A.017 [1.0 point] (18.0)
Two critical reactors at low power 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 will be lower.
b. The resulting power level will be higher.
c. The resulting period will be longer.
d. The resulting period will be shorter.

Answer: A.017 d.
Ref: Burn, Introduction to Nuclear Reactor Operations, page 3-33.

QUESTION A.018 [1.0 point] (19.0)
In a subcritical reactor, K_{eff} is increased from 0.861 to 0.946. Which ONE of the following is the amount of reactivity that was added to the reactor core?

a. 0.085 delta k/k ($10.90)
b. 0.104 delta k/k ($13.33)
c. 0.161 delta k/k ($20.64)
d. 0.218 delta k/k ($27.95)

Answer: A.018 b.
Ref: From Equation Sheet, $\rho = (K - 1)/K$. When $K = 0.861$, $\rho = -0.161$ $\Delta K/K$. When $K = 0.946$, $\rho = -0.057$ $\Delta K/K$. $\Delta\rho = -0.057 - (-0.161) = +0.104$ $\Delta K/K$.

A. Rx THEORY, THERMO & FACILITY OPERATING CHARACTERISTICS

QUESTION A.019 [1.0 point] (20.0)

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

a. Conduction.

b. Mixed convection.

c. Forced convection.

d. Natural convection.

Answer: A.019 d.
Ref: SAR section 4.6

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

B. NORMAL/EMERGENCY OPERATING PROCEDURES & RADIOLOGICAL CONTROLS

QUESTION B. 001 [1.0 point] (1.0)

The Total Effective Dose Equivalent (TEDE) is defined as the sum of the deep-dose equivalent and the committed effective dose equivalent. The deep-dose equivalent is related to:

a. the dose to organs or tissues.

b. the external exposure to the skin or an extremity.

c. the external exposure to the lens of the eye.

d. the external whole-body exposure.

Answer: B.001 d.
Ref: 10CFR20.

QUESTION B. 002 [1.0 point] (2.0)

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 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 5 rems.

c. 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.

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

Answer: B.002 a.
Ref: 10 CFR 20

QUESTION B. 003 [1.0 point] (3.0)

A small radioactive source is to be stored in the reactor facility. The source activity is estimated to be 25 curies and emits a 1.33 Mev gamma. Assuming no shielding is used, the dose rate from the source at a distance of 10 feet would be approximately:

a. 0.33 Rem/hour.

b. 2.0 Rem/hour.

c. 6.0 Rem/hour.

d. 20.0 Rem/hour.

Answer: B.003 b.
Ref: Dose Rate = $6CiE/R^2$ = 6x25x1.33/100 = 2 Rem/hour.

B. NORMAL/EMERGENCY OPERATING PROCEDURES & RADIOLOGICAL CONTROLS

QUESTION B.004 [2.0 points, 0.5 each] (5.0)
Match the type of radiation in column A with its associated Quality Factor (10CFR20) from column B.

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

Answer: B.004 a. = 20; b. = 1; c. = 1; d. = 10
Ref: 10CFR20.100x

QUESTION B.005 [2.0 points, 0.5 each] (7.0)
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

Answer: B.005 a. = 2; b. = 3; c. = 3; d. = 4
Ref: 10 CFR 20.1003, Definitions

QUESTION B.006 [1.0 point] (8.0)
Which one of the following does NOT require NRC approval for changes?

a. License
b. Requalification plan
c. Emergency Implementation Procedures
d. Emergency Plan

Answer: B.006 c
Ref: 10 CFR 50.54 (q); 10 CFR 50.59; 10 CFR 55.59

B. NORMAL/EMERGENCY OPERATING PROCEDURES & RADIOLOGICAL CONTROLS

QUESTION B.007 [1.0 point] (9.0)
In accordance with 10 CFR Part 50.54(x), under what conditions can an operator take reasonable action that departs from a license condition or a Technical Specification?

1. In any emergency.

2. In an emergency, when the action is needed to protect health and safety and no other action is immediately apparent.

3. In an emergency declared by the Emergency Director.

4. In an emergency declared by the Emergency Director along with the approval of the Senior Reactor Operator on site.

Answer: B.007 b.
Ref: 10CFR50.54 (x)

QUESTION B.008 [1.0 point] (10.0)
Based on 10CFR55, which one of the following is the MINIMUM requirement that must be met to retain an "active" license?

a. Must perform license duties at least 4 hours per calendar quarter.

b. Must perform license duties a minimum of 8 hours per month.

c. Must perform license duties a minimum of 5 eight-hour shifts per calendar quarter.

d. Must perform license duties at least 40 hours per calendar year.

Answer: B.008 a.
Ref: 10CFR55.53(e)

QUESTION B.009 [1.0 point] (11.0)
Which of the following is not considered to cause a whole body exposure?

a. Ar-41

b. I-131

c. Xe-133

d. Kr-88

Answer: B.009 b.
Ref: Glasstone/Sesonske - Chapter 9

B. NORMAL/EMERGENCY OPERATING PROCEDURES & RADIOLOGICAL CONTROLS

QUESTION B.010 [1.0 point] (12.0)
Which ONE of the listed radioisotopes produces the highest ionizing energy gamma?

a. H^3
b. N^{16}
c. Ar^{41}
d. U^{235}

Answer: B.010 b.
Ref: Chart of the Nuclides

QUESTION B.011 [1.0 point, 0.25 each] (13.0)
Identify the PRIMARY source (irradiation of **A**ir, irradiation of **W**ater, or **F**ission product) of EACH of the radioisotopes listed.

a. $_1H^3$
b. $_{18}Ar^{41}$
c. $7N^{16}$
d. $_{54}Xe^{135}$

Answer: B.011 a. = Water; b. = Air; c. = Water; d. = Fission
Ref: Standard NRC OL-04-02 **QUESTION** .

QUESTION B.012 [1.0 point] (14.0)
In accordance with Technical Specifications, a REACTOR SHUTDOWN condition requires all control rods are fully inserted and:

a. the console key is removed.
b. the reactor is shutdown by at least $1.00.
c. no operations are in progress which involve control rod maintenance.
d. no operations are in progress which involve moving fuel pins in the reactor vessel.

Answer: B.012 b.
Ref: Technical Specifications, Definitions.

B. NORMAL/EMERGENCY OPERATING PROCEDURES & RADIOLOGICAL CONTROLS

QUESTION B.013 [1.0 point] (15.0)
The reactor parameter which is protected by Safety Limits is:

a. steady state power level.
b. fuel pellet temperature.
c. moderator level.
d. fuel clad temperature.

Answer: B.013 b.
Ref: Technical Specifications, 2.0.

QUESTION B.014 [1.0 point] (16.0)
In accordance with the Technical Specifications, which ONE situation below is NOT permissible?

a. A power level trip setting of 120 watts.
b. Operation with three operable control rods.
c. Operation with the Log N, Period channel bypassed.
d. Criticality detector system removed from service and replaced by an equivalent portable unit.

Answer: B.014 b.
Ref: Technical Specifications, 3.1(2).

QUESTION B.015 [1.0 point] (17.0)
Assuming that no channels are bypassed, the safety system channels which are required by the Technical Specifications to be operating in all modes of operation are:

a. log N power level, reactor period, pool water level
b. linear power level, manual scram, criticality detector
c. reactor period, water dump valve scram, manual scram
d. building power failure, reactor door scram, manual scram

Answer: B.015 d.
Ref: Technical Specifications, Table 1.

B. NORMAL/EMERGENCY OPERATING PROCEDURES & RADIOLOGICAL CONTROLS

QUESTION B.016 [1.0 point] (18.0)

A temporary procedure change may be made with the approval of the Operations Supervisor without prior approval from the NSRB if it is a change:

a. required for safe reactor shutdown.

b. that does not change the original intent of the procedure.

c. required for safe operation of experiments and experiment facilities.

d. that specifies corrective actions to be taken for specific forseen malfunctions.

Answer: B.016 b.
Ref: Technical Specifications, 6.2.

QUESTION B.017 [1.0 point, 0.25 each] (19.0)

Match each of the following actions in Column A with the correct term from the Technical Specifications in Column B. Only one term from Column B may be used for each action in Column A.

Column A	Column B
a. Immersing a thermometer in an ice bath, then in boiling water and noting the readings.	1. Channel Check
b. Placing a source next to a radiation detector and observing meter movement.	2. Channel Test
c. Performing a determination of reactor power with irradiated foils, then adjusting neutron instrumentation to correspond to measured power.	3. Channel Calibration
d. Observing the overlap between two different neutron detectors as power increases.	

Answer: B.017 a. = 2; b. = 1; c. = 3; d. = 1.
Ref: Technical Specifications, Definitions.

B. NORMAL/EMERGENCY OPERATING PROCEDURES & RADIOLOGICAL CONTROLS

QUESTION B.018 [1.0 point] (20.0)
The maximum reactivity change allowed for withdrawal and insertion of an experiment with an absolute worth of $.50 is:

a. $0.40/second.

b. $0.35/second.

c. $0.20/second.

d. $0.15/second.

Answer: B.018 c.
Ref: RPI Technical Specifications, Section 3.4.

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

C. FACILITY AND RADIATION MONITORING SYSTEMS

QUESTION C.001 [1.0 point] (1.0)
A linear power channel uses a (an):

a. uncompensated ion chamber
b. compensated ion chamber
c. fission chamber
d. boron-trifluoride detector

Answer: C.001 a.
Ref: SER, page 4-7. Vol. 2, Control Instrumentation Block Diagram.

QUESTION C.002 [1.0 point] (2.0)
During normal operation, the principal airborne radionuclide formed is:

a. N-16
b. I-131
c. Cs-137
d. Ar-41

Answer: C.002 d.
Ref: SER, page 11-1.

QUESTION C.003 [1.0 point] (3.0)
Which ONE of the following types of detector is utilized in the area gamma radiation monitoring system?

a. Geiger-Mueller tube
b. Scintillation detector
c. Ionization chamber
d. Proportional counter

Answer: C.003 ~~b.~~ per facility comment answer a. Geiger-Mueller tube is accepted as correct
Ref: SER, page 7-3.

C. FACILITY AND RADIATION MONITORING SYSTEMS

QUESTION C.004 [1.0 point] (4.0)

The Dump Valve Bypass control:

a. allows air to be admitted to the dump valve operator regardless of the scram condition

b. bleeds air from the dump valve operator to ensure that the valve opens on a scram

c. recloses the dump valve once it has opened if no scram conditions exist

d. locks air onto the dump valve operator if an automatic scram occurs but still allows response to manual scrams

Answer: C.004 a.
Ref: Vol. 2, Control Instrumentation Block Diagram.

QUESTION C.005 [1.0 point] (5.0)

With regard to the Solenoid Interrupt Circuit:

a. if one of the electrical leads in one of the instrument scram's external contacts broke (open circuit), it would cause a scram.

b. if one of the electrical leads in one of the control rod solenoid circuits broke (open circuit), it would cause all control rods to drop.

c. if one of the electrical leads in one of the manual scram's external contacts broke (open circuit), it would not cause a scram.

d. the rectified DC current flows through two series instrument scram relays, the opening of either of which would cause a scram.

Answer: C.005 d. per facility comment on OL0701 re-write prior to next use.
Ref: Vol. 2, Solenoid Interrupt Circuit.

QUESTION C.006 [1.0 point] (6.0)

Differentiation between gamma and neutron induced signals in the startup channels is accomplished by:

a. amplifying only neutron signals coming from the detector.

b. counting only signals at strengths greater than the gamma signals.

c. adjusting amplifier gain.

d. adjusting the compensating voltage applied to the detector.

Answer: C.006 b.
Ref: Manual of Experiments, Chapter II, Startup Channel Calibration.

C. FACILITY AND RADIATION MONITORING SYSTEMS

QUESTION C.007 [1.0 point] (7.0)
There are three scram functions which may be BYPASSED. Two of them are:

a. high water level scram, reactor door scram.

b. linear power scram, period scram.

c. linear power scram, reactor door scram.

d. reactor door scram, period scram.

Answer: C.007 d.
Ref: Technical Specifications, Table 1.

QUESTION C.008 [1.0 point] (8.0)
The temperature monitoring system monitors the temperatures of the:

a. reactor coolant and fuel.

b. reactor coolant and reactor room air.

c. fuel and reactor room air.

d. reactor coolant and control room air.

Answer: C.008 b.
Ref: SER, page 7-4.

QUESTION DELETED ~~**QUESTION** C.009 [1.0 point] (9.0)~~
~~There are five (5) interlocks which are required to be met in order to permit rod withdrawal. Three of these are:~~

~~a. 400 cycle power on, reactor room area monitor on, fill pump off.~~

~~b. fill pump on, reactor period > 15 seconds, startup channel > 2 cps.~~

~~c. reactor room area monitor on, chart recorder on, startup channel > 2 cps.~~

~~d. 400 cycle power on, fill pump off, chart recorder on.~~

~~Answer: C.009 d.~~
~~Ref: Technical Specifications, Table 2.~~

C. FACILITY AND RADIATION MONITORING SYSTEMS

QUESTION C.010 [1.0 point] (10.0)

The area gamma monitoring system has detectors located in the control room, the reactor room:

a. on the reactor deck and outside the reactor room window.

b. in the counting room and outside the reactor room window.

c. on the reactor deck and in the fuel storage vault.

d. in the counting room and in the fuel storage vault.

Answer: C.010 a.
Ref: SER, page 7-3.

QUESTION C.011 [1.0 point] (11.0)

The water dump valve operation may be bypassed by:

a. locking closed the water dump valve operator locally.

b. depressing the bypass pushbutton on the main control panel.

c. placing key switch located on CP-2 to the “By-Pass” position.

d. disconnecting the DC current output at the Solenoid Interrupt Circuit module.

Answer: C.011 c.
Ref: Operating Procedures, F, Bypass Conditions.

QUESTION C.012 [1.0 point] (12.0)

Which ONE of the following describes the warning output of the criticality detector system?

a. An audible alarm is provided in the control room and a visual alarm is provided outside the facility.

b. An audible and visual alarm is provided in the control room.

c. An audible alarm is provided in the reactor room and a visual alarm is provided in the control room.

d. An audible and visual alarm is provided in the reactor room.

Answer: C.012 b.
Ref: Emergency Procedures, 3.1.

C. FACILITY AND RADIATION MONITORING SYSTEMS

QUESTION DELETED ~~**QUESTION** C.013 [1.0 point] (13.0)~~
~~The GANG/SINGLE switch for rod #3 fails CLOSED. As a result:~~

~~a. rod #3 cannot be moved.~~

~~b. rod #3 moves with the ganged bank.~~

~~c. rod #3 inserts.~~

~~d. rod #3 withdraws.~~

~~Answer: C.013 b.~~
~~Ref: Safety Analysis for the Ganged Control Rod Operating System, page 3.~~

QUESTION C.014 [1.0 point] (14.0)
Period information is supplied from the:

a. BF_3 detector.

b. Linear Channel 1.

c. Linear Channel 2.

d. Log Amplifier.

Answer: C.014 d.
Ref: SAR, Figure 7.1

QUESTION C.015 [1.0 point] (15.0)
If control rod sensitivity is known, withdrawal of the rods as a bank is permitted as long as:

a. reactor period is greater than 20 seconds

b. the reactivity addition does not exceed $0.05 per second

c. the reactivity addition does not exceed $0.20 per second

d. the source level channel has increased by less than one decade

Answer: C.015 b.
Ref: Operating Procedures, Section A.

C. FACILITY AND RADIATION MONITORING SYSTEMS

QUESTION C.016 [1.0 point] (16.0)
The time required to fill the 2000 gallon reactor tank is approximately:

a. 30 minutes
b. 40 minutes
c. 60 minutes
d. 80 minutes

Answer: C.016 b.
Ref: Operating Procedures, Section J.

QUESTION C.017 [1.0 point, 0.25 each] (17.0)
For the area radiation monitoring system, match the alarm settings in Column B with the appropriate channel in Column A. Items in Column B may be used once, more than once, or not at all.

Column A	Column B
a. Control room	1. 20 mr/hour
b. Reactor window	2. 100 mr/hour
c. Reactor room	3. 40 mr/hour
d. Reactor deck	4. 10 mr/hour

Answer: C.017 a. = 4; b. = 3; c. = 1; d. = 2.
Ref: SAR, Section 7.7.

QUESTION C.018 [1.0 point] (18.0)
Which ONE of the following safety system scram conditions has a scram BYPASS associated with it?

a. Loss of power to the reactor building.
b. Magnet switch on control panel OFF.
c. Linear power scram.
d. Reactor door OPEN.

Answer: C.018 d.
Ref: Technical Specifications, Table 1.

C. FACILITY AND RADIATION MONITORING SYSTEMS

QUESTION C.019 [1.0 point] (19.0)
The structure within the core that forms the base of the three-tiered core-support structure is the:

a. carrier plate.
b. plastic spacer plate.
c. fuel pin lattice plate.
d. unistrut support plate.

Answer: C.019 a.
Ref: SAR, Section 4.2.5.

QUESTION DELETED ~~**QUESTION** C.020 [1.0 point] (20.0)~~
~~The reactor is operating at 100% power when the 400 cycle MG set fails. As a result:~~

~~a. the reactor scrams.~~
~~b. control rods cannot be moved.~~
~~c. control rods cannot be withdrawn.~~
~~d. the dump valve automatically opens.~~

~~Answer: C.020 c.~~
~~Ref: SAR, Figure 7.2.~~

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

EQUATION SHEET

$Q = m\, c_p\, \Delta T$

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

$SUR = 26.06/\tau$

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

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

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

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

$DR_1 D_1^2 = DR_2 D_2^2$

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

$DR = 6CiE/D^2$

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

$1 \text{ eV} = 1.6\text{x}10^{-19}$ watt-sec.

$1 \text{ Curie} = 3.7\text{x}10^{10}$ dps

1 gallon water = 8.34 pounds

1 Btu = 778 ft-lbf

$^\circ F = 9/5\,^\circ C + 32$

$1 \text{ Mw} = 3.41\text{x}10^6$ BTU/hr

$^\circ C = 5/9\,(^\circ F - 32)$