U.S. NUCLEAR REGULATORY COMMISSION REGION I
OPERATOR LICENSING EXAMINATION REPORT

EXAMINATION REPORT NO.	89-01 (OL)
FACILITY DOCKET NO.	50-225
FACILITY LICENSE NO.	CX-22
LICENSEE:	Rensselaer Polytechnic Institute Troy, New York 12180
FACILITY:	Rensselaer Polytechnic Institute
EXAMINATION DATES:	September 6-7, 1989

CHIEF EXAMINER: David M Silk — 12/19/89
D.M. Silk, Senior Operations Engineer — Date

APPROVED BY: P.W. Eselgroth for PWE — 12/20/89
P.W. Eselgroth, Chief, PWR Section — Date

SUMMARY: Written examinations and operating tests were administered to three senior reactor operator (SRO) candidates. Immediately following the written examination, the licensee was given a copy of the written examination. The licensee did not submit any formal comments regarding the written examination. All candidates passed the operating portion of the examination. Two candidates failed two sections of the written examination with both failing Section K, Fuel Handling and Core Parameters and, thus, will not be issued a license.

DETAILS

TYPE OF EXAMINATIONS: Replacement

EXAMINATION RESULTS:

	RO Pass/Fail	SRO Pass/Fail
Written	--	1/2
Operating	--	3/0
Overall	--	1/2

1. CHIEF EXAMINER AT SITE: D.M. Silk

2. The following is a generic deficiency noted on the operating tests. This information is being provided to aid the license in upgrading license and requalification training programs. No license response is required.

   - The candidates had minor difficulty locating controls or valves throughout the facility.

3. The following is a summary of generic deficiencies noted from the grading of written examinations. (Note: A deficiency is considered to exist when the sum of the points lost by the candidates in a question is 50% or greater of the total points of that question). This information is being provided to aid the licensee in upgrading license and requalification training programs. No licensee response is required.

Question No.	Knowledge
H.01	Subcritical Multiplication
H.02	Reactivity calculation using doubling times
H.10	Heat transfer processes in a reactor
H.11	Application of pump laws
I.10	Personal Safety and Radiation Monitor Manual recommendations for obtaining meaningful radiation measurements

I.11	Most probable direction a radioactive release would travel from the RPI Critical Facility
I.12.a	Approval required for exceeding 10 CFR 20 exposure limits.
J.05	Circuit diagram of SCRAM system
J.08	Indications per procedure that the reactor is critical
K.05	Supervision necessary for fuel handling as per fuel transfer
K.06	Actions to be performed before proceeding with a fuel transfer
K.10	Reactivity worth of the control rods when removed as a bank
K.13	Core components and construction
L.06	Individuals who are permitted to manipulate controls affecting core reactivity
L.08	Technical Specification definition of Reportable Occurrences

4. Personnel Present at Exit Interview:

NRC Personnel: D. Silk, Chief Examiner

RPI Personnel: Dr. Harris, Facility Director
P. Angelo, Operations Supervisor

5. Exit interview topics:

- The NRC received clarification from licensee personnel regarding questions that arose during the operating examination in the performance of procedural steps and technical information regarding facility equipment.

- The NRC discussed the following deficiencies on the part of the licensee regarding the pre-examination administrative details:

  1. Reference material sent to the NRC was not bound and tabbed as requested in the March 21, 1980 letter formalizing the examination details. The NRC stated that no examinations will be given in the future if the reference material is not properly bound and tabbed.

2. The NRC informed the licensee that material sent to the NRC for examination development should only include information related to the present facility configuration and which is pertinent to reactor operations.

3. Two sets of two volumes were sent to the NRC and an NRC contractor. The package sent to the contractor contained two copies of the same volume while the NRC was sent two copies of the other volume.

4. The original material sent did not include the Experiment Manual, which was listed in the reference material Table of Contents. Therefore, the NRC had to request that it be sent.

5. The applications were not received in the regional office until one working day before the examiner was to leave to go to administer the examinations. The licensee was to submit the original applications with two copies of each. No copies were sent to the NRC.

6. The Nonmedical Certification portions of Form 396 were not signed when sent to the NRC. The examiner had the licensee sign the forms just prior to the administration of the written examination.

7. The details of the training were not delineated on the applications. One application contained the candidate's previous nuclear training without listing the site specific training received at RPI. In order to determine if the applicants met the requirements of ANSI/ANS 15.4-1977, the NRC had to discuss the details of the candidates training with the licensee.

8. All of the candidates' applications indicated that RPI was a "Cold" reactor. RPI is a "Hot" reactor since it has already achieved critically.

- The following are a list of observations made by the NRC:

1. During the performance of the reactor startups, the NRC observed that the console keys ("Power On" and "Reactor On") could be removed from the console without initiating a reactor SCRAM. As per the Safety Evaluation Report, one key energizes the safety amplifiers while the other key energizes the control rod magnets and when either key is taken to the "Off" position a reactor SCRAM will occur. The SER states that "the key switches also serve as operational 'prevents' (by denying power to the magnets and safety channel circuits) when in the "Off" position." Since both keys could be removed directly from the "On" position without going through the "Off" position, a situation could result in the reactor being secured according to Technical Specifications (rods fully inserted, the console key removed, no movement

of fuel or experiments, and no control rod maintenance). However, this condition would not meet the intent of Technical Specification since all of the systems would remain energized without the keys in the console. In order for the reactor to go critical, the moderator must be in the reactor tank and the control rods must be withdrawn. Without a SCRAM signal or a disruption of power, the air operated reactor tank dump valve will remain closed, keeping the moderator in the tank, and the control rods could be withdrawn. Thus, not only is the intent of securing the reactor not being met, but also there exists the possibility of a reactor startup without the keys being present at the console.

2. During two of the candidates' startups, the reactor SCRAMMED when the candidates changed the scale on the linear power channel. Changing the scale induced a spike that exceeded the 90% of scale SCRAM set point and generated a SCRAM signal. These two unplanned SCRAMs demonstrate that some existing equipment or components may be disruptive to reactor operations.

3. Step 4 of 7.3.5, Radiation Emergency, directs that the airborne radioactivity be calculated in microcuries per cubic centimeter after obtaining a reading from the air particulate monitor. None of the candidates knew how to perform the calculation. The licensee said that the intent of that step is for the Radiation Safety Officer to perform that calculation. A step like this, inserted among steps directing the actions of the operator should be clearly indicated as an action to be accomplished by someone else so as to avoid confusing the operator.

4. While talking through how an operator would refill the reactor storage tank, the examiner observed that the refill procedure does not address Valve #16 (See Diagram) which needs to be opened or checked open in order to fill the reactor storage tank. Also, there is ambiguity in the procedure about the filling process. The procedure has the operator check the amount of water in the system by filling the reactor tank without securing the water that is feeding the reactor storage tank. Therefore, a situation could arise where both the reactor storage tank and the reactor tank are being filled simultaneously, thus not meeting the intent of the procedure which is to fill only the reactor storage tank.

- FACILITY RESPONSE

  - The licensee contributed the pre-examination difficulties to communications breakdown and attrition of clerical support in the department.

  - Regarding the key switch issue, the licensee assured the NRC that when the reactor is secured that the key switches are in

the "Off" position and the water is dumped from the reactor tank. During a conversation on December 7, 1989, between Peter Eselgroth, Chief, PWR Section, and D. R. Harris, Director of the RPI Reactor Critical Facility, the NRC was informed that, on December 1, 1989, the licensee installed a new console Power key switch. This new key cannot be withdrawn when this switch is in the "On" position. The Reactor key switch arrangement will be unchanged; but, when the Power key switch is turned off, the Reactor key switch power turns off. Thus, the new Power key switch has become the actual Power/Reactor key, and it cannot be withdrawn without deenergizing both the power and control functions. As a result, the intent of securing the reactor is met, and the reactor cannot be started up without the key being inserted in the console.

- The licensee attributed the unplanned scrams to the old circuitry that is sensitive to humidity as on the day of the operating examination.

- The licensee said the new procedures that will correct the existing procedures - both normal and emergency - should be in place by January 1990, following review and approval by the Nuclear Safety Review Board.

For planning purposes, the licensee requested information regarding the status of non-power reactor licensees developing banks of objective questions for use during initial and requalification examinations. The examiner was unable to provide any information to the licensee at the time of the exit interview.

Attachment 1

Note: Told students to replace "fuel element" with "fuel pin" thru out the exam

*QNUM
*QDAT 1989/09/06
*FAC 225
*RTYP TEST
*EXLV S
*EXMNR SILK, D.
*QVAL 2.0
*SEC H
*KA
*QUESTION
Assume that two different neutron sources were used during two reactor startups. One neutron source, which emits ten times as many neutrons as the other, was used in the first startup. Assume all other factors are the same for the second startup except for the source strength.

a. When criticality is achieved for the two startups, which statement BEST describes the power levels of the two startups?

1. The power levels will be the same
2. The power level will be higher for the first startup
3. The power level will be higher for the second startup
4. There is no set rule for predicting power level

b. When criticality is achieved for the two startups, which statement BEST describes the critical rod positions of the two startups?

1. The rod positions will be the same
2. The first startup will an higher rod position
3. The second startup will have an higher rod position
4. The rod position will depend upon power level at criticality

*ANSWER
a. 2 [1.0]
b. 1 [1.0]
*REFERENCE
Lamarsh, pp 102-104

*QNUM
*QDAT 1989/09/06
*FAC 225
*RTYP TEST
*EXLV S
*EXMNR SILK, D.
*QVAL 1.0
*SEC H
*KA
*QUESTION
With the reactor critical at 10 watts, the operator withdraws the regulating rod a small amount. Reactor power doubles in 24 seconds. HOW MUCH reactivity was added to the core?

a. 0.159% Delta-K/K
b. 0.206% Delta-K/K
c. 0.285% Delta-K/K
d. 0.318% Delta-K/K

*ANSWER
a. [1.0]

*REFERENCE
Equation Sheet

*QNUM
*QDAT 1989/09/06
*FAC 225
*RTYP TEST
*EXLV S
*EXMNR SILK, D.
*QVAL 2.0
*SEC H
*KA
*QUESTION
The following conditions will result in an HIGHER critical rod position than if these conditions did not exist.

a. Bulk pool temperature is increased 30 F
b. The reactor is started up 10 hours after a SCRAM from operating at 100% power for eight hours
c. Two used fuel elements replace two new elements in the core
d. A boron-lined neutron detector is placed next to the core

For each condition listed above, CHOOSE the ONE BEST reason below that will explain the reason for the higher critical rod position.

1. Removal of core reactivity
2. Acts as a better reflector
3. Less effective neutron moderation
4. Xenon
5. Absorbs neutrons that could be reflected
6. Acts as a better neutron moderator
7. Reduces neutron leakage

*ANSWER
a. 3
b. 4
c. 1
d. 5 [0.5 points each]

*REFERENCE
Lamarsh, Chapter 7

*QNUM
*QDAT 1989/09/06
*FAC 225
*RTYP TEST
*SXLV S
*EXMNR SILK, D.
*QVAL 1.0
*SEC H
*KA
*QUESTION
Which of the following conditions will result in an INCREASED amount of shutdown margin for the reactor?

a. Reactor power is increased from 10% to 100% power
b. A safety rod fails to insert during a SCRAM
c. A used fuel element is replaced by a new fuel element
d. A neutron source of twice the strength (identical substance) replaces the present neutron source
e. Two hours after a SCRAM that was preceded by eight hours of 100% power operation

*ANSWER
e. [1.0]

*REFERENCE
Nuclear Reactor Analysis, pp 537-540
SER Sect 4-8

*QNUM
*QDAT 1989/09/06
*FAC 225
*RTYP TEST
*EXLV S
*EXMNR SILK, D.
*QVAL 3.0
*SEC H
*KA
*QUESTION
Consider the following reactor conditions:

Three safety rods are fully withdrawn
Actual reactivity present in the core is minus 4% delta-K/K
Startup channel indication is 100 CPS
An experiment near the core has a reactivity worth of minus 0.5% delta-K/K

The removal of the experiment and a change in the Xenon concentration over time increases the source range indication to 196 CPS. CALCULATE the reactivity contribution from Xenon during this time. SHOW ALL WORK.

*ANSWER
rho1 = K1-1/K1 = -0.04 [0.5]
K1 =1/((1-(-0.04)) = 0.9615 [0.5]
100(1-0.9615) = 196(1-K2), K2 = 0.9804 [0.5]
rho2 = 90.9804-1)/0.9804 = -0.02 [0.5]
Delta rho = rho2 -rho1 = -0.02 - (-0.04) = 0.02 [0.5]
0.02 - 0.005 (experiment) = 0.015 delta-K/K from Xenon [0.5]

*REFERENCE
Equation Sheet

*QNUM
*QDAT 1989/09/06
*FAC 225
*RTYP TEST
*EXLV S
*EXMNR SILK, D.
*QVAL 1.0
*SEC H
*KA
*QUESTION
If the reactor has a Keff of 0.97, HOW MUCH reactivity must be added to make the reactor prompt critical?

a. 0.031 Delta-K/K
b. 0.038 Delta-K/K
c. 0.007 Delta-K/K
d. 0.031% Delta-K/K
e. 0.001 Delta-K/K

*ANSWER
b. [1.0]

*REFERENCE
Lamarsh, pp 250-252

*QNUM
*QDAT 1989/09/06
*FAC 225
*RTYP TEST
*EXLV S
*EXMNR SILK, D.
*QVAL 1.5
*SEC H
*KA
*QUESTION
With the reactor at 100% power, WHICH of the following conditions will result in an increased fuel centerline temperature?

a. Primary circulating pump is turned on
b. Film boiling occurs on the surface of the fuel element
c. Crud build-up on the fuel elements
d. Bowing fuel elements that are in contact

*ANSWER
b, c, and d [0.5 pts each]

*REFERENCE
Lamarsh pp 321-326, 343-350
Murray, Nuclear Energy, pp 137,138

*QNUM
*QDAT 1989/09/06
*FAC 225
*RTYP TEST
*EXLV S
*EXMNR SILK, D.
*QVAL 1.0
*SEC H
*KA
*QUESTION
CHOOSE the ONE answer below that BEST explains the shape of a differential rod worth graph?

a. It is dependent upon the boron concentration in the poison section of the rod

b. It is dependent upon the enrichment of the U-235 in the fuel following section of the rod

c. It is dependent upon reactor power

d. It is dependent upon the neutron flux in the vicinity of the rod

*ANSWER
d. [1.0]

*REFERENCE
SER pg 4-5, Sect 4.1.2
Plant Data, Fig. 6
Lamarsh, p 270

*QNUM
*QDAT 1989/09/06
*FAC 225
*RTYP TEST
*EXLV S
*EXMNR SILK, D.
*QVAL 1.0
*SEC H
*KA
*QUESTION
WHICH ONE of the following reactions occurs to produce source neutrons for the RPI reactor? CHOOSE the BEST ONE.

a. $\alpha + {}^{9}_{4}\mathrm{Be} \rightarrow {}^{12}_{6}\mathrm{C} + {}^{1}_{0}n$

b. $\gamma + {}^{9}_{4}\mathrm{Be} \rightarrow {}^{8}_{4}\mathrm{Be} + {}^{1}_{0}n$

c. $\gamma + {}^{2}_{1}\mathrm{H} \rightarrow {}^{1}_{1}\mathrm{H} + {}^{1}_{0}n$

d. $\alpha + {}^{7}_{3}\mathrm{Li} \rightarrow {}^{10}_{5}\mathrm{B} + {}^{1}_{0}n$

*ANSWER
a. [1.0]

*REFERENCE
SER Sect 7.4

*QNUM
*QDAT 1989/09/06
*FAC 225
*RTYP TEST
*EXLV S
*EXMNR SILK, D.
*QVAL 1.0
*SEC H
*KA
*QUESTION
WHICH ONE of the following BEST describes the process by which heat is removed from the fuel and transferred to the pool.

	Fuel	Clad	Water
a.	1	1	1
b.	2	1	3
c.	1	2	1
d.	1	1	2
e.	1	1	3

NOTE: 1 - Conduction
2 - Radiation
3 - Convection

*ANSWER
e. [1.0]

*REFERENCE
Lamarsh, Chapter 8

*QNUM
*QDAT 1989/09/06
*FAC 225
*RTYP TEST
*EXLV 5
*EXMNR SILK, D.
*QVAL 1.0
*SEC H
*KA
*QUESTION
A centrifugal pump is operated at rated flow when the discharge valve is throttled towards the shut direction. WHICH ONE of the following statements BEST describes the parameter changes that will occur?

a. Flow constant, Discharge pressure constant, motor amps increase, net positive suction (NPSH) head increases

b. Flow decreases, discharge pressure increases, motor amps increase, NPSH increases

c. Flow decreases, discharge pressure increases, motor amps increase, NPSH decreases

d. Flow decreases, discharge pressure increases, motor amps decrease, NPSH increases

*ANSWER
d. [1.0]

*REFERENCE
GER Sect 5.1
Pump Laws

*QNUM
*QDAT 1989/09/06
*FAC 225
*RTYP TEST
*EXLV S
*EXMNR SILK, D.
*QVAL 1.0
*SEC H
*KA
*QUESTION
As the core ages, the ratio of Pu-239 atoms to U-235 atoms increases. This changing ratio causes WHICH ONE of the following?

a. Reactor startup rate (SUR) increases for the same reactivity addition

b. Void coefficient becomes less negative

c. Moderator Temperature Coefficient becomes less negative

d. Delayed neutron fraction increases

*ANSWER
a. [1.0]

*REFERENCE
Nuclear Reactor Analysis, pp 235-237

*QNUM
*QDAT 1989/09/06
*FAC 225
*RTYP TEST
*EXLV S
*EXMNR SILK, D.
*QVAL 1.0
*SEC H
*KA
*QUESTION
WHICH ONE of the following conditions would result in a CONSERVATIVE 1/M plot during fuel loading?

a. Loading fuel in the order of low reactivity worth to high reactivity worth

b. Fuel being loaded closer to a detector than to the neutron source

c. Placing the source next to the detector during the entire refueling

d. L ding the core from the perimeter inward

*ANSWER
b. [1.0]

*REFERENCE
CAF

*QNUM
*QDAT 1989/09/06
*FAC 225
*RTYP TEST
*EXLV S
*EXMNR SILK, D.
*QVAL 1.0
*SEC H
*KA
*QUESTION
WHICH ONE of the following statements BEST describes the production and removal of Xenon-135?

a. At full power, equilibrium conditions, about half of the Xenon is produced by Iodine decay and the other half is produced as a direct fission product

b. Following a reactor SCRAM from equilibrium conditions, Xenon peaks because delayed neutron precursors continue to decay to Xenon while neutron absorption (burnout) has ceased

c. Xenon production and removal increases linearly as power level increases (i.e., the value of 100% equilibrium Xenon is twice that of 50% equilibrium Xenon)

d. At low power levels, Xenon decay is the major removal method. At high power levels, burnout is the major removal method

*ANSWER
d. [1.0]

*REFERENCE
Lamarsh, pp 284-290

*QNUM
*QDAT 1989/09/06
*FAC 225
*RTYP TEST
*EXLV S
*EXMNR SILK, D.
*QVAL 2.0
*SEC H
*KA
*QUESTION
A small experiment sample is in the reactor pool and is currently 1.0 foot under water. A radiation survey meter held at the surface of the water reads 200 mRem/hr. The reading taken one-half hour ago with the sample in the same position was 400 mRem/hr. The time is 8:00 AM.

a. HOW LONG must you wait before the radiation level at the surface of the water drops to 20 mRem/hr assuming that the sample remains at the same position?

1. 1.4 minutes
2. 100 minutes
3. 30 minutes
4. 50 minutes

b. Ignoring buildup, WHAT radiation level would be expected if the sample was raised to the surface at 8:00 AM assuming u is 0.178/inch for water?

1. 0.24 Rem/hr
2. 3.4 Rem/hr
3. 1.7 Rem/hr
4. 0.17 Rem/hr

*ANSWER
a. 2 [1.0]
b. 3 [1.0]

*REFERENCE
Lamarsh, pp 22, 80-85

*end

$f = ma$

$w = mg$

$E = mc^2$

$KE = 1/2\ mv^2$

$PE = mgh$

$V_f = V_o + at$

$W = v\ \Delta P$

$\Delta E = 931\ \Delta m$

$\dot{Q} = \dot{m} C_p \Delta t$

$\dot{Q} = UA\Delta t$

$Pwr = W_f \Delta h$

$P = P_o 10^{sur(t)}$

$P = P_o e^{t/T}$

$SUR = 26.06/T$

$SUR = 26\rho/\ell^* + (\beta - \rho)T$

$T = (\ell^*/\rho) + [(\beta - \rho)/\lambda\rho]$

$T = \ell/(\rho - \beta)$

$T = (\beta - \rho)/(\lambda\rho)$

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

$\rho = [(\ell^*/(T K_{eff})] + [\bar{\beta}_{eff}/(1 + \bar{\lambda}T)]$

$P = (\Sigma\phi V)/(3 \times 10^{10})$

$\Sigma = \sigma N$

$v = s/t$

$s = V_o t + 1/2\ at^2$

$a = (V_f - V_o)/t$

$w = \theta/t$

Cycle efficiency = (Network out)/(Energy in)

$A = \lambda N \qquad A = A_o e^{-\lambda t}$

$\lambda = \ln 2/t_{1/2} = 0.693/t_{1/2}$

$t_{1/2}^{eff} = \dfrac{[(t_{1/2})(t_b)]}{[(t_{1/2}) + (t_b)]}$

$I = I_o e^{-\Sigma x}$

$I = I_o e^{-ux}$

$I = I_o 10^{-x/TVL}$

$TVL = 1.3/u$

$HVL = -0.693/u$

$SCR = S/(1 - K_{eff})$

$CR_x = S/(1 - K_{effx})$

$CR_1(1 - K_{eff1}) = CR_2(1 - K_{eff2})$

$M = 1/(1 - K_{eff}) = CR_1/CR_o$

$M = (1 - K_{effo})/(1 - K_{eff1})$

$SDM = (1 - K_{eff})/K_{eff}$

$\ell^* = 10^{-5}$ seconds

$\bar{\lambda} = 0.1$ seconds^{-1}

$I_1 d_1 = I_2 d_2$

$I_1 d_1^{\ 2} = I_2 d_2^{\ 2}$

$R/hr = (0.5\ CE)/d^2$(meters)

$R/hr = 6\ CE/d^2$ (feet)

Water Parameters

1 gal. = 8.345 lbm.
1 gal. = 3.78 liters
1 ft^3 = 7.48 gal.
Density = 62.4 lbm/ft^3
Density = 1 gm/cm^3
Heat of vaporization = 970 Btu/lbm
Heat of fusion = 144 Btu/lbm
1 Atm = 14.7 psi = 29.9 in. Hg.
1 ft. H_2O = 0.4335 $lbf/in.^2$

Miscellaneous Conversions

1 curie = 3.7×10^{10} dps
1 kg = 2.21 lbm
1 hp = 2.54×10^3 Btu/hr
1 mw = 3.41×10^6 Btu/hr
1 in = 2.54 cm
°F = 9/5°C + 32
°C = 5/9 (°F-32)
1 BTU = 778 ft-lbf

*QNUM
*QDAT 1989/09/06
*FAC 225
*RTYP TEST
*EXLV S
*EXMNR SILK, D.
*QVAL 2.0
*SEC I
*KA
*QUESTION
An area has been roped off and posted with a RADIATION AREA sign. Five feet within the boundary is as experiment that produces a 2500 mRem/hr field at 18 inches. IS the area properly posted? EXPLAIN your answer and show all work.

*ANSWER
I D(sq) = 1 d(sq)
1 = (2500 mRem/hr) (2.25 ft sq) / (25 ft sq)
1 = 225 mRem/hr [1.0]
Area is not properly posted [0.5] because dose rate is greater than 100 mRem/hr [0.5]

*REFERENCE
10 CFR 20.101
10 CFR 20.202

*QNUM
*QDAT 1989/09/06
*FAC 225
*RTYP TEST
*EXLV S
*EXMNR SILK, D.
*QVAL 2.5
*SEC I
*KA
*QUESTION
Work must be performed in a radiation field of 400 mRem/hr gamma and 2.0 Rem/hr fast neutron. The worker is 24 years old and has a lifetime exposure through last quarter of 28 Rem on his NRC Form 4. HOW LONG may the man be permitted to work in this area per 10 CFR 20 limits? Assume that the man has no exposure in the present quarter. Show all wok and state all assumptions.

*ANSWER
5(24-18) = 30 Rem; Lifetime limit = 30 - 28 = 2 Rem [0.5]
With NRC Form 4 on file he is permitted 3 Rem/qtr [0.5]
Lifetime limit is more restrictive [0.5]
0.4 Rem/hr + 2.0 Rem/hr = 2.4 Rem/hr [0.5]
2.0 Rem / (2.4 Rem/hr) = 0.83 hrs = 50 minutes [0.5]

*REFERENCE
10 CFR 20.101
10 CFR 20.202

*QNUM
*QDAT 1989/09/06
*FAC 225
*RTYP TEST
*EXLV S
*EXMNR SILK, D.
*QVAL 1.0
*SEC I
*KA
*QUESTION
If the dead skin layer of a person sufficiently shields against beta radiation, WHY is tritium (a low energy beta emitter) still considered particularly hazardous? CHOOSE the ONE BEST response.

a. Tritium is toxic
b. Tritium is readily present at reactor sites
c. Tritium has a long half-life
d. Tritium is readily taken in by the body by inhalation, ingestion or absorption
e. Tritium is corrosive to reactor components

*ANSWER
d. [1.0]

*REFERENCE
CAF

*QNUM
*QDAT 1989/09/06
*FAC 225
*RTYP TEST
*EXLV S
*EXMNR SILK, D.
*QVAL 2.0
*SEC I
*KA
*QUESTION
If 2 mCi of Ar-41 and 0.1 mCi of H-3 were dispersed throughout the reactor area, WOULD it be safe to remain there? The reactor area volume is 1.98 X 10**9 cc and 1 ml is equal to 1 cc. The MPC for Ar-41 and H-3 are 2 X 10**-6 and 2 X 10**-7 uCi/ml respectively. Show all work and state all assumptions. Refer to SHEET 1 (attached).

*ANSWER
a. 2 X 10**3 uCi / 1.98 X 10**9 cc = 1.01 X 10**-6 uCi/ml [0.5]

b. 0.1 X 10**3 uCi / 1.98 X 10**9 cc = 5.05 X 10**-8 uCi/ml [0.5]

Ca/MPCa + Cb/MPCb < 1 is considered safe

a / 2 X 10**-6 uCi/ml + b / 2 X 10**-7 uCi/ml = 0.76 [0.5]

0.76 < 1; SAFE [0.5]

*REFERENCE
10 CFR 20.103 Appdx B

NOTE: In any case where there is a mixture in air or water of more than one radionuclide, the limiting values for purposes of his Appendix should be determined as follows:

1. If the identity and concentration of each radionuclide in the mixture are known, the limiting values should be derived as ollows: Determine, for each radionuclide in the mixture, the ratio between the quantity present in the mixture and the limit otherwise established in Appendix B for the specific radionuclide when not in a mixture. The sum of such ratios for all the adionuclides in the mixture may not exceed "1" (i.e., "unity")

EXAMPLE: If radionuclides A, B, and C are present in concentrations C_A, C_B, and C_C, and if the applicable MPC's, are MPC_A, and MPC_B, and MPC_C respectively, then the concentrations shall be limited so that the following relationship exists:

$$(C_A/MPC_A)+(C_B/MPC_B)+(C_C/MPC_C) \leq 1$$

2. If either the identity or the concentration of any radionuclide in the mixture is not known, the limiting values for purposes of Appendix B shall be:

a. For purposes of Table I, Col. 1—6×10^{-13}
b. For purposes of Table I, Col. 2—4×10^{-7}
c. For purposes of Table II, Col. 1—2×10^{-14}
d. For purposes of Table II, Col. 2—3×10^{-8}

3. If any of the conditions specified below are met, the corresponding values specified below may be used in lieu of those pecified in paragraph 2 above.

a. If the identity of each radionuclide in the mixture is known but the concentration of one or more of the radionuclides in he mixture is not known the concentration limit for the mixture is the limit specified in Appendix "B" for the radionuclide in the nixture having the lowest concentration limit; or

b. If the identity of each radionuclide in the mixture is not known, but it is known that certain radionuclides specified in ppendix "B" are not present in the mixture, the concentration limit for the mixture is the lowest concentration limit specified n Appendix "B" for any radionuclide which is not known to be absent from the mixture; or

*QNUM
*QDAT 1989/09/06
*FAC 225
*RTYP TEST
*EXLV S
*EXMNR SILK, D.
*QVAL 1.0
*SEC I
*KA
*QUESTION
WHAT can the wearer of a TLD do that will enable a TLD to differentiate different types of radiation exposure to his body? CHOOSE the ONE BEST answer.

a. Wear multiple TLDs
b. Use different filters on the TLD
c. Change the location of the TLD on the body at regular intervals
d. TLDs cannot differentiate between different bodily exposures

*ANSWER
b. [1.0]

*REFERENCE
Personal Safety and Radiation Monitoring (PSRM) manual, p 5

*QNUM
*QDAT 1989/09/06
*FAC 225
*RTYP TEST
*EXLV S
*EXMNR SILK, D.
*QVAL 3.5
*SEC I
*KA
*QUESTION
MATCH the detector in COLUMN A with the appropriate radiation particle it is designed to measure in COLUMN B. More than one response may be required.

COLUMN A	COLUMN B
a. G-M tube	1. Fast neutrons
b. Cutie Pie	2. Alpha
c. BF-3 proportional counter (bare)	3. Low level beta fields
d. Cadmium-paraffin covered BF-3 proportional counter	4. Thermal neutrons
e. Gas filled (Argon & Methane) tube	5. High gamma fields
	6. Low level gamma fields

*ANSWER
a. 3 [0.5], 6 [0.5]
b. 2 [0.5], 5 [0.5]
c. 4 [0.5]
d. 1 [0.5]
e. 1 [0.5]

*REFERENCE
PSRM manual pp 6, 7

*QNUM
*QDAT 1989/09/06
*FAC 225
*RTYP TEST
*EXLV S
*EXMNR SILK, D.
*QVAL 1.5
*SEC I
*KA
*QUESTION
According to the Personal Safety and Radiation Monitoring manual, WHAT are the THREE aspects of shielding the reactor?

*ANSWER
1. Slow down fast neutrons [0.5]
2. Capturing the slowed down neutrons [0.5]
3. Attenuating all forms of gamma radiation [0.5]

*REFERENCE
PSRM manual, p 2

#QNUM
#QDAT 1989/09/06
#FAC 325
#RTYP TEST
#EXLV S
#EXMNR SILK, D.
#QVAL 1.5
#SEC I
#KA
#QUESTION
HOW (quantitatively) will dose change if each variable which affects an individual's dosage were doubled? Consider each separately.

#ANSWER
Time: Dosage will double [0.5]
Distance: Dosage will decrease by 4 [0.5]
Shielding: Dosage will decrease exponentially [0.5]

#REFERENCE
PSRM manual, p 2

```
*QNUM
*QDAT       1989/09/06
*FAC        225
*RTYP       TEST
*EXLV       S
*EXMNR      SILK, D.
*QVAL       1.0
*SEC        I
*KA
*QUESTION
WHICH ONE of the isotopes listed below is the most commonly
expected airborne radioactive effluent  produced at the RPI
reactor?

a.  N-16
b.  I-131
c.  Ar-41
d.  H-3
e.  He-4

*ANSWER
c.  [1.0]

*REFERENCE
SER Sect 11.3
```

*QNUM
*QDAT 1989/09/06
*FAC 225
*RTYP TEST
*EXLV S
*EXMNR SILK, D.
*QVAL 2.5
*SEC I
*KA
*QUESTION
According to the Personal Safety and Radiation Monitoring manual, WHAT are FIVE practices to be followed for obtaining meaningful radiation measurements?

*ANSWER
1. Test the detector with a test source
2. Repeat measurements to verify reproducibility of technique
3. Make measurements of distances as accurately as possible
4. Check if reading is dependant on detector orientation
5. Ascertain effect of environmental factors
6. Use the proper detector for the quantity being measured
7. Examine equipment for modification

[Any five, 0.5 pts each]

*REFERENCE
PSRM manual, pp 8, 9

#QNUM
#QDAT 1989/09/06
#FAC 225
#RTYP TEST
#EXLV 3
#EXMNR SILK, D.
#QVAL 1.0
#SEC I
#KA
#QUESTION
If a radioactive release were to occur from the RPI facility, WHICH ONE of the directions listed would be the MOST likely direction the release would go according to meteorological data?

a. North East
b. North West
c. South East
d. South West

#ANSWER
c. [1.0]

#REFERENCE
SER, p 2-4

*QNUM
*QDAT 1989/09/06
*FAC 225
*RTYP TEST
*EXLV S
*EXMNR SILK, D.
*QVAL 2.0
*SEC I
*KA
*QUESTION
Answer the following questions assuming an extreme radiological emergency has occurred.

a. In accordance with the Personal External Exposure procedure exposures exceeding 10 CFR 20 limits can be approved by (CHOOSE ONLY ONE):

1. Radiation Safety Officer
2. Senior Operator on duty
3. Operations Supervisor
4. Radiation Safety Officer and Operations Supervisor
5. Facility Director

b. The total whole body dose exposure for an adult shall be limited to WHICH ONE of the following:

as per the Personal External Exposure procedure

1. 7.5 Rem
2. 12.5 Rem
3. 18.5 Rem
4. 25.0 Rem
5. 50.0 Rem

*ANSWER
a. 4 [1.0]
b. 2 [1.0]

*REFERENCE
Emergency Procedure, 9.3, Personal External Exposure
*end

*QNUM
*QDAT 1989/09/06
*FAC 225
*RTYP TEST
*EXLV S
*EXMNR SILK, D.
*QVAL 1.0
*SEC J
*KA
*QUESTION
WHICH ONE of the following reactivity coefficients has a peak positive value near the mid axial core position as per the Plant Data?

a. Moderator Temperature Coefficient
b. Boron Coefficient
c. Fuel Temperature Coefficient
d. Void Coefficient

*ANSWER
d. [1.0]

*REFERENCE
Plant Data, Fig 11

#QNUM
#QDAT 1989/09/06
#FAC 225
#RTYP TEST
#EXLV S
#EXMNR SILK, D.
#QVAL 3.0
#SEC J
#KA
#QUESTION
Using Figure 1 from Gamma and Neutron Dosimetry for the RPI Critical Facility and the designated positions listed below. Answer the following questions by selecting ONE position per question.

I.	3	VI.	16
II.	4	VII.	17
III.	8	VIII.	19
IV.	14	IX.	21
V.	15	X.	24

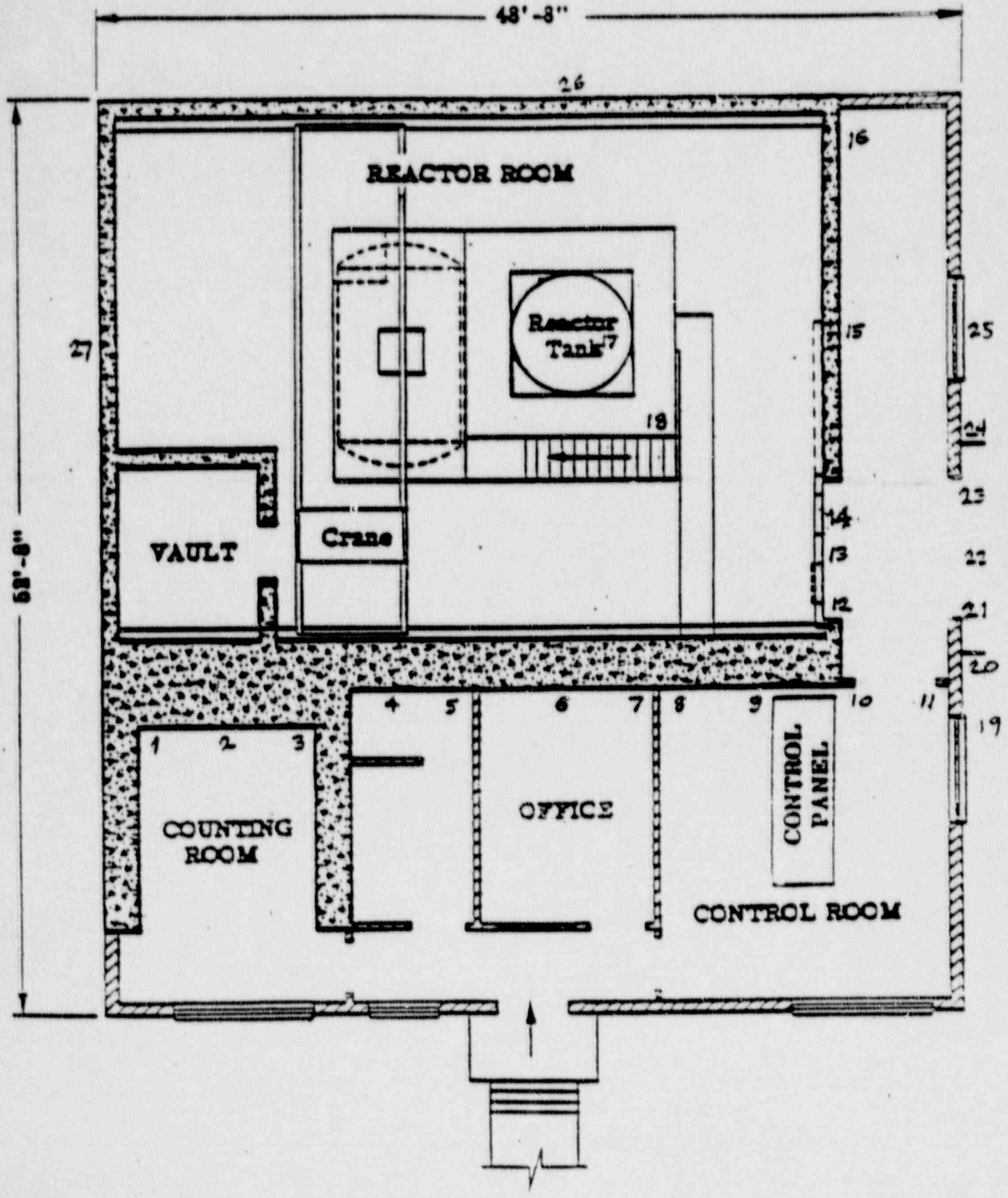
a. WHICH is the hottest spot outside the reactor building while the reactor is at full power?

b. WHICH is the hottest spot when the reactor is shutdown?

c. WHICH is the hottest spot in the reactor building when the reactor is at full power?

#ANSWER
a. IX [1.0]
b. VII [1.0]
c. ~~IV~~ VII [1.0]

#REFERENCE
Gamma and Neutron Dosimetry for the RPI Critical Facility


48'-8"
26
53'-8"
27
REACTOR ROOM
Reactor Tank
17
18
VAULT
Crane
16
15
25
24
23
14
13
22
12
21
20
11
10
19
4
5
6
7
8
9
1
2
3
COUNTING ROOM
OFFICE
CONTROL PANEL
CONTROL ROOM

#QNUM
#QDAT 1989/09/06
#FAC 225
#RTYP TEST
#EXLV S
#EXMNR SILK, D.
#QVAL 3.5
#SEC J
#KA
#QUESTION
MATCH the Interlocks, COLUMN B, to the Actions that will result if the interlock is not satisfied, COLUMN A.

COLUMN A Action	COLUMN B Interlock
a. Prevent control rod motion	1. Reactor console key "ON"
b. Stops water fill	2. Reactor period < 15 sec
c. Reactor SCRAM	3. Neutron Flux 2 CPS
	4. Failure of 400 cycle synchro power supply
	5. Failure of line voltage to recorders
	6. Moderator-Reflector water fill "ON"
	7. Water level in reactor tank 10 + or - 1" above core top grid

#ANSWER
a. 2, 3, 4, 5, 6
b. 7
c. 1 [0.5 pts each]

#REFERENCE
TS Table 2

*QNUM
*QDAT 1989/09/06
*FAC 225
*RTYP TEST
*EXLV S
*EXMNR SILK, D.
*QVAL 1.5
*SEC J
*KA
*QUESTION
WHICH of the following safety channels can be bypassed? More than one response may be required.

a. Log Count Rate
b. Linear Power
c. Log-N: Period
d. Manual SCRAM
e. Building Power
f. Reactor Door SCRAM

*ANSWER
a, c, f [0.5 pts each]

*REFERENCE
TS Table 1

*QNUM
*QDAT 1989/09/06
*FAC 225
*RTYP TEST
*EXLV S
*EXMNR SILK, D.
*GVAL 1.0
*SEC J
*KA
*QUESTION
Listed below are components as depicted on the Control Instrumentation Block Diagram.

1. Logarithmic and Period Amp
2. Solenoid Interrupt Circuit
3. Reactor Key Switch
4. SCRAM Button
5. Intermediate Amp and SCRAM Relays
6. Door Interlock
7. Dump Bypass Key Switch
8. SCRAM Switch
9. Relay to Magnet Power Supply

From the sequences listed below, CHOOSE the ONE sequence that BEST places the components in order from the A/C power supply to the control rod magnetic clutches.

a. 3, 4, 2, 1, 6, 5
b. 3, 6, 4, 9, 2, 8
c. 3, 6, 7, 4, 9, 8
d. 4, 3, 1, 5, 2, 8
e. 4, 6, 7, 2, 8, 5

*ANSWER
b. [1.0]

*REFERENCE
Control Instrumentation Block Diagram

*QNUM
*QDAT 1989/09/06
*FAC 225
*RTYP TEST
*EXLV S
*EXMNR SILK, D.
*QVAL 1.5
*SEC J
*KA
*QUESTION
Following a reactor SCRAM, WHAT THREE conditions must be met prior to starting up the reactor?

*ANSWER
1. Cause of SCRAM has been determined [0.5]
2. Cause of SCRAM corrected [0.5]
3. System returned to the startup condition [0.5]

*REFERENCE
SCRAM Recovery

*QNUM
*QDAT 1989/09/06
*FAC 225
*RTYP TEST
*EXLV S
*EXMNR SILK, D.
*QVAL 1.0
*SEC J
*KA
*QUESTION
A reactor period of _____ (CHOOSE ONE from below) should not be sustained and calls for rod insertion.

a. Infinity
b. - 15 seconds
c. Less than 20 seconds
d. 45 seconds
e. 60 seconds

*ANSWER
c. [1.0]

*REFERENCE
Operating Procedures, step 3

#QNUM
#QDAT 1989/09/06
#FAC 225
#RTYP TEST
#EXLV S
#EXMNR SILK, D.
#QVAL 1.5
#SEC J
#KA
#QUESTION
WHAT are THREE indications or conditions per Operating Procedures that the operator can evaluate to determine if the Keff of the reactor is greater than or equal to 1.0?

#ANSWER
1. Positive reactor period after rod motion is stopped
2. Neutron level or period are not affected by re-insertion and removal of the source
3. Infinite period after rod motion has stopped and source is removed

[0.5 pts each]

#REFERENCE
Operating Procedures , steps 4, 5, 6

#QNUM
#DAT 1989/09/06
#FAC 225
#RTYP TEST
#EXLV S
#EXMNR SILK, D.
#QVAL 1.0
#SEC J
#KA
#QUESTION
During a startup four control rods may be withdrawn simultaneously if (CHOOSE the ONE BEST response):

a. Keff is greater than 0.99
b. Permission is granted from the Senior Operator on duty
c. Under no condition may four rods be withdrawn simultaneously
d. The log count rate interlock is bypassed
e. Source channel has increased by more than one decade from the shutdown condition
f. Source channel has increased by less than one decade from the shutdown condition

#ANSWER
f. [1.0]

#REFERENCE
Operating Procedure step 1

*QNUM
*QDAT 1989/09/06
*FAC 225
*RTYP TEST
*EXLV 3
*EXMNR SILK, D.
*QVAL 1.0
*SEC J
*KA
*QUESTION
While checking the Solenoid Interrupt Circuit parameters during the pre-startup procedure, CHOOSE the ONE set of parameters that BEST describes the normal parameter indications.

	AC Volts	DC Volts	Control Rod Solenoid Current (mA)	Dump Valve Solenoid Current (mA)
a.	200-220	100-120	25-50	50-75
b.	100-120	50-75	90-110	90-110
c.	100-120	100-120	100-120	100-120
d.	100-120	100-120	50-75	90-110
e.	100-120	16-18	100-120	25-50

*ANSWER
d. [1.0]

*REFERENCE
Startup Procedure step 13

#QNUM
#QDAT 1989/09/06
#FAC 225
#RTYP TEST
#EXLV S
#EXMNR SILK, D.
#QVAL 1.0
#SEC J
#KA
#QUESTION
WHICH ONE of the following is indicative that a Major Nuclear Incident has occurred?

a. Area survey meter exceeds 50 mRem/hr
b. One control rod fails to insert on a SCRAM
c. Water leakage has occurred
d. Fire in the reactor building
e. Reactor power spikes to 150% of full power

#ANSWER
1. [1.0]

#REFERENCE
Emergency Procedure, 7.3.5, Radiation Emergency

#QNUM
#QDAT 1989/09/06
#FAC 229
#RTYP TEST
#EXLV S
#EXMNR SILK, J.
#QVAL 1.0
#SEC J
#KA
#QUESTION
WHICH ONE of the following parameters is not directly measured at the RPI facility?

a. Air temperature inside the reactor room
b. Reactor coolant temperature
c. Fuel temperature
d. Particulate activity in the reactor room
e. Reactor tank level

#ANSWER
. [1.0]

#REFERENCE
SER pp 7-3, 7-4

*QNUM
*QDAT 1989/09/06
*FAC 225
*RTYP TEST
*EXLV S
*EXMNR SILK, D.
*QVAL 1.0
*SEC J
*KA
*QUESTION
WHICH ONE of the following is not correct for the ventilation system?

a. Natural Circulation type
b. Single vent to outside stack
c. Equipped with gross particulate and dust filter
d. Reactor room and control room share common ventilation system components

*ANSWER
d. [1.0]

*REFERENCE
SER p 9-2

*end

#QNUM
#QDAT 1989/09/06
#FAC 225
#RTYP TEST
#EXLV S
#EXMNR SILK, D.
#QVAL 2.0
#SEC K
#KA
#QUESTION
In accordance with the Fuel Handling Procedure, care must be taken to prevent contact between the fuel and sharp objects during fuel transfer. LIST FOUR such objects.

#ANSWER
Platform grating
Control rod cap assemblies
Neutron source pig
Unistrut support (0.5 pts each)

#REFERENCE
Operating Procedure, Fuel Handling

*QNUM
*QDAT 1989/09/06
*FAC 225
*RTYP TEST
*EXLV S
*EXMNR SILK, D.
*QVAL 2.5
*SEC K
*KA
*QUESTION
In accordance with Technical Specifications, WHAT is meant by the phrase "REACTOR SECURED"?

*ANSWER
1. Full insertion of all control rods has been verified [0.5]
2. The console key is removed [0.5]
3. No operation in progress which involves moving fuel elements in the reactor vessel [0.5], the insertion or removal of experiments from the reactor vessel [0.5], or control rod maintenance [0.5]

*REFERENCE
TS p 1-2

*QNUM
*QDAT 1989/09/06
*FAC 225
*RTYP TEST
*EXLV S
*EXMNR SILK, D.
*QVAL 1.0
*SEC K
*KA
*QUESTION
In accordance with the Fuel Handling Procedure, fuel transfers from the Vault require the direct control of the _____.
(CHOOSE ONE.)

a. Radiation Safety Officer
b. Chairman of the Nuclear Engineering Department
c. Director of RPI Critical Facility
d. Reactor Supervisor
e. Health Physicist

*ANSWER
a. [1.0]

*REFERENCE
Operating Procedure, Fuel Handling

*QNUM
*QDAT 1989/09/06
*FAC 225
*RTYP TEST
*EXLV S
*EXMNR SILK. D.
*QVAL 1.0
*SEC K
*KA
*QUESTION
WHY is the normal moderator-reflector water level of the reactor established at not greater than 10 inches above the top grid of the core?

*ANSWER
To assure that the water dump will introduce negative reactivity within the time assumed in the safety analysis [1.0]

*REFERENCE
TS p 3-4

*QNUM
*QDAT 1989/09/06
*FAC 225
*RTYP TEST
*EXLV S
*EXMNR SILK, D.
*QVAL 1.0
*SEC K
*KA
*QUESTION
In accordance with the Fuel Handling Procedure, all fuel handling will be accomplished under the supervision of the _____.
(CHOOSE ONE.)

a. Operator on duty
b. Senior operator on duty
c. Health Physicist
d. Radiation Safety Officer
e. Reactor Supervisor

*ANSWER
b. [1.0]

*REFERENCE
Operating Procedure, Fuel Handling

*QNUM
*QDAT 1989/09/06
*FAC 225
*RTYP TEST
*EXLV S
*EXMNR SILK, D.
*QVAL 1.5
*SEC K
*KA
*QUESTION
In accordance with Technical Specifications, WHAT are the conditions that exist when the reactor is considered to be operating?

*ANSWER
Control rods not inserted [0.5] and the reactor not subcritical by at least$ 2.0e [0.5]

or more fuel elements loaded in the core [0.5]

*REFERENCE
TS p 1-2

Deleted

*QNUM
*QDAT 1989/09/06
*FAC 225
*RTYP TEST
*EXLV S
*EXMNR SILK, D.
*QVAL 1.0
*SEC K
*KA
*QUESTION
In accordance with the Fuel Handling Procedure, WHAT must be performed by fuel handlers before proceeding with the transfer?

*ANSWER
Survey the area [0.5] and the fuel [0.5]

*REFERENCE
Operating Procedure, Fuel Handling

*QNUM
*QDAT 1989/09/06
*FAC 225
*RTYP TEST
*EXLV S
*EXMNR SILK, D.
*QVAL 1.0
*SEC K
*KA
*QUESTION
WHICH TWO of the design features listed below have the primary function of ensuring that if the fuel storage vault were filled to capacity and were to be completely flooded that the configuration would not become critical?

a. Geometry of the configuration
b. Boron lined walls surrounding the vault
c. Cadmium metal bolted to the frame in parallel rows
d. Poor neutron reflective properties of the reinforced concrete
e. Criticality monitor

*ANSWER
a. [0.5] and c. [0.5]

*REFERENCE
SER p 6-1
TS p 5-3

*QNUM
*QDAT 1989/09/06
*FAC 225
*RTYP TEST
*EXLV S
*EXMNR SILK, D.
*QVAL 1.0
*SEC K
*KA
*QUESTION
WHICH ONE of following is the maximum core excess reactivity limit?

a. $0.12
b. $0.40
c. $0.60
d. $1.00
e. $4.33

*ANSWER
c. [1.0]

*REFERENCE
SER p 4-8
TS p 3-1

*QNUM
*QDAT 1989/09/06
*FAC 225
*RTYP TEST
*EXLV S
*EXMNR SILK, D.
*QVAL 1.0
*SEC K
*KA
*QUESTION
WHICH ONE of the following is the reactivity worth of the four control rods when removed as a bank?

a. $0.41
b. $1.00
c. $1.49
d. $2.43
e. $4.33

*ANSWER
e. [1.0]

*REFERENCE
SER p 4-8

*QNUM
*QDAT 1989/09/06
*FAC 225
*RTYP TEST
*EXLV S
*EXMNR SILK, D.
*QVAL 1.0
*SEC K
*KA
*QUESTION
WHICH ONE of the following is the maximum reactivity worth of unsecured experiments?

a. $0.12
b. $0.40
c. $0.60
d. $1.00
e. $1.49

*ANSWER
c. [1.0]

*REFERENCE
SER p 4-8
TS p 3-7

*QNUM
*QDAT 1989/09/06
*FAC 225
*RTYP TEST
*EXLV S
*EXMNR SILK, D.
*QVAL 2.0
*SEC K
*KA

Deleted

*QUESTION
Using the following figure answer the following questions.

a. WHAT does the number inside the boxes indicate?

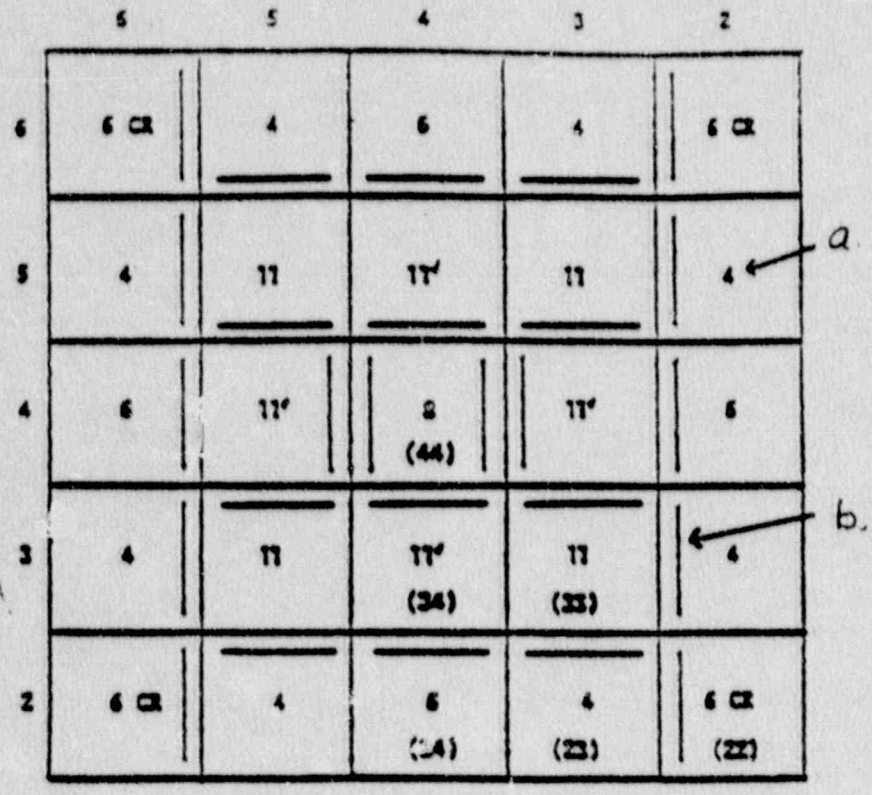
1. Average U-235 enrichment of the assembly
2. Number of grams of U-235 in the assembly
3. Number of fuel plates in the assembly
4. Number of years the assembly has been in the core
5. Reactivity worth in cents of the assembly

b. WHAT does the line inside the boxes indicate?

1. Location of highest enriched plate in the assembly
2. Location and orientation of slot #1
3. Location of lowest enriched plate in the assembly
4. Location of newest plate in the assembly
5. Location of burnable poison in the assembly

*ANSWER
a. 3 [1.0]
b. 2 [1.0]

*REFERENCE
SER pp 4-5, 4-6


5
5
4
3
2
6
5
3
2
a.
b.
6 ck
4
6
4
6 ck
4
11
11'
11
4
6
11'
8
(44)
11'
6
4
11
11'
(34)
11
(33)
4
6 ck
4
6
(24)
4
(23)
6 ck
(22)

*QNUM
*QDAT 1989/09/06
*FAC 225
*RTYP TEST
*EXLV S
*EXMNR SILK, D.
*QVAL 1.0
*SEC K
*KA
*QUESTION
Listed below are core components.

1. Foil exposure port
2. Control rod basket
3. Carrier plate
4. Control rod guide and bushing
5. Reactor core and reflector support plate
6. Top plate and grid assembly

WHICH ONE set of the components listed below BEST represents how the components would be ordered as going from the top of the reactor tank to the bottom?

a. 6, 1, 2, 3, 4, 5
b. 2, 6, 1, 5, 3, 4
c. 4, 2, 6, 3, 1, 5
d. 1, 2, 3, 6, 4, 3
e. 3, 4, 2, 6, 1, 5

*ANSWER
b. [1.0]

*REFERENCE
SER Fig 4.2

#QNUM
#QDAT 1989/09/06
#FAC 225
#RTYP TEST
#EXLV S
#EXMNR SILK, D.
#QVAL 1.0
#SEC K
#KA
#QUESTION
In accordance with Technical Specifications, for a known system, up to a quadrant of fuel elements may be removed from the core or a single stationary fuel element be replaced with another stationary element only under five of the following conditions. WHICH TWO are not required?

a. The critical rod bank position is checked after the operation is complete
b. The net change in reactivity has been previously determined to be negative or is less than 0.72$
c. There is initially only one vacant position within the active fuel lattice
d. A licensed operator must be at the console monitoring nuclear instrumentation
e. The reactor is subcritical by at least 2.86$
f. The nuclear instrumentation is on scale and the dump valve is not bypassed
g. All area radiation monitors must be operable

#ANSWER
d. [0.5] and g. [0.5]

#REFERENCE
TS p 5-4

Deleted

*QNUM
*QDAT 1989/09/06
*FAC 225
*RTYP TEST
*EXLV S
*EXMNR SILK, D.
*QVAL 1.0
*SEC K
*KA
*QUESTION Two
WHICH ~~ONE~~ of the following substances is NOT present in the RPI reactor control rods?

a. Boron
b. Iron
c. Stainless Steel
d. U-235
e. Aluminum

*ANSWER
e. ~~[1.0]~~ [0.5] and d. [0.5]

*REFERENCE
SER, p 4-5, Sect 4.1.2
*end

*QNUM
*QDAT 1989/09/06
*FAC 225
*RTYP TEST
*EXLV S
*EXMNR SILK, D.
*QVAL 1.5
*SEC L
*KA
*QUESTION
MATCH the phrases listed below (a, b, c) with the correct definition (1-7) that follows.

a. Channel Check
b. Channel Test
c. Channel Calibration

1. The combination of sensor, lines, amplifiers, and output devices which are connected for the purpose of measuring the value of a process variable

2. The correlation of channel outputs to known input signals and other known parameters and shall encompass the entire channel, including equipment actuation, alarm, or trip

3. The value of the process variable as it appears on the output of a measuring channel

4. The injection of simulated signal into the instrument primary sensor to verify the proper instrument response alarm and/or initiating action

5. The actual value at any instant of a process variable

6. Combination of safety channels and associated circuitry which forms the automatic protective system for the reactor or [illegible] to be initiated

7. Qualitative determination of acceptable operability by observation of instrument behavior during operation and shall include, where possible, comparison of the instrument with other independent instruments measuring the same variable

*ANSWER
a. 7 [0.5]
b. 4 [0.5]
c. 2 [0.5]

*REFERENCE
TS Section 1.0

*QNUM
*QDAT 1989/09/06
*FAC 225
*RTYP TEST
*EXLV S
*EXMNR SILK, D.
*QVAL 1.0
*SEC L
*KA
*QUESTION
As per the Radiation Emergency procedure, WHO has authority to bypass the water dump and under WHAT condition can this be done?

*ANSWER
Senior operator [0.5] if it is determined that water shielding is beneficial [0.5]

*REFERENCE
Emergency Procedure p 12

*QNUM
*QDAT 1989/09/06
*FAC 225
*RTYP Test
*EXLV S
*EXMNR SILK, D.
*QVAL 2.0
*SEC L
*KA
*QUESTION
In accordance with the Emergency Response procedure, answer the following questions.

a. Upon sounding the emergency alarm, WHERE are all the personnel at the RCF to assemble? (CHOOSE ONE.)

1. Counting Room
2. Control Room
3. Front Gate on Maxon Road
4. RCF Office
5. Outside in front of the RCF

b. If an evacuation is deemed necessary, WHERE are personnel to assemble? (CHOOSE ONE.)

1. Counting Room
2. Control Room
3. Front Gate on Maxon Road
4. RCF Office
5. Outside in front of the RCF

*ANSWER
a. 1 [1.0]
b. 3 [1.0]

*REFERENCE
Emergency Plan, Emergency Response

#QNUM
#QDAT 1989/09/06
#FAC 225
#RTYP TEST
#EXLV S
#EXMNR SILK, D.
#QVAL 1.0
#SEC L
#KA
#QUESTION
In accordance with the Emergency Plan, WHO does the operating Staff call in the occurrence of an Abnormal Event? (CHOOSE ONE.)

a. Radiation Safety Officer
b. Facility Supervisor
c. Facility Director
d. Campus Security
e. Health Physics

#ANSWER
b. [1.0]

#REFERENCE
Emergency Plan Figure 1

*QNUM
*QDAT 1989/09/06
*FAC 225
*RTYP TEST
*EXLV S
*EXMNR SILK, D.
*QVAL 1.0
*SEC L
*KA
*QUESTION
Listed below are the Emergency Priorities as stated in the Emergency Procedures.

1. Extent of damage to RCF and equipment should be minimized
2. Procedures be complete but simple
3. Human Safety
4. Prevent spread of hazards associated with accident conditions

WHICH ONE set of Priorities listed below is in the order of highest to lowest priority?

a. 3, 1, 4, 2
b. 3, 4, 1, 2
c. 4, 3, 2, 1
d. 1, 3, 4, 2
e. 4, 3, 1, 2

*ANSWER
b. [1.0]

*REFERENCE
Emergency Procedure p 3

*QNUM
*QDAT 1989/09/06
*FAC 225
*RTYP TEST
*EXLV S
*EXMNR SILK, D.
*QVAL 2.0
*SEC L
*KA
*QUESTION
After completing work on a control rod drive while the reactor was at 20% power, the technician asks the Senior operator for permission to use the rod control to move the rod to test the work which had just been completed. EXPLAIN WHY or WHY NOT this request can be granted.

*ANSWER
The request should be denied [0.5] because only licensed individuals [0.5] or individuals in training under the supervision of a licensed operator [0.5] are allowed to manipulate the controls that affect the reactivity of the core [0.5].

*REFERENCE
10 CFR 55.4, 13

*QNUM
*QDAT 1989/09/06
*FAC 225
*RTYP TEST
*EXLV S
*EXMNR SILK, D.
*QVAL 1.0
*SEC L
*KA
*QUESTION
Following a safety limit violation, WHO can authorize the resumption of reactor operations? (CHOOSE ONE.)

a. NSRB
b. Dean of Engineering
c. Facility Director
d. NRC
e. American Nuclear Insurers
f. Governor of New York

*ANSWER
d. [1.0]

*REFERENCE
TS 6.4.1

*QNUM
*QDAT 1989/09/06
*FAC 225
*RTYP TEST
*EXLV S
*EXMNR SILK, D.
*QVAL 2.5
*SEC L
*KA
*QUESTION
As defined in Technical Specifications, LIST FIVE conditions that are considered Reportable Occurrences.

*ANSWER
1. LSSS exceeds setting
2. LCO exceeded
3. Unplanned or uncontrolled radiation release from restricted area
4. Safety system component failure
5. Degradation of a fission product barrier
6. Uncontrolled or unanticipated change in reactivity greater than $0.~~70~~ 60
7. Natural or manmade event that affects or threatens to affect safe operation
8. Inadequate controls that could lead to unsafe conditions

[Any five, 0.5 pts each]

*REFERENCE
TS Section 1.0

*QNUM
*QDAT 1989/09/06
*FAC 225
*RTYP TEST
*EXLV S
*EXMNR SILK. D.
*QVAL 1.0
*SEC L
*KA

Deleted

*QUESTION
WHAT are the safety limits? (CHOOSE ONE.)

	Power Level (Watts)	Integrated Power (KW-hr)	Min Period (Sec)	Min Flux Level (CPS)	Max Tank Level (Inches above top grid)
a.	135	200	2	5	10
b.	270	200	5	2	-
c.	135	-	5	2	10
d.	270	200	-	-	-
e.	270	200	-	-	~10
f.	135	-	5	2	-

*ANSWER
d. [1.0]

*REFERENCE
TS Section 2.0

*QNUM
*QDAT 1989/09/06
*FAC 225
*RTYP TEST
*EXLV S
*EXMNR SILK, D.
*QVAL 1.0
*SEC L
*KA
*QUESTION
Substantive changes to procedures required by Technical Specifications shall be made only with the prior approval of the _____. (CHOOSE ONE.)

a. Operations Supervisor
b. Facility Director
c. Chairman of the NSRB
d. NSRB
e. Radiation Safety Officer
f. NRC

*ANSWER
d. [1.0]

*REFERENCE
TS 6.2

*QNUM
*QDAT 1989/09/06
*FAC 225
*RTYP TEST
*EXLV S
*EXMNR SILK, D.
*QVAL 1.0
*SEC L
*KA
*QUESTION
Temporary nonsubstantive changes to procedures may be made with the approval of the _____. (CHOOSE ONE.)

a. Operations Supervisor
b. The operator at the console
c. Facility Director
d. NSRB
e. Radiation Safety Officer
f. Senior operator on duty

*ANSWER
a. [1.0]

*REFERENCE
TS 6.2

*QNUM
*QDAT 1989/09/06
*FAC 225
*RTYP TEST
*EXLV S
*EXMNR SILK, D.
*QVAL 1.0
*SEC L
*KA
*QUESTION
WHAT actions shall be performed in the event of a safety limit violation?

*ANSWER
1. Shutdown the reactor
2. Notify RCF management
3. Notify NRC
4. Prepare a safety limit violation report

*REFERENCE
TS 6.4.1

*QNUM
*QDAT 1989/09/06
*FAC 225
*RTYP TEST
*EXLV S
*EXMNR SILK, D.
*QVAL 3.0
*SEC L
*KA
*QUESTION
According to Technical Specification 3.3, Radiation Monitoring, WHAT is the minimum complement of radiation monitoring equipment required to be operating for reactor operation?

*ANSWER Following detectors shall be provided
1. ~~Criticality detector system~~ [0.5]
2. Area gamma monitoring system for
   Control room [0.5]
   Reactor room near fuel vault [0.5] (criticality monitor)
   Reactor room (high level monitor) [0.5]
   Reactor room window [0.5]
3. Particulate activity monitor for reactor room [0.5]

*REFERENCE
TS 3.3

*end

Attachment 2

NRC Changes to the Written Examination

Question No.	Change/Reason
As appropriate	The candidates were informed that where the words "fuel element(s)" appear to replace them with the words "fuel pin(s)" because the reference material was not clear as to which (elements or pins) is used in the core.
H.10	The candidates were informed that choice c. was changed to 1 2 1 instead of 1 1 1 to correct a typographical error.
I.12.b	The candidates were informed to answer the question in accordance with the RPI Personal External Exposure procedure to elicit the desired response.
J.02.a	The candidates were informed to answer the question in regard to the reactor building instead of the reactor to clarify the question.
J.02.c	The answer was changed to "VII" to correct the answer key.
J.10	The candidates were informed that the currents were in units of milli-amps.
K.03	Since the question could be interpreted in more than one way, it has been deleted.
K.12	The question was deleted because the figure of the core map is no longer applicable. The reference material was not clear as to what type of fuel is presently used in the core.
K.14	The question was deleted because it required detailed memorization of a Technical Specification related to an infrequent evolution.
K.15	The candidates were informed to change the word "ONE" to "TWO" to elicit the desired responses.
L.08	Answer 5 was changed to $0.60 instead of $0.70 to correct a typographical error.
L.09	The question was deleted because there was no correct answer provided as a choice.

L.13 Will require in the answer "Portable detectors shall be provided" and mention must be made of the requirement of a criticality monitor or that the reactor room area monitor near the fuel vault doubles as the criticality monitor.

Figure 1. PIPING DIAGRAM. Critical Facility at RPI.