July 21, 2003

Dr. Gunter Kegel, Director
Nuclear Radiation Laboratory
University of Massachusetts — Lowell
One University Avenue
Lowell, MA 01854

SUBJECT: INITIAL EXAMINATION REPORT NO. 50-223/OL-03-01, UNIVERSITY OF MASSACHUSETTS–LOWELL

Dear Dr. Kegel:

During the week of June 16, 2003, the NRC administered an operator licensing examination at your University of Massachusetts–Lowell Reactor. The examination was conducted according to NUREG-1478, "Non-Power Reactor Operator Licensing Examiner Standards," Revision 1. Examination questions and preliminary findings were discussed with those members of your staff identified in the enclosed report at the conclusion of the examination.

In accordance with 10 CFR 2.790 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 Paul Doyle at (301) 415-1058 or via internet E-mail at pvd@nrc.gov.

Sincerely,

/RA/

Patrick M. Madden, Section Chief
Research and Test Reactors Section
New, Research and Test Reactors Program
Division of Regulatory Improvement Programs
Office of Nuclear Reactor Regulation

Docket No. 50-223

Enclosures: 1. Initial Examination Report No. 50-223/OL-03-01
2. Examination and answer key (RO/SRO)

cc w/encls:
Please see next page

cc:

Mayor of Lowell
City Hall
Lowell, MA 01852

Mr. Leo Bobek
Reactor Supervisor
University of Massachusetts - Lowell
One University Avenue
Lowell, MA 01854

Office of the Attorney General
Environmental Protection Division
19th Floor
One Ashburton Place
Boston, MA 02108

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

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<u>DISTRIBUTION</u> w/ encls.:

PUBLIC	RNRP R&TR r/f	PMadden
MMendonca	Facility File (EBarnhill) O-6 D-17	

ADAMS ACCESSION #: ML031970156 **TEMPLATE NO.: NRR-074**

OFFICE	RNRP:CE		IEHB:LA	E	RNRP:SC	
NAME	PDoyle:rdr		EBarnhill		PMadden	
DATE	07/ 16 /2003		07/ 16 /2003		07/ 21 /2003	

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

REPORT NO.: 50-223/OL-03-01

FACILITY DOCKET NO.: 50-223

FACILITY LICENSE NO.: R-125

FACILITY: University of Massachusetts – Lowell

EXAMINATION DATES: June 17-18, 2003

SUBMITTED BY: ***/RA/*** 07/02/2003
Paul Doyle, Chief Examiner Date

SUMMARY:

During the week of June 16, 2003, the NRC administered operator licensing examinations to two Reactor Operator license candidates and one Senior Operator license candidate. All three license candidate passed all portions of the examinations administered.

REPORT DETAILS

1. Examiners:
   Paul Doyle, Chief Examiner

2. Results:

	RO PASS/FAIL	SRO PASS/FAIL	TOTAL PASS/FAIL
Written	2/0	0/0	2/0
Operating Tests	2/0	1/0	3/0
Overall	2/0	1/0	3/0

3. Exit Meeting:
   Paul Doyle, Examiner, NRC
   Leo Bobek, Reactor Supervisor, Univ. of Massachusetts-Lowell
   Thomas Regan, Reactor Engineer, University of Massachusetts-Lowell

   Following the administration of the operating tests, the examiner met with facility management to discuss the examination. The facility committed to submitting comments on the written examination by e-mail, within 5 days. The examiner related that all three candidates were very well prepared, giving well thought out answers promptly.

UNIVERSITY OF MASSACHUSETTS-LOWELL

With Answer Key

UNITED STATES NUCLEAR REGULATORY COMMISSION

OPERATOR LICENSING
EXAMINATION

June 17, 2003

Enclosure 2

QUESTION A.1 [1.0 point]
Core excess reactivity changes with …

a. fuel element burnup

b. control rod height

c. neutron energy level

d. reactor power level

QUESTION A.2 [1.0 point]
You're increasing reactor power on a steady +26 second period. How long will it take to increase power by a factor of 1000?

a. 60 seconds (1 minute)

b. 180 seconds (3 minutes)

c. 300 seconds (5 minutes)

d. 480 seconds (8 minutes)

QUESTION A.3 [1.0 point]
The delayed neutron precursor (β) for U^{235} is 0.0065. However, when calculating reactor parameters you use β_{eff} with a value of ~0.0070. Why is β_{eff} larger than β?

a. Delayed neutrons are born at higher energies than prompt neutrons resulting in a greater worth for the neutrons.

b. Delayed neutrons are born at lower energies than prompt neutrons resulting in less leakage during slowdown to thermal energies.

c. The fuel also contains U^{238} which has a relatively large β for fast fission.

d. U^{238} in the core becomes Pu^{239} (by neutron absorption), which has a higher β for fission.

QUESTION A.4 [1.0 point]
The difference between a moderator and a reflector is that a reflector …

a. increases the fast non-leakage factor and a moderator increases the thermal utilization factor.

b. increases the neutron production factor and a moderator increases the fast fission factor.

c. increases the neutron production factor and a moderator decreases the thermal utilization factor.

d. decreases the fast non-leakage factor and a moderator increases the thermal utilization factor.

QUESTION A.5 [1.0 point]
Which of the following atoms will cause a neutron to lose the most energy during an elastic scattering reaction?

a. O^{16}

b. C^{12}

c. U^{235}

d. H^{1}

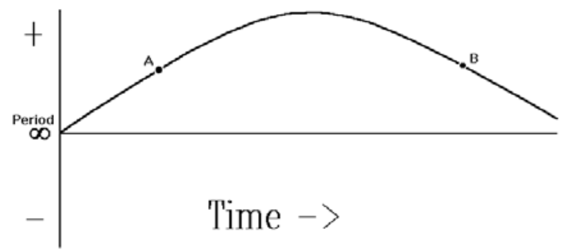
QUESTION A.6 [1.0 point]
Shown below is a trace of reactor period as a function of time. Between points A and B reactor power is:

a. continually increasing.

b. continually decreasing.

c. increasing, then decreasing.

d. constant.



QUESTION A.7 [1.0 point]
INELASTIC SCATTERING is the process by which a neutron collides with a nucleus and …

a. recoils with the same kinetic energy it had prior to the collision.

b. is absorbed, with the nucleus emitting a gamma ray, and the neutron with a lower kinetic energy.

c. is absorbed, with the nucleus emitting a gamma ray.

d. recoils with a higher kinetic energy than it had prior to the collision with the nucleus emitting a gamma ray.

QUESTION A.8 [1.0 point]
Which ONE of the following is an example of alpha decay?

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

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

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

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

QUESTION A.9 [1.0 point]
Which ONE of the following is the reason for the -80 second period following a reactor scram?

a. The ability of U^{235} to fission source neutrons.

b. The half-life to the longest-lived group of delayed neutron precursors is 55 seconds.

c. The amount of negative reactivity added on a scram is greater than the shutdown margin.

d. The Doppler effect, which adds positive reactivity due to the temperature decrease following a scram.

QUESTION A.10 [1.0 point]
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 target nucleus mass increases

d. decreases as target nucleus mass increases

QUESTION A.11 [1.0 point]
WHICH ONE of the following is the MAJOR source of energy released during fission?

a. Kinetic energy of the fission neutrons.

b. Kinetic energy of the fission fragments.

c. Decay of the fission fragments.

d. Prompt gamma rays.

QUESTION A.12 [1.0 point]
Which ONE of the following is the reason for an installed neutron source within the core? A startup without an installed neutron source …

a. is impossible as there would be no neutrons available to start up the reactor.

b. would be very slow due to the long time to build up neutron population from so low a level.

c. could result in a very short period due to the reactor going critical before neutron population built up high enough to be read on nuclear instrumentation.

d. can be compensated for by adjusting the compensating voltage on the source range detector.

QUESTION A.13 [1.0 point]
Several processes occur that may increase or decrease the available number of neutrons. SELECT from the following the six-factor formula term that describes an INCREASE in the number of neutrons during the cycle.

a. Thermal utilization factor.

b. Resonance escape probability.

c. Thermal non-leakage probability.

d. Reproduction factor.

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

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

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

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

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

QUESTION A.15 [1.0 point]
By definition, an exactly critical reactor can be made prompt critical by adding positive reactivity equal to …

a. the shutdown margin

b. the K_{excess} margin

c. the β_{eff} value

d. 1.0 %ΔK/K.

QUESTION A.16 [1.0 point]
The number of neutrons passing through a one square centimeter of target material per second is the definition of which one of the following?

a. Neutron Population (np)

b. Neutron Impact Potential (nip)

c. Neutron Flux (nv)

d. Neutron Density (nd)

QUESTION A.17 [1.0 point]
Reactor power doubles in 42 seconds. Based on the period associated with this transient, how long will it take for reactor power to increase by a factor of 10?

a. 80 seconds

b. 110 seconds

c. 140 seconds

d. 170 seconds

QUESTION A.18 [1.0 point]
Which ONE of the following is the correct reason that delayed neutrons enhance control of the reactor?

a. There are more delayed neutrons than prompt neutrons.

b. Delayed neutrons increase the average neutron generation time.

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

d. Delayed neutrons take longer to reach thermal equilibrium.

QUESTION A.19 [1.0 point]
Regulating rod worth for a reactor is 0.001 ΔK/K/inch. Moderator temperature **INCREASES** by 9°F, and the regulating rod moves 4½ inches inward to compensate. The moderator temperature coefficient α_{Tmod} is …

a. $+5 \times 10^{-4}$ ΔK/K/°F

b. -5×10^{-4} ΔK/K/°F

c. $+2 \times 10^{-5}$ ΔK/K/°F

d. -2×10^{-5} ΔK/K/°F

QUESTION A.20 [1.0 point]
K_{eff} is K_{∞} times …

a. the fast fission factor (ε)

b. the total non-leakage probability ($\mathscr{L}_f \times \mathscr{L}_{th}$)

c. the reproduction factor (η)

d. the resonance escape probability (p)

QUESTION B.1 [1.0 point]
An experiment irradiated in the pool reads 50mr/hr at 2 feet below the pool surface and 100 mr/hr at 1 foot below the pool surface. You decide to place the experiment at 20 feet below the surface of the pool. Based on the attenuation you noted between the 2 foot and 1 foot levels, you would expect the shielding due to 20 feet of water to reduce the dose by a factor of approximately … (Note: Ignore dose decrease due to distance.)

a. 1000

b. 10,000

c. 100,000

d. 1,000,000

QUESTION B.2 [2.0 points, 0.4 each]
As a licensed reactor operator you will be responsible for ensuring the correctness of Irradiation Request Forms (IRFs). To do this you must know your technical specification reactivity limits. Match the terms listed in column A with the respective reactivity limit from column B. (Note: “Significant Reactivity” is defined as the amount of reactivity which may be added to the core by someone without an RO license. Only one answer for each item in column A. Items in column B may be used more than once or not at all.)

Column A	Column B
a. Significant Reactivity	1. 0.02% ΔK/K
b. Single Moveable	2. 0.025%ΔK/K
c. Total Moveable	3. 0.05%ΔK/K
d. Single Secured	4. 0.1%ΔK/K
e. Total Secured	5. 0.2%ΔK/K
	6. 0.25%ΔK/K
	7. 0.5%ΔK/K
	8. 2.0%ΔK/K
	9. 2.5%ΔK/K

QUESTION B.3 [1.0 point]
After a reactor scram, neither you nor the SRO have been able to determine the cause of the scram. What is the minimum level of management who may authorize restart of the reactor under this condition?

a. The Senior Reactor Operator on his/her own.

b. The Senior Reactor Operator on consultation with either the Chief Reactor Operator or the Reactor Supervisor.

c. The Chief Reactor Operator after consultation with the Reactor Supervisor.

d. The Reactor Supervisor after consultation with the Reactor Director.

QUESTION B.4 [1.0 point]
Which ONE of the following classifications for an emergency is not credible for the U. Mass.-Lowell reactor? (Note: Items are listed alphabetically, **NOT** in order of severity!)

a. Alert

b. Non-Reactor Safety Related Event

c. Notification of Unusual Event

d. Site Area Emergency

QUESTION B.5 [1.0 point]
While working on an experiment, you receive the following radiation doses: 100 mrem (β), 25 mrem (γ), and 5 mrem (thermal neutrons). Which ONE of the following is your total dose?

a. 175 mrem

b. 155 mrem

c. 145 mrem

d. 130 mrem

QUESTION B.6 [1.0 point]
Following work in a drained pool, whose permission (minimum) is required to use the primary system for refill?

a. None, this is the normal method for refill.

b. The Chief Reactor Operator.

c. The Reactor Supervisor.

d. The Reactor Director.

QUESTION B.7 [1.0 point]
During a normal reactor startup, the neutron source is normally removed at …

a. 500 milliwatts

b. 5 watts

c. 50 watts

d. 500 watts

QUESTION B.8 [2.0 point, 0.5 each]
Identify each of the following as either a Safety Limit (SL), a Limiting Safety System Setting (LSSS) or as a Limiting Condition for Operations (LCO).

a. ~~1250 gpm Primary Flow~~ To correct this choice to a LSSS, change 1250 to 1170

b. 24 feet of water above core centerline.

c. 110°F Reactor Inlet Temperature (T_P)

d. 1.25 Megawatts

QUESTION B.9 [2.0 points, 0.5 each]
Identify whether each of the following reactor experiments has no special requirements (NR), requires Double encapsulation (DOUBLE), or is Not Authorized (NA).

a. Corrosive Materials

b. Cryogenic Materials

c. contains 1.6 milligrams of explosive material

d. the calculated temperature outside the capsule will be 110°C.

QUESTION B.10 [1.0 points, 0.25 each]
Identify the source for the listed radioisotopes. Irradiation of air, water, structural material or fission product.

a. N^{16}

b. Na^{24}

c. Ar^{41}

d. Xe^{188}

QUESTION B.11 [1.0 point]
The CURIE content of a radioactive source is a measure of

a. the number of radioactive atoms in the source.

b. the amount of energy emitted per unit time by the source

c. the amount of damage to soft body tissue per unit time.

d. the number of nuclear disintegrations per unit time.

QUESTION B.12 [1.0 point]
Consider two point sources, each having the SAME curie strength. Source A's gammas have an energy of 0.5 MeV, while Source B's gammas have an energy of 1.0 MeV. Using a Geiger-Müller detector the reading from source B will be … (NOTE: Ignore detector efficiency.)

a. four times that of source A.

b. twice that of source A.

c. the same.

d. half that of source A.

QUESTION B.13 [1.0 point]
Which ONE of the following conditions is an Reportable Occurrence per the Technical Specification definition?

a. Operation of the reactor with a minimum shutdown margin (Xenon free, with the most reactive rod in the fully withdrawn position) of 3.0% $\Delta k/k$.

b. Operation of the reactor with valve "H, Acid Vent (Basement)" out of service with the valve in the closed position.

c. Operation of the reactor with the Continuous Air Monitor (CAM) on the experimental level out of service. The CAM on the pool level is operating fine.

d. Operation of the reactor with a pool level of 25 ft. above the centerline of the core.

QUESTION B.14 [1.0 point, 0.25 each]
Identify the correct number which correctly defines the maximum period between testing intervals per the Technical Specifications definitions.

a. Weekly: ___ days

b. Monthly: ___ weeks

c. Quarterly: ___ months

d. Annually: ___ months

QUESTION B.15 [1.0 point]
Which ONE of the following is the definition of a CHANNEL TEST?

a. the combination of sensor, line, amplifier, and output devices which are connected for the purpose of measuring the value of a parameter

b. an adjustment of the channel such that it output corresponds with acceptable accuracy to known values of the parameter which the channel measures. Calibration shall encompass the entire channel, Including equipment actuation, alarm, or 'trip and shall be deemed to include a channel test

c. a qualitative verification of acceptable performance by observation of channel behavior.' This verification, where possible, shall Include comparison of the channel with other Independent channels or systems measuring the same variable.

d. the introduction of a signal into the channel for verification that It Is operable.

QUESTION B.16 [1.0 point]
During a reactor start-up the console operator is withdrawing a control blade and notices that the position indicator for the control blade is not changing. Select the operator action for these conditions.

a. Attempt to insert the control blade whose position indicator was not changing during blade withdrawal.

b. Continue the reactor start-up. Level power at 1 watt and investigate the cause.

c. Verify that source range counts are not changing.

d. Run the other unstuck blades and the Regulating Rod fully in.

QUESTION B.17 [1.0 point]
Which one of the following statements concerning operation of the crane is NOT CORRECT? The crane may be used …

A. to lower fuel shipping casks into the bulk pool, providing the gate is in place in the stall pool.

B. to move shipping casks over the stall pool.

C. to pull equipment sideways.

D. with slings.

QUESTION C.1 [1.0 point]
Which one of the following valves does NOT receive a signal in response to a ventilation freeze alarm?

a. "B" Fan EF-12 Exhaust Isolation

b. "D" Fan EF-14 Exhaust Isolation

c. "F" Fan AC-2 Exhaust Isolation

d. "H" Acid Vent Isolation

QUESTION C.2 [1.0 point]
With the MASTER SWITCH in the TEST position, and the BLADE 1 OUT light ENERGIZED, what it the position of BLADE 1 control rod?

a. The rod is fully out, the lead screw is fully inserted.

b. The rod is fully inserted ,the lead screw is fully out.

c. Both the rod and the lead screw are fully out.

d. Both the rod and the lead screw are fully inserted.

QUESTION C.3 [1.0 point]
Which one of the following is NOT a reason for having excess reactivity in the core?

a. Fission Product poisons buildup

b. Pool Temperature changes

c. Insertion of Experiments

d. The use of a neutron source

QUESTION C.4 [1.0 point]
Which one of the following radiation detectors does NOT supply a signal for initiation of either an GREA or an LREA?

a. Stack Particulate "A"

b. CAM 2 "C"

c. FPM "E"

d. Rabbit Filters "G"

QUESTION C.5 [1.0 point]
The console operator is maintaining reactor power at 100 kilowatts with reactor control in automatic at the 50% withdrawn position. The operator notes an unexplained power excursion and scrams the reactor. All four of the control blades fully insert into the core. Which one of the following describes the position of the regulating rod?

a. fully inserted.

b. 50% withdrawn in AUTO control.

c. 50% withdrawn in MANUAL control

d. 100% withdrawn in AUTO control.

QUESTION C.6 [1.0 point]
Which ONE of the following is the main function performed by the DISCRIMINATOR circuit in the Startup Channel?

a. To generate a current signal equal and of opposite polarity as the signal due to gammas generated within the Startup Channel Detector.

b. To filter out small pulses due to gamma interactions, passing only pulses due to neutron events within the Startup Channel Detector.

c. To convert the linear output of the Startup Channel Detector to a logarithmic signal for metering purposes.

d. To convert the logarithmic output of the metering circuit to a δt (delta time) output for period metering purposes.

QUESTION C.7 [1.0 point]
Which ONE of the following is NOT a Rod Withdrawal Interlock?

a. Low source count rate < 3 cps

b. High flux - 110%

c. Short Period - 15 seconds

d. Source Range Signal/noise ratio of 2

QUESTION C.8 [1.0 point]
The reactor is operating at 1 Megawatt, when the SECONDARY coolant pump trips on overload. Assuming NO OPERATOR ACTION, which ONE of the following trips would most likely cause a reactor scram?

a. High Flux

b. Short Period

c. High Coolant Inlet Temperature

d. Low Secondary Flow

QUESTION C.9 [2.0 points, 0.5 each]
Match the Radiation Detection Systems in Column A with its corresponding detector type from Column B.

Column A	Column B
a. Continuous Air Monitors	1. Proportional Counter
b. Stack Effluent Monitor (Gaseous)	2. Geiger-Müeller
c. Stack Effluent Monitor (Particulate)	3. Scintillation
d. Bridge Area Radiation Monitor	4. Ion Chamber

QUESTION C.10 [2.0 points, 0.33 each]
Using the drawing of the primary system provided, if the reactor is in position 1, with the coolant system in the cross-stall mode (preferred line-up). Identify the position of the valves listed (Open, Closed, Throttled).

a. P-1

b. P-2

c. P-3

d. P-4

e. P-9

f. P-11

QUESTION C.11 [2.0 points, 0.25 each]
Using the drawing of the ventilation system provided, give the status of the following valves (OPEN, SHUT) and fans (ON, OFF) upon receipt of a GRVS signal.

a. Valve A

b. Valve B

c. Valve C

d. Fans 3 through 6

e. Valve E

f. Valve F

g. Fan EF-12

h. Fan AC-2

QUESTION C.12 [1.0 point]
Fan EF-14 and valve D operate independently of a GRVS signal. For which of the listed conditions below, would fan EF-14 be operating? Containment Pressure =

a. +0.6 inches H_2O

b. +0.3 inches H_2O

c. -0.3 inches H_2O

d. -0.6 inches H_2O

QUESTION C.13 [1.0 point]
To ensure that there is no leakage between the primary and the secondary systems …

a. the primary is sampled for secondary chemicals.

b. the secondary is sampled for Na^{24}.

c. the primary is sampled for pH.

d. the secondary is sampled for O^{19}

QUESTION C.14 [1.0 point] NOTE: The facility has new equipment. Although the answer in the FSAR is as described in "d", a more correct answer would be as described in "b" as rewritten in "redline". In the future this question should list "b" as correct. No change to grading was made for the June, 2003 examination.
Which ONE of the following describes how the signal for regulating rod position indication is generated?

a. A series of magnetic switches which respond to lead screw position.

b. ~~A tachometer that counts the revolutions of the lead screw.~~ A detector counts the black and white stipes on a cylinder directly connected to the drive motor, and coverts this number to rod position.

c. A series of limit switches that are actuated by the ball bearing screw assembly.

d. A mechanical position transmitter that is chain driven by the drive motor.

QUESTION C.15 [1.0 point]
The purpose of the filter in the reactor pool cleanup system is to …

a. prevent demineralizer resin fines from entering the pool.

b. prevent larger particles from plugging the demineralizer resin.

c. remove crud from the coolant limiting the radiation levels associated with the demineralizer.

d. remove particles that could clog the cleanup system pump seals.

QUESTION C.16 [1.0 point]
Which ONE of the following is an "ELECTRONIC" scram?

a. High flux

b. High temperature primary coolant

c. Seismic

d. Low pool water level

QUESTION C.17 [1.0 point]
Which ONE of the following conditions will result in a control blade withdrawal inhibit?

a. Positive 20 second Log N period.

b. Movement of the startup detector.

c. Startup detector indication of 5 CPS.

d. Picoammeter range switch in the most sensitive position.

A.1 a
REF: Burn, R., Introduction to Nuclear Reactor Operations, © 1988, §

A.2 b
REF: Burn, R., Introduction to Nuclear Reactor Operations, © 1988, §
ln (P/P0) × period = time, ln(1000) × 26 = 6.908 × 26 = 179.6 ≈ 180 seconds

A.3 b
REF: Burn, R., Introduction to Nuclear Reactor Operations, © 1988, §

A.4 a
REF: Burn, R., Introduction to Nuclear Reactor Operations, © 1988, §

A.5 d
REF: Burn, R., Introduction to Nuclear Reactor Operations, © 1988, §

A.6 a
REF: Burn, R., Introduction to Nuclear Reactor Operations, © 1988, §

A.7 b
REF: Burn, R., Introduction to Nuclear Reactor Operations, © 1988, §

A.8 a
REF: Burn, R., Introduction to Nuclear Reactor Operations, © 1988, §

A.9 b
REF: Burn, R., Introduction to Nuclear Reactor Operations, © 1988, §

A.10 b
REF: Burn, R., Introduction to Nuclear Reactor Operations, © 1988, §

A.11 b
REF: Burn, R., Introduction to Nuclear Reactor Operations, © 1988, §

A.12 c
REF: Burn, R., Introduction to Nuclear Reactor Operations, © 1988, §

A.13 d
REF: Burn, R., Introduction to Nuclear Reactor Operations, © 1988, §

A.14 c
REF: Burn, R., Introduction to Nuclear Reactor Operations, © 1988, §

A.15 c
REF: Burn, R., Introduction to Nuclear Reactor Operations, © 1988, §

A.16 c
REF: Burn, R., Introduction to Nuclear Reactor Operations, © 1988, §

A.17 c
$P = P_0 e^{t/\tau}$ 1st find τ. τ = time/(ln(2)) = 42/0.693 = 60.6 sec. Time = τ × ln(10) = 60.6 × 139.5 sec
REF: Burn, R., Introduction to Nuclear Reactor Operations, © 1988, §

A.18 b
REF: Burn, R., Introduction to Nuclear Reactor Operations, © 1988, §

A.19 a
$0.001\ \Delta K/K/\cancel{inch} \times 4.5\ \cancel{inch} \div 9^\circ F = 0.001 \div 2 = 0.0005 = 5 \times 10^{-4}\ \Delta K/K/^\circ F$
REF: Burn, R., Introduction to Nuclear Reactor Operations, © 1988, §

A.20 b
REF: Burn, R., Introduction to Nuclear Reactor Operations, © 1988, §

B.1 d
REF: 2^{20} = 1,048,756 ≈ 1,000,000

B.2 a, 1; b, 4; c, 7; d, 7; e, 9
REF: U. Mass-Lowell Technical Specifications § 3.1, Table on IV-14.

B.3 b
REF: RO-7, *Reactor Shutdown,* § 7.32.4. pp. RO7-2 & 3.

B.4 d
REF: Emergency Plan §§ 4.0 through 4.5.

B.5 d
REF: A rem is a rem is a rem.

B.6 c
REF: Special Procedure 18, Draining the Pool, § 4.8 Refilling the pool.

B.7 d
REF: RO-5 *Routine Startup*, § 5.1.5.i, page RO5-3.

B.8 ~~a, LSSS~~; b, SL; c, SL; d, LSSS; Note the question will be corrected to input the correct number into choice a.
REF: Technical Specifications §§ 2.1 and 2.2

B.9 a, DOUBLE; b, NA; c, NR; d, NA
REF: Technical Specifications § 3.6, *Limitations on Experiments*

B.10 a, water; b, structural material; c, air; d, fission product
REF:

B.11 d
REF: Standard Health Physics Definition.

B.12 c
REF: Standard NRC Health Physics Question. G-M detector is not sensitive to incident energy levels.

B.13 c
REF: Technical Specification 1.1, 3.1.1, 3.1.3, 3.5.2

B.14 a, 10; b, 6; c, 4; d, 15
REF:

B.15 d
REF: Technical Specifications §§ 1.2, 1.3, 1.4 and 1.5.

B.16 d
REF: EO-7, "Stuck Rod or Safety Blade," step 1, also NRC examination administered November, 1994.

B.17 b or c
REF: U. Mass-Lowell, RO-4 § 4.1.7, p. 4-2, also NRC examination administered September, 1996

C.1 b
REF: UFSAR, §3.4.2.3 pp. 3-24, 3-25, also NRC examination administered April, 1996

C.2 b
REF: UFSAR, § 4,4,3, Table 4.3 p. 4-49, also NRC examination administered April 1996.

C.3 d
REF:

C.4 d
REF: UMLR Study Guide Section covering Radiation Monitors.

C.5 c
REF: UFSAR §§ 4.6 and 4.7.

C.6 b
REF:

C.7 d
REF: U. Mass. Lowell Reactor RO-9 System Checkout Procedures

C.8 c
REF: NRC Examination question administered September 1996

C.9 a, 2; b, 2; c, 3; d, 4
REF: NRC Examination Question administered September, 1996.

C.10 a, Open; b, Open; c, Closed; d, Closed; e, Open; f, Throttled
REF: SAR § 4.2.2, also, Training Handout section on Primary System, and drawing.

C.11 a, SHUT; b, SHUT; c, SHUT; d, OFF; e, SHUT; f, OPEN; g, OFF; h, ON
REF:

C.12 b
REF: Training Handout Section on Containment/Ventilation, last page.

C.13 b
REF:

C.14 d
REF: ULR SAR, §4.1.8, p 4-11; Figures 4.6 and 4.7. C.14

C.15 a
REF: ULR SAR, §4.2.5, p 4-29.

C.16 a
REF: ULR SAR, §4.4.15.2, p 4-74.

C.17 b
REF: ULR RO-9, Rev 8, p RO-9-6, Standing Order #11, p 2.

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

FACILITY: University of Massachusetts- Lowell

REACTOR TYPE: GE Pool

DATE ADMINISTERED: 2003/06/16

CANDIDATE: ______________________________

INSTRUCTIONS TO CANDIDATE:
Answers are to be written on the answer sheet provided. Attach the answer sheets to the examination. Points for each question are indicated in brackets for each question. A 70% in each section is required to pass the examination. Examinations will be picked up three (3) hours after the examination starts.

Category Value	% of Total	% of Candidates Score	Category Value	Category
20.00	33.3	______	____	A. Reactor Theory, Thermodynamics and Facility Operating Characteristics
20.00	33.3	______	____	B. Normal and Emergency Operating Procedures and Radiological Controls
20.00	33.3	______	____	C. Facility and Radiation Monitoring Systems
60.00		______	____% FINAL GRADE	TOTALS

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

____
Candidate's Signature

NRC RULES AND GUIDELINES FOR LICENSE EXAMINATIONS

During the administration of this examination the following rules apply:

1. Cheating on the examination means an automatic denial of your application and could result in more severe penalties.

2. After the examination has been completed, you must sign the statement on the cover sheet indicating that the work is your own and you have neither received nor given assistance in completing the examination. This must be done after you complete the examination.

3. Restroom trips are to be limited and only one candidate at a time may leave. You must avoid all contacts with anyone outside the examination room to avoid even the appearance or possibility of cheating.

4. Use black ink or dark pencil <u>only</u> to facilitate legible reproductions.

5. Print your name in the blank provided in the upper right-hand corner of the examination cover sheet and each answer sheet.

6. Mark your answers on the answer sheet provided. USE ONLY THE PAPER PROVIDED AND DO NOT WRITE ON THE BACK SIDE OF THE PAGE.

7. The point value for each question is indicated in [brackets] after the question.

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

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

10. Ensure all information you wish to have evaluated as part of your answer is on your answer sheet. Scrap paper will be disposed of immediately following the examination.

11. To pass the examination you must achieve a grade of 70 percent or greater in each category.

12. There is a time limit of three (3) hours for completion of the examination.

13. When you have completed and turned in you examination, leave the examination area. If you are observed in this area while the examination is still in progress, your license may be denied or revoked.

EQUATION SHEET

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

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

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

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

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

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

$$CR_1(-\rho_1) = CR_2(-\rho_2)$$

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

DR – Rem, Ci – curies, E – Mev, R – feet

$$\frac{(\rho_2-\beta)^2}{Peak_2} = \frac{(\rho_1-\beta)^2}{Peak_1}$$

1 Curie = 3.7 x 10^{10} dis/sec

1 kg = 2.21 lbm

1 Horsepower = 2.54 x 10^3 BTU/hr

1 Mw = 3.41 x 10^6 BTU/hr

1 BTU = 778 ft-lbf

°F = 9/5 °C + 32

1 gal (H_2O) ≈ 8 lbm

°C = 5/9 (°F - 32)

c_P = 1.0 BTU/hr/lbm/°F

c_p = 1 cal/sec/gm/°C

A.1 a b c d ___

A.2 a b c d ___

A.3 a b c d ___

A.4 a b c d ___

A.5 a b c d ___

A.6 a b c d ___

A.7 a b c d ___

A.8 a b c d ___

A.9 a b c d ___

A.10 a b c d ___

A.11 a b c d ___

A.12 a b c d ___

A.13 a b c d ___

A.14 a b c d ___

A.15 a b c d ___

A.16 a b c d ___

A.17 a b c d ___

A.18 a b c d ___

A.19 a b c d ___

A.20 a b c d ___

B.1 a b c d ___

B.2a 1 2 3 4 5 6 7 8 9 ___

B.2b 1 2 3 4 5 6 7 8 9 ___

B.2c 1 2 3 4 5 6 7 8 9 ___

B.2d 1 2 3 4 5 6 7 8 9 ___

B.2e 1 2 3 4 5 6 7 8 9 ___

B.3 a b c d ___

B.4 a b c d ___

B.5 a b c d ___

B.6 a b c d ___

B.7 a b c d ___

B.8a SL LSSS LCO ___

B.8b SL LSSS LCO ___

B.8c SL LSSS LCO ___

B.8d SL LSSS LCO ___

B.9a NR Double NA ___

B.9b NR Double NA ___

B.9c NR Double NA ___

B.9d NR Double NA ___

B.10a Water Air Structural Fission ___

B.10b Water Air Structural Fission ___

B.10c Water Air Structural Fission ___

B.10d Water Air Structural Fission ___

B.11 a b c d ___

B.12 a b c d ___

B.13 a b c d ___

B.14a ___ days

B.14b ___ weeks

B.14c ___ months

B.14d ___ months

B.15 a b c d ___

B.16 a b c d ___

B.17 a b c d ___

C.1 a b c d ___

C.2 a b c d ___

C.3 a b c d ___

C.4 a b c d ___

C.5 a b c d ___

C.6 a b c d ___

C.7 a b c d ___

C.8 a b c d ___

C.9a 1 2 3 4 ___

C.9b 1 2 3 4 ___

C.9c 1 2 3 4 ___

C.9d 1 2 3 4 ___

C.10a Open Closed Throttled ___

C.10b Open Closed Throttled ___

C.10c Open Closed Throttled ___

C.10d Open Closed Throttled ___

C.10e Open Closed Throttled ___

C.10f Open Closed Throttled ___

C.11a Open Shut On Off ___

C.11b Open Shut On Off ___

C.11c Open Shut On Off ___

C.11d Open Shut On Off ___

C.11e Open Shut On Off ___

C.11f Open Shut On Off ___

C.11g Open Shut On Off ___

C.11h Open Shut On Off ___

C.12 a b c d ___

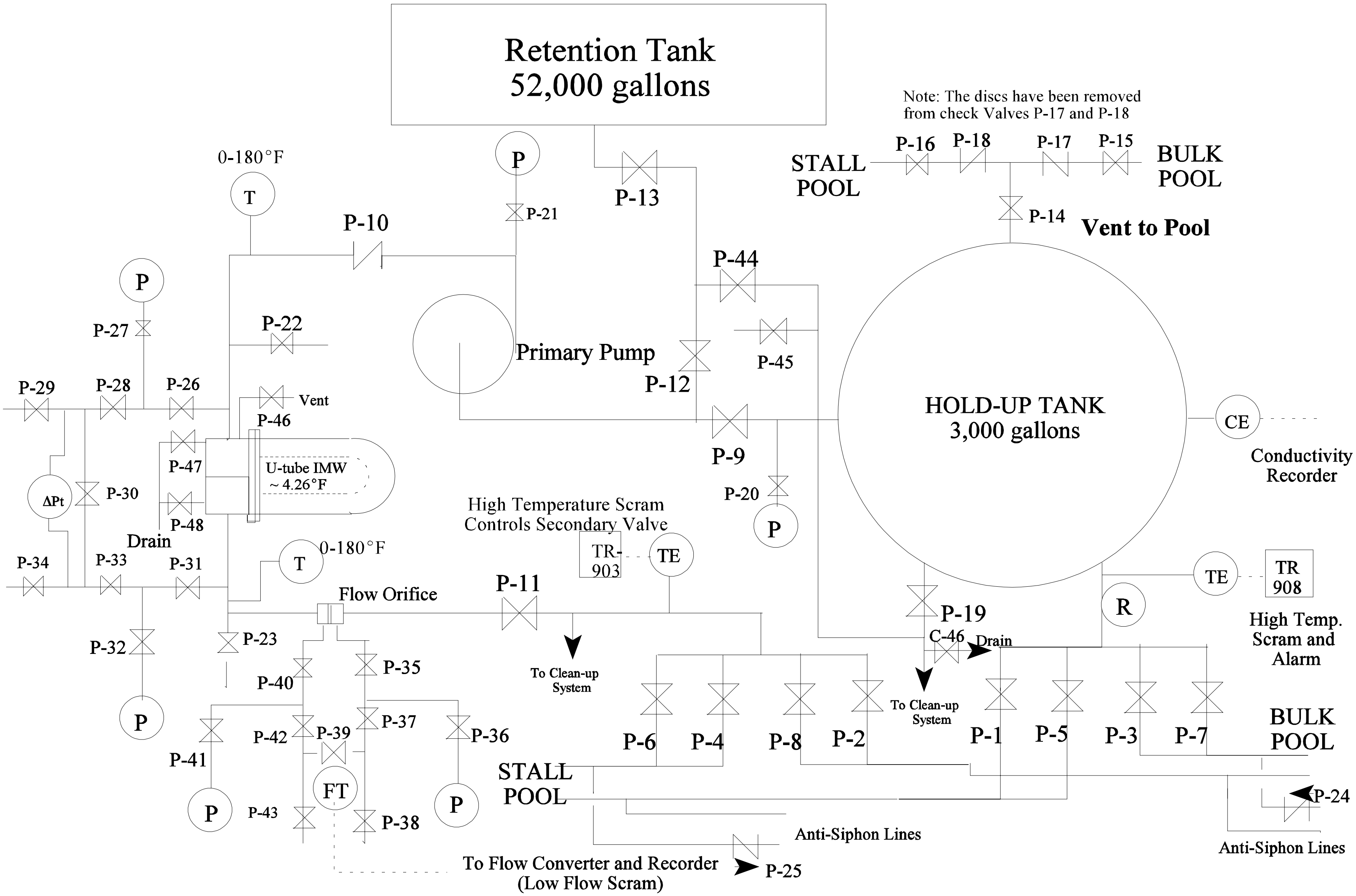
C.13 a b c d ___

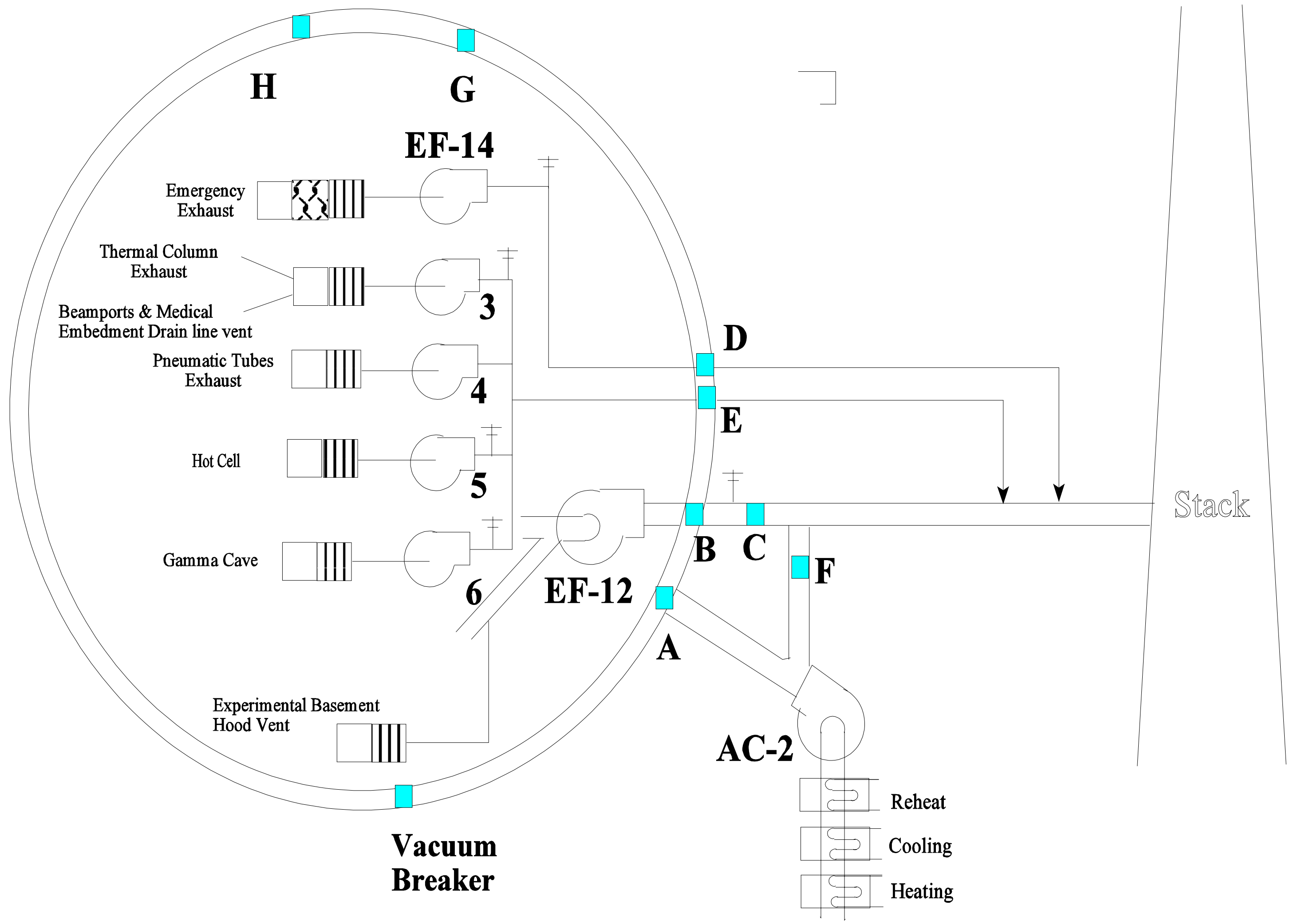
C.14 a b c d ___

C.15 a b c d ___

C.16 a b c d ___

C.17 a b c d ___


Retention Tank
52,000 gallons
Note: The discs have been removed from check Valves P-17 and P-18
STALL POOL
P-16
P-18
P-17
P-15
BULK POOL
P-14
Vent to Pool
0-180°F
T
P
P-21
P-13
P-10
P-44
P
P-27
P-22
Primary Pump
P-12
P-45
HOLD-UP TANK
3,000 gallons
CE
Conductivity Recorder
P-29
P-28
P-26
Vent
P-46
P-47
U-tube IMW ~ 4.26°F
P-9
P-20
ΔPt
P-30
P-48
Drain
High Temperature Scram Controls Secondary Valve
TR-903
TE
P
0-180°F
T
P-34
P-33
P-31
Flow Orifice
P-11
TE
TR 908
R
P-19
C-46
Drain
High Temp. Scram and Alarm
P-32
P-23
To Clean-up System
P-40
P-35
To Clean-up System
P
P-42
P-39
P-37
P-36
P-6
P-4
P-8
P-2
P-1
P-5
P-3
P-7
BULK POOL
P-41
FT
STALL POOL
P-24
P
P-43
P-38
P
Anti-Siphon Lines
Anti-Siphon Lines
To Flow Converter and Recorder (Low Flow Scram)
P-25


H
G
EF-14
Emergency Exhaust
Thermal Column Exhaust
Beamports & Medical Embedment Drain line vent
3
Pneumatic Tubes Exhaust
4
Hot Cell
5
Gamma Cave
6
EF-12
D
E
B
C
F
A
Stack
Experimental Basement Hood Vent
AC-2
Reheat
Cooling
Heating
Vacuum Breaker

QUESTION C.14 [1.0 point]

Which ONE of the following describes how the signal for regulating rod position indication is generated?

a. A series of magnetic switches which respond to lead screw position.

b. A detector counts the black and white stipes on a cylinder directly connected to the drive motor, and coverts this number to rod position.

c. A series of limit switches that are actuated by the ball bearing screw assembly.

d. A mechanical position transmitter that is chain driven by the drive motor.