April 12, 2005

Dr. Mariesa Crow, Dean
School of Materials, Energy and Earth Resources
University of Missouri - Rolla
305 McNutt Hall
Rolla, MO 65409-0810

SUBJECT: RETAKE EXAMINATION REPORT NO. 50-123/OL-05-01, UNIVERSITY OF MISSOURI–ROLLA

Dear Dr. Crow:

During the week of February 14, 2005, the NRC administered operator licensing examinations at your University of Missouri–Rolla Reactor. The examinations were conducted according to NUREG-1478, "Non-Power Reactor Operator Licensing Examiner Standards," Revision 1.

The last two initial examination reports for your facility (examinations administered in March 2003 and May 2004) listed concerns regarding the quality of your operator licensing program. As a result, the NRC carefully reviewed this examination. The applications submitted for this retake examination had small problems, however, in general, they were substantially better than those received in support of the previous two initial examinations. The NRC is also encouraged to see that all candidates passed their respective retake written examinations, but we are still concerned that four of the five individuals scored just above passing. The NRC is pleased to note the overall improvements in your program, and looks forward to further improvements.

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 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. 50-123

Enclosures:
1. Initial Examination Report No. 50-123/OL-05-01
2. Examination with answer key (Section A Exam)
3. Examination with answer key (Section B Exam)

cc w/encls: Please see next page

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cc w/encls: Please see next page

DISTRIBUTION:

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Facility File (EBarnhill) O-6 F-2 PIsaac

EXAMINATION PACKAGE ACCESSION NO.: ML050950382
EXAMINATION REPORT ACCESSION #: ML050950212 **TEMPLATE #: NRR-074**

OFFICE	RNRP:CE		IROB:LA	E	RNRP:SC	
NAME	PDoyle		EBarnhill		PMadden	
DATE	4/ 6 /2005		4/ 6 /2005		4/ 11/2005	

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

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

REPORT NO.: 50-123/OL-05-01

FACILITY DOCKET NO.: 50-123

FACILITY LICENSE NO.: R-79

FACILITY: University of Missouri–Rolla

EXAMINATION DATES: February 15, 2005

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

SUMMARY:

The NRC administered Operator Licensing retake examinations to four Reactor Operator (RO) and one Senior Reactor Operator (Instant) (SRO(I)) license candidates. All license candidates passed their respective written retake examinations. All but one will be issued licenses. One candidate must still pass an operating test to receive an RO license.

REPORT DETAILS

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

2. Results:

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

3. Exit Meeting:

Because of the nature of the examination (written only) the NRC did not have a formal exit meeting with the facility.

U.S. Nuclear Regulatory Commission
OPERATOR LICENSING EXAMINATION
Section A *ONLY*
With Answer Key

UNIVERSITY OF MISSOURI-ROLLA
RESEARCH REACTOR
Week of February 14, 2005

ENCLOSURE 2

QUESTION A.01 [2.0 points, ½ each]
The listed isotopes are all potential daughter products due to the radioactive decay of $_{35}Br^{87}$. Identify the type of decay necessary (Alpha, Beta, Gamma or Neutron emission) to produce each of the isotopes.

a. $_{33}As^{83}$

b. $_{35}Br^{86}$

c. $_{35}Br^{87}$

d. $_{36}Kr^{87}$

QUESTION A.02 [1.0 point]
What is the definition of reactivity? A measure of the …

a. number of neutrons being produced in the core.

b. number of neutrons being absorbed by the fuel.

c. reactor's multiplication factor.

d. reactor's departure from critical.

QUESTION A.03 [2.0 points, ½ each]
Using the drawing of the Integral Rod Worth Curve provided, identify each of the following reactivity worths.

a. Total Rod Worth

b. Actual Shutdown Margin

c. Technical Specification Shutdown Margin Limit

d. Excess Reactivity

1. B - A
2. C - A
3. C - B
4. D - C
5. E - C
6. E - D
7. E - A

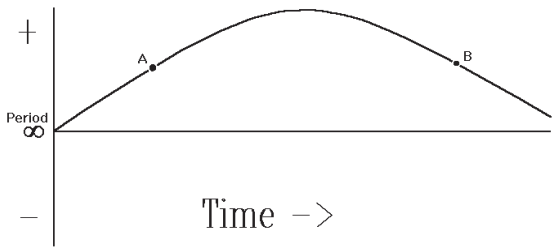
QUESTION A.04 [1.0 point]
Shown below is a trace of reactor period as a function of time. Between points A and B reactor power is:

a. continually increasing.

b. continually decreasing.

c. increasing, then decreasing.

d. constant.



QUESTION A.05 [1.0 point]
What is the kinetic energy range of a thermal neutron?

a. > 1 MeV

b. 100 KeV – 1 MeV

c. 1 eV – 100 KeV

d. < 1 eV

QUESTION A.06 [1.0 point]
Which ONE of the following statements is correct with respect to why Xenon peaks following a shutdown?

a. Delayed neutrons continue causing fissions increasing the “direct” Xenon.

b. The decay constant for Xenon is longer than the decay constant for Iodine.

c. The decay constant for Xenon is longer than the decay constant for Cesium.

d. The decay constant for Cesium is essentially zero.

QUESTION A.07 [1.0 point]
Suppose the temperature coefficient of a core is -2.5×10^{-4} ΔK/K/EC and the average control rod worth of the regulating control rod is 5.895×10^{-3} ΔK/K/inch. If the temperature ***INCREASES*** by 50EC what will the automatic control command the regulating rod to do? Select the answer that is closest to the calculated value.

a. 5.6 inches in

b. 2.1 inches out

c. 0.5 inches in

d. 4.3 inches out

QUESTION A.08 [1.0 point]
Given the following data, which ONE of the following is the closest to the half life of the material?

TIME	ACTIVITY
0	2400 cps
10 min.	1757 cps
20 min.	1286 cps
30 min.	941 cps
60 min.	369 cps

a. 11 minutes

b. 22 minutes

c. 44 minutes

d. 51 minutes

QUESTION A.09 [1.0 point]
During a fuel loading of the core, as the reactor approaches criticality, the value of 1/M:

a. Increases toward one

b. Decreases toward one

c. Increases toward infinity

d. Decreases toward zero

QUESTION A.10 [1.0 point]
Which ONE of the following is the major source of energy released during fission?

a. Absorption of prompt gamma rays

b. Slowing down of fission fragments

c. Neutrino interactions

d. Fission neutron scattering

QUESTION A.11 [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.12 [1.0 point]
In a reactor at full power, the thermal neutron flux (φ) is 2.5 x 10^{12} neutrons/cm^2/sec. and the macroscopic fission cross-section G_f is 0.1 cm^{-1}. The fission reaction rate is:

a. 2.5 x 10^{11} fissions/sec.

b. 2.5 x 10^{13} fissions/sec.

c. 2.5 x 10^{11} fissions/cm^3/sec.

d. 2.5 x 10^{13} fissions/cm^3/sec.

QUESTION A.13 [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.14 [1.0 point]
Which ONE of the following explains the response of a ***SUBCRITICAL*** reactor to equal insertions of positive reactivity as the reactor approaches criticality? Each insertion causes a …

a. ***SMALLER*** increase in the neutron flux resulting in a ***LONGER*** time to stabilize.

b. ***LARGER*** increase in the neutron flux resulting in a ***LONGER*** time to stabilize.

c. ***SMALLER*** increase in the neutron flux resulting in a ***SHORTER*** time to stabilize.

d. ***LARGER*** increase in the neutron flux resulting in a ***SHORTER*** time to stabilize.

QUESTION A.15 [1.0 point]
Which ONE of the following atoms will cause a neutron to lose the most energy in an elastic collision?

a. Uranium^{238}

b. Carbon^{12}

c. Hydrogen^{2}

d. Hydrogen^{1}

QUESTION A.16 [1.0 point]
A thin foil target of 10% copper and 90% aluminum is in a thermal neutron beam. Given $\sigma_{a\ Cu}$ = 3.79 barns, $\sigma_{a\ Al}$ = 0.23 barns, $\sigma_{s\ Cu}$ = 7.90 barns, and $\sigma_{s\ Al}$ =1.49 barns, which ONE of the following reactions has the highest probability of occurring? A neutron …

a. scattering reaction with aluminum

b. scattering reaction with copper

c. absorption in aluminum

d. absorption in copper

QUESTION A.17 [1.0 point]
When performing rod calibrations, many facilities pull the rod out a given increment, then measure the time for reactor power to double (doubling time), then calculate the reactor period. If the doubling time is 42 seconds, what is the reactor period?

a. 29 sec

b. 42 sec

c. 61 sec

d. 84 sec

QUESTION A.18 [1.0 point]
Which ONE of the following statements concerning reactor poisons is NOT true?

a. Following shutdown, Samarium concentration will increase to some value then stabilize.

b. Following shutdown, Xenon concentration will initially increase to some value then decrease exponentially

c. During reactor operation, Samarium concentration is independent of reactor power level.

d. During reactor operation, Xenon concentration is dependent on reactor power level.

A.01 a, alpha; b, neutron; c, gamma; d, Beta
Ref: Burn, R., Introduction to Nuclear Reactor Operations, © 1988, §

A.02 d
REF:

A.03 a, 7; b, 2; c, 1; d, 5
REF:

A.04 a
REF:

A.05 d
REF: Glasstone, S., Nuclear Reactor Engineering, Kreiger Publishing, Malabar: Florida, 1991. 3rd Edition. pg. 13

A.06 b
REF:

A.07 B
REF: The temperature increase will result in a change in reactivity of: -2.5×10^{-4} ΔK/K/EC × 50EC = -1.25×10^{-2} ΔK/K. Since the temperature rise results in a negative reactivity insertion, the control rod will need to drive out to add positive reactivity. D = $(1.25 \times 10^{-2}$ ΔK/K) ÷ $(5.895 \times 10^{-3}$ ΔK/K/inch) = 2.12 inches

A.08 b
REF:

A.09 d
REF: Glasstone, S., Nuclear Reactor Engineering, Kreiger Publishing, Malabar: Florida, 1991. 3rd Edition. pg. 191

A.10 b
REF: Glasstone, S., Nuclear Reactor Engineering, Kreiger Publishing, Malabar: Florida, 1991. 3rd Edition. pg. 16

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

A.12 c
REF: Lamarsh, J.R., *Introduction to Nuclear Engineering,* 1983. § 5.1, pp. 189 –191.
$R = \varphi G_f = (2.5 \times 10^{12}) \times 0.1 = 2.5 \times 10^{11}$

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

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

A.15 d
REF: Lamarsh, J.R., *Introduction to Nuclear Engineering,* 1983. § Appendix II Table II.2, p. 643.

A.16 a
REF: Glasstone, S. and Sesonske, A, *Nuclear Reactor Engineering,* Kreiger Publishing, Malabar, Florida, 1991, §

A.17 c
REF: ln (2) = -time/τ τ = time/(ln(2)) = 60.59 . 61 seconds

A.18 c
REF: Primary Reference, Volume 2, Module 3, Reactor Theory (Nuclear Parameters), Enabling Objectives 4.1 through 4.15.

U. S. NUCLEAR REGULATORY COMMISSION
RESEARCH AND TEST REACTOR OPERATOR LICENSING EXAMINATION

FACILITY: University of Missouri – Rolla

REACTOR TYPE: UMRR

DATE ADMINISTERED: 2005/02/____

CANDIDATE: _____

INSTRUCTIONS TO CANDIDATE:
Answers are to be written on the answer sheets provided. Points for each question are indicated in brackets for each question. You must score 70% to pass. Examinations will be picked up one (1) hour after the examination starts.

Category Value	% of Total	% of Candidates Score	Category Value	Category
20.00	100.0	_____	____	A. Reactor Theory, Thermodynamics and Facility Operating Characteristics
20.00		_____	____%	TOTALS

FINAL GRADE

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

_____
Candidate's Signature

NRC RULES AND GUIDELINES FOR LICENSE EXAMINATIONS

During the administration of this examination the following rules apply:

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

2. After the examination has been completed, you must sign the statement on the cover sheet indicating that the work is your own and you have 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 only 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 proctor 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.

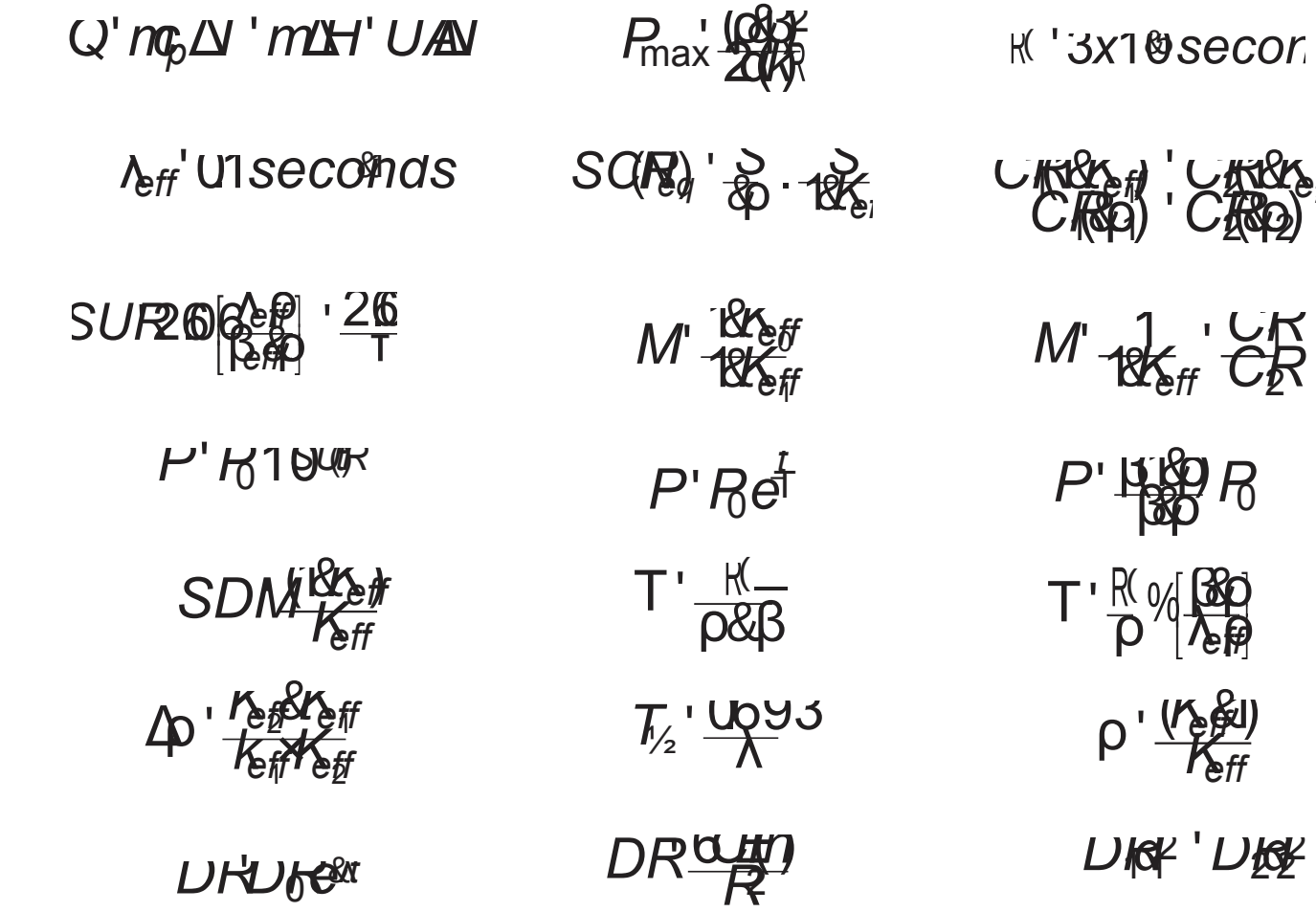
10. Ensure all information you wish to have evaluated as part of your answer is on your answer sheet. Scrap paper will be disposed of immediately following the examination.

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

12. There is a time limit of one (1) hour 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



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

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 = 3.413 x 10^{6} BTU/hr

1 BTU = 778 ft-lbf

EF = 9/5 EC + 32

1 gal (H_2O) . 8.272 lbm

EC = 5/9 (EF - 32)

c_P = 0.998 BTU/hr/lbm/EF

c_p = 0.998 cal/sec/gm/EC

α_T = -3.9 pcm/EF

Pool Volume = 15650 gallons

A.1a alpha neutron beta gamma ____

A.1b alpha neutron beta gamma ____

A.1c alpha neutron beta gamma ____

A.1d alpha neutron beta gamma ____

A.2 a b c d ___

A.3a 1 2 3 4 5 6 7 ___

A.3b 1 2 3 4 5 6 7 ___

A.3c 1 2 3 4 5 6 7 ___

A.3d 1 2 3 4 5 6 7 ___

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 ___

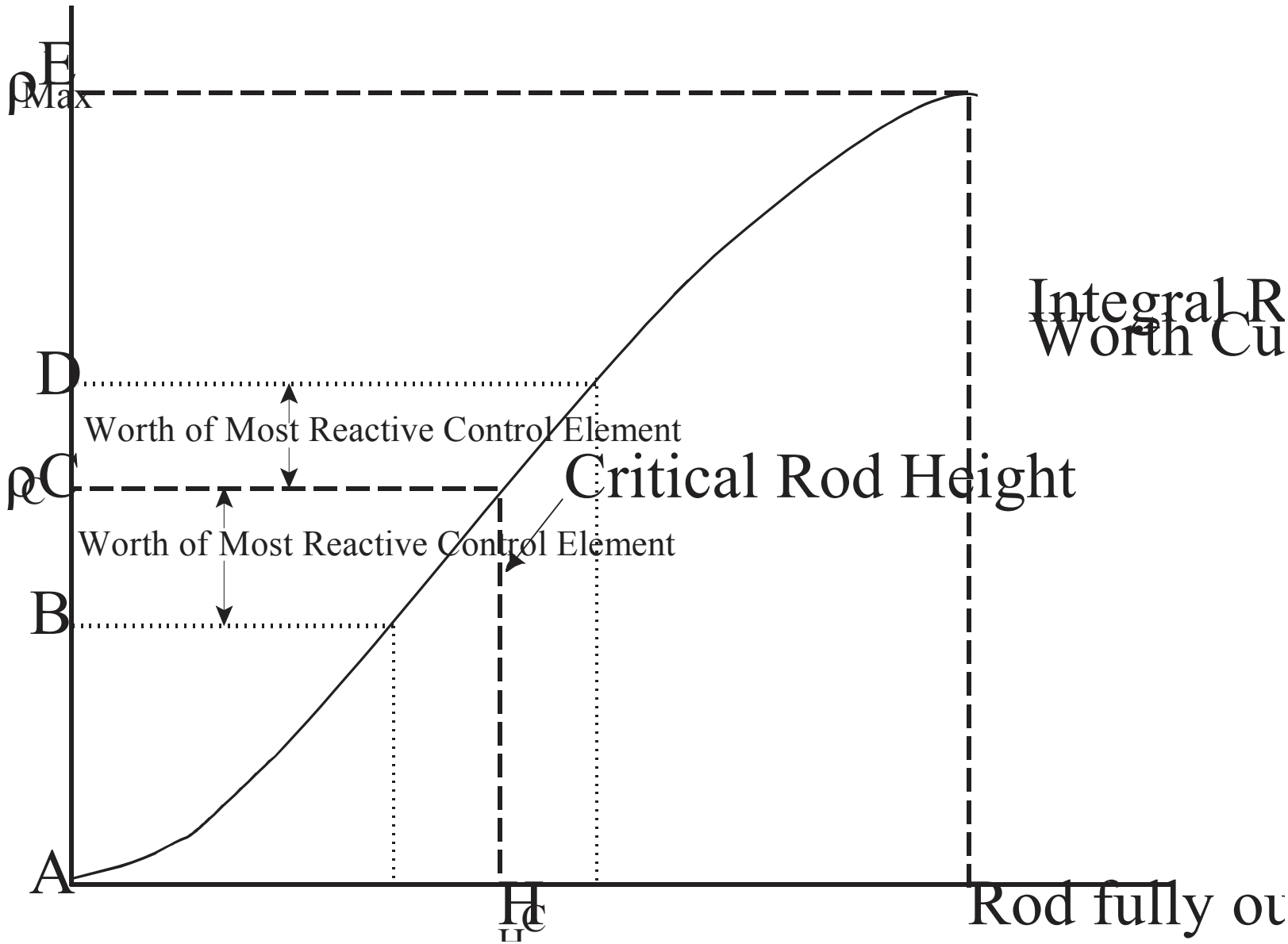
A.14 a b c d ___

A.15 a b c d ___

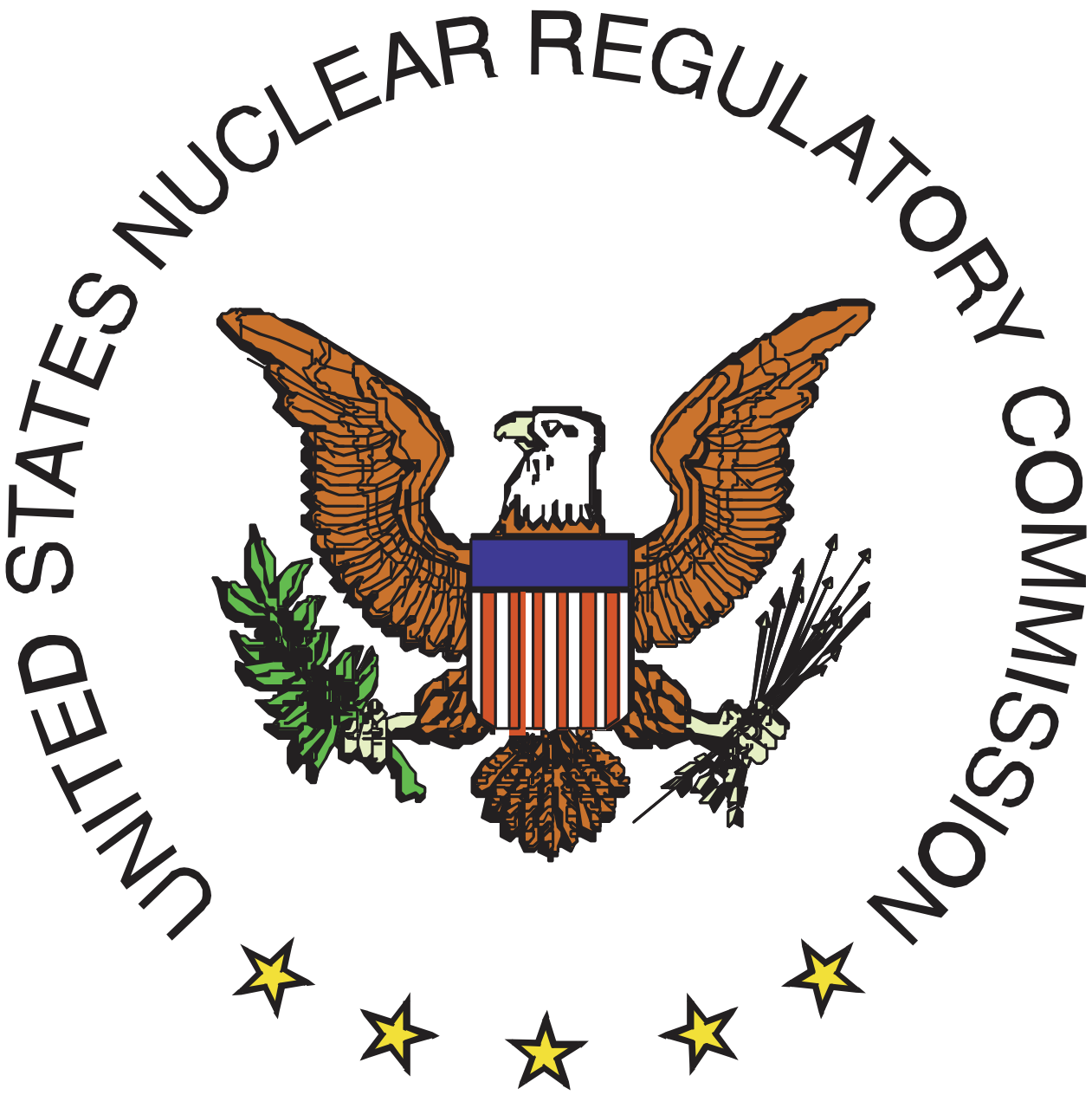
A.16 a b c d ___

A.17 a b c d ___

A.18 a b c d ___


ρE
ρMax
Integral R
Worth Cu
D
Worth of Most Reactive Control Element
ρC
ρc
Critical Rod Height
Worth of Most Reactive Control Element
B
A
Hc
Rod fully ou

U.S. Nuclear Regulatory Commission
OPERATOR LICENSING EXAMINATION
Section B *ONLY*
With Answer Key



UNIVERSITY OF MISSOURI-ROLLA
RESEARCH REACTOR
Week of February 14, 2005

ENCLOSURE 3

QUESTION B.1 [1.0 point]
Which one of the following describes the Emergency Planning Zone (EPZ) for the UMRR? The EPZ …

a. is the area that enclosed by the walls of the reactor facility.

b. specifies contamination levels of airborne, radiological dose or dose rates that may be used as thresholds for establishing emergency classes.

c. is the geographical area that is beyond the site boundary where the Reactor Director has direct authority over all activities.

d. lies within the site boundary and is bounded by a 150 meter radius from the UMRR exhaust stack.

QUESTION B.2 [1.0 point]
10CFR50.54(x) states: *"A licensee may take reasonable action that departs from a license condition or a technical specification (contained in a license issued under this part) in an emergency when this action is immediately needed to protect the public health and safety and no action consistent with license conditions and technical specifications that can provide adequate or equivalent protection is immediately apparent.* 10CFR50.54(y) states that the minimum level of management which may authorize this action is …

a. any Reactor Operator licensed at facility

b. any Senior Reactor Operator licensed at facility

c. Facility Manager (or equivalent at facility).

d. NRC Project Manager

QUESTION B.3 [1.0 point]
Which ONE of the following is the 10 CFR 20 definition of **TOTAL EFFECTIVE DOSE EQUIVALENT (TEDE)**?

a. The sum of the deep does equivalent and the committed effective dose equivalent.

b. The dose that your whole body receives from sources outside the body.

c. The sum of the external deep dose and the organ dose.

d. The dose to a specific organ or tissue resulting from an intake of radioactive material.

QUESTION B.4 [1.0 point]
Many research reactors use different methods to reduce the dose due to N^{16} at the pool top. If the method used keeps the N^{16} ten (10) feet below the surface of the water, and a half-thickness for the N^{16} gamma(s) is one foot for water, then the dose due to N^{16} is reduced (approximately) by a factor of … (Note: Neglect any reduction in dose rate due to half-life.)

a. 20

b. 100

c. 200

d. 1000

QUESTION B.5 [1.0 point]
Which ONE of the following is the definition of ***Emergency Action Level***?

a. a condition that calls for immediate action, beyond the scope of normal operating procedures, to avoid an accident or to mitigate the consequences of one.

b. Specific instrument readings, or observations; radiation dose or dose rates; or specific contamination levels of airborne, waterborne, or surface-deposited radioactive materials that may be used as thresholds for establishing emergency classes and initiating appropriate emergency methods.

c. classes of accidents grouped by severity level for which predetermined emergency measures should be taken or considered.

d. a document that provides the basis for actions to cope with an emergency. It outlines the objectives to be met by the emergency procedures and defines the authority and responsibilities to achieve such objectives.

QUESTION B.6 [1.0 point]
Which ONE of the following types of experiments maybe within the confines of the pool and does ***NOT*** require Radiation Safety Committee permission?

a. explosive materials greater than 25 milligrams.

b. fueled experiments which generates a power of 50 watts

c. corrosive materials

d. explosive materials less than 25 milligrams

QUESTION B.7 [2.0 points, ½ each]
Match the 10CFR55 requirements for maintaining an active operator license in column A with the corresponding time period from column B.

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

QUESTION B.8 [1.0 point]
The reactor scrams during operations after normal operating hours. The cause of the scram was an electrical storm which caused you to temporarily lose power. The power has been restored. What is the minimum level of management who may authorize restart of the reactor under these conditions. (Note: you've completed SOP 308.)

A. The Senior Operator on his/her own.

B. The Senior Operator on consultation with either the Reactor Manager or the Reactor Director.

C. The Reactor Manager after consultation with the Reactor Director.

D. The Reactor Director only.

QUESTION B.9 [1.0 points]
Which ONE of the following correctly defines a Safety Limit?

a. Limits on important process variables which are found to be necessary to reasonably protect the integrity of certain physical barriers which guard against the uncontrolled release of radioactivity.

b. The Lowest functional capability of performance levels of equipment required for safe operation of the facility.

c. Settings for automatic protective devices related to those variables having significant safety functions.

d. a measuring or protective channel in the reactor safety system.

QUESTION B.10 [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.11 [2.0 points, ½ each]
Identify each of the following reactor plant limitations as a Safety Limit (SL), Limiting Safety System Setting (LSSS) or a Limiting Condition for Operation (LCO). (Choices may be used more than once or not at all.)

a. Excess reactivity above the reference core condition will be no more than 1.5% Δk/k.

b. Reactor thermal power, P, shall be no greater than 300 kWt, or 150% of full power

c. The regulating rod shall be worth no more than 0.7% Δk/k in reactivity

d. The fuel element cladding temperature shall be less than 580EC (1067EF)

QUESTION B.12 [2.0 points, $^{2}/_{5}$ each]
Match the Control Channel in column A with its respective rundown setpoint in column B.

Control Channel	Setpoint
a. Linear power (%)	1. 15
b. Reactor period (seconds)	2. 20
c. Low CIC voltage (%)	3. 80
d. Radiation Monitors (mR/hr)	4. 120
e. Log power	

QUESTION B.13 [1.0 point]
While working in an area marked "Caution, Radiation Area," you discover your dosimeter is off scale and leave the area. Assuming you had been working in the area for 45 minutes, what is the maximum dose you would have received?

a. 3.8 mr

b. 35.6 mr

c. 75 mr

d. 100 mr

QUESTION B.14 [1.0 point]
For the purposes of a reactor startup, the reactor is considered "clean" if it hasn't been operated if within the past 52 hours, it hasn't exceeded …

a. 2 kW-hr.

b. 10 kW-hr.

c. 20 kW-hr.

d. 100 kW-hr.

QUESTION B.15 [1.0 point]
An experimenter wishes to irradiate three specimens with reactivity worths of 0.5% Δk/k, 0.13% Δk/k and 0.27% Δk/k. Can these specimens be placed in the reactor as UNSECURED experiments and why (why not).

a. Yes, the sum of the three specimens is less than 1.2% Δk/k.

b. No, the sum of the three specimens is greater than 0.8% Δk/k.

c. Yes, each specimen is less than 0.6% Δk/k.

d. No, one of the specimens is greater than 0.4% Δk/k.

QUESTION B.16 [1.0 point]
SOP 501 *Emergency Procedures for Reactor Building Evacuation* lists the actions for you (the RO) and the SRO on duty to take during this type of an emergency. The lowest level of management authorized to instruct you to proceed differently from the items listed in your checklist is …

a. SRO on Duty

b. Reactor Manager

c. Reactor Director

d. NRC Project ManagerThe SRO on Duty may instruct the operator to proceed differently from the items listed in the checklist.

QUESTION B.17 [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

B.1 a
REF: Emergency Plan, § 6.0 *Emergency Planning Zone*

B.2 b
REF: 10CFR50.54(y)

B.3 a
REF: 10 CFR 20.1003 Definitions

B.4 d
REF: Basic Radiological Controls knowledge: “Half-Thickness and Tenth-Thickness". $2^{10} = 1024$

B.5 b
REF: Emergency Plan, § 2.0 Definitions, p. 2-1.

B.6 c
REF: UMRR Technical Specification 3.7(1), (2) and (3)

B.7 a, 6; b, 2; c, 2 or 1; d, 1
REF: 10CFR55. Second answer for c added per Requal Plan requirements.

B.8 a
REF: SOP 103 Startup to Low Power, § B.8

B.9 a
REF: Technical Specifications § 1, Definitions

B.10 d
REF: Standard Health Physics Definition.

B.11 a, LCO; b, LSSS; c, LCO; d, SL
Ref: Technical Specifications 2.1, 2.2, 3.1(1) and 3.1(4).

B.12 a, 4; b, 1; c, 3; d, 2; e, 4
REF: Technical Specification Table 3.1

B.13 c
REF: 10 CFR 20.1003 Maximum dose in a radiation area is 100 mr/hr. 100 mr/hr × 0.75 hr = 75 mr.

B.14 c
REF: SOP 103 Startup to Low Power, § B.2.

B.15 d
REF: Technical Specifications 3.7.1

B.16 ~~b~~ a Answer changed per facility comment (Typographical error).
REF: SOP 501 *Emergency Procedures for Reactor Building Evacuation* § C.I.6

B.17 d
REF: A rem is a rem is a rem.

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

FACILITY: University of Missouri – Rolla

REACTOR TYPE: UMRR

DATE ADMINISTERED: 2005/12/24

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% is required to pass the examination. Examinations will be picked up one (1) hour after the examination starts.

Category Value	% of Total	% of Candidates Score	Category Value	Category
20.00	100.0	_____	____	B. Normal and Emergency Operating Procedures and Radiological Controls
20.00		_____	____% 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 only 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.

12. There is a time limit of one (1) hour 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

$$Q = mc_p\Delta T = m\Delta H = UA\Delta T$$

$$P_{max} = \frac{(\beta - \rho)^2}{2\beta(\lambda)}$$

$$\lambda = 1 \times 10^{-4} \text{ sec}$$

$$\lambda_{eff} = \text{neutron lifetime}$$

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

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

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

$$M = \frac{1 - K_{eff0}}{1 - K_{eff}}$$

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

$$P = P_0 10^{t/T}$$

$$P = P_0 e^{\frac{t}{T}}$$

$$P = \frac{\beta - \rho}{\beta - \rho} P_0$$

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

$$T = \frac{\lambda}{\rho - \beta}$$

$$T = \frac{\lambda}{\rho} + \left[\frac{\beta}{\lambda_{eff}}\right]$$

$$\Delta\rho = \frac{K_{eff2} - K_{eff1}}{K_{eff1} K_{eff2}}$$

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

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

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

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

$$DR_1 = DR_2$$

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

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

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

1 Horsepower = 2.54 x 10^3 BTU/hr

1 BTU = 778 ft-lbf

1 gal (H_2O) . 8 lbm

c_P = 1.0 BTU/hr/lbm/EF

1 kg = 2.21 lbm

1 Mw = 3.41 x 10^6 BTU/hr

EF = 9/5 EC + 32

EC = 5/9 (EF - 32)

c_p = 1 cal/sec/gm/EC

B.1 a b c d ___

B.2 a b c d ___

B.3 a b c d ___

B.4 a b c d ___

B.5 a b c d ___

B.6 a b c d ___

YEARS

B.7a 1 2 4 6 ___

B.7b 1 2 4 6 ___

B.7c 1 2 4 6 ___

B.7d 1 2 4 6 ___

B.8 a b c d ___

B.9 a b c d ___

B.10 a b c d ___

B.11a SL LSSS LCO ___

B.11b SL LSSS LCO ___

B.11c SL LSSS LCO ___

B.11d SL LSSS LCO ___

B.12a 1 2 3 4 ___

B.12b 1 2 3 4 ___

B.12c 1 2 3 4 ___

B.12d 1 2 3 4 ___

B.12e 1 2 3 4 ___

B.13 a b c d ___

B.14 a b c d ___

B.15 a b c d ___

B.16 a b c d ___

B.17 a b c d ___