June 22, 2001

Mr. Ralph A. Butler, Chief Operating Officer
Research Reactor Facility
University of Missouri
Columbia, MO 65211

SUBJECT: INITIAL EXAMINATION REPORT NO. 50-186/OL-01-02

Dear Mr. Butler:

During the week of June 10, 2001, the NRC administered initial examinations to employees of your facility who had applied for a license to operate your University of Missouri – Columbia Reactor. The examination was conducted in accordance with NUREG-1478, "Non-Power Reactor Operator Licensing Examiner Standards," Revision 1. At the conclusion of the examination, the examination questions and preliminary findings were discussed with those members of your staff identified in the enclosed report.

In accordance with 10 CFR 2.790 of the Commission's regulations, a copy of this letter and the enclosures will be available electronically for public inspection in the NRC Public Document Room or from the Publicly Available Records (PARS) component of NRC's document system (ADAMS). ADAMS is accessible from the NRC Web site at (the Public Electronic Reading Room) http://www.nrc.gov/NRC/ADAMS/indesx.html. The NRC is forwarding the individual grades to you in a separate letter which will not be released publicly. Should you have any questions concerning this examination, please contact Mr. Paul Doyle at 301-415-1058 or Internet e-mail pvd@nrc.gov.

Sincerely,

/RA/

Ledyard B. Marsh, Chief
Events Assessment, Generic Communications
and Non-Power Reactors Branch
Division of Regulatory Improvement Programs
Office of Nuclear Reactor Regulation

Docket No. 50-186

Enclosures: 1. Initial Examination Report
No. 50-186/OL-01-02
2. Examination and answer key (RO/SRO)

cc w/encls:

Please see next page
University of Missouri-Columbia Docket No. 50-186

cc:

University of Missouri
Associate Director
Research Reactor Facility
Columbia, MO 65201

A-95 Coordinator
Division of Planning
Office of Administration
P.O. Box 809, State Capitol Building
Jefferson City, MO 65101

Mr. Ron Kucera, Director
Intergovernmental Cooperation
and Special Projects
Missouri Department of Natural Resources
P.O. Box 176
Jefferson City, MO 65102

Fac[illegible] Docket No. 50-186

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2. Exam[illegible]

RE[illegible]

June 22, 20

Off[illegible]

LMarsh

ADAMS ACCESSION #: ML011700564

OFFICE	REXB:CE	E	IOLB	E	REXB:BC	
NAME	PDoyle		EBamhill		LMarxh	
DATE	06/ 21 /2001		06/ 20 /2001		06/ 21 /2001	

C = COVER
E = COVER & ENCLOSURE
N = NO COPY
OFFICIAL RECORD COPY

TEMPLATE #:NRR-074

A.9 Mr

Jo

3/0	3/0	3/0	RO PASS/FAIL
0/0	0/0	0/0	SRO PASS/FAIL
3/0	3/0	3/0	TOTAL PASS/FAIL

REPORT DETAILS

OPERATOR LICE

U. S. NUCLEA

Un

Paul Doyle, Chief Examiner

Date

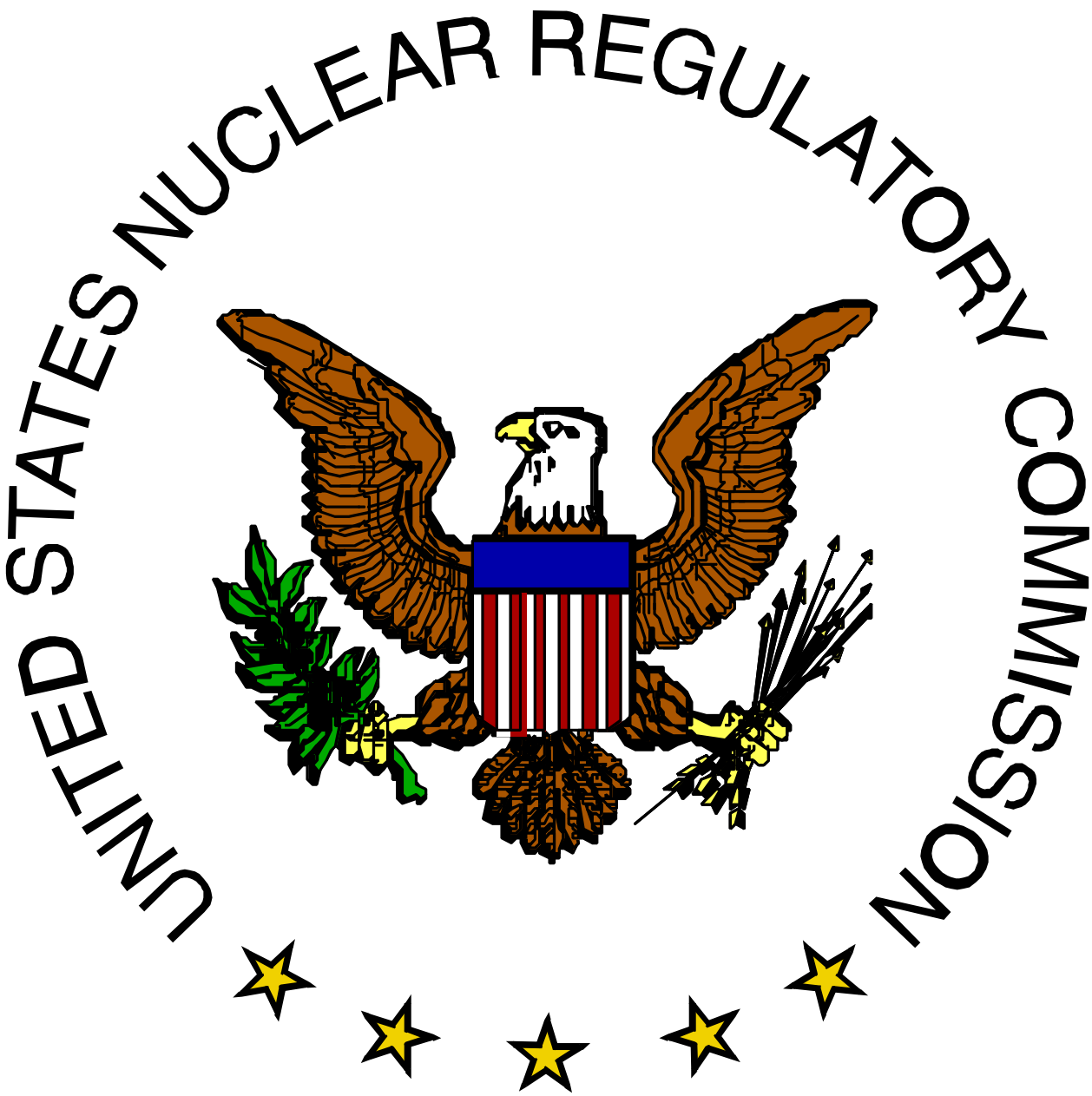
006/18/2

Continued on n

ENCLOSURE 1

UNIVERSITY OF MISSOURI–COLUMBIA

With Answer Key



OPERATOR LICENSING
EXAMINATION
June 12, 2001

ENCLOSURE 2

d. c. b. a.

20%

into the reactor.

40 seconds

[1.0 point]

[1.0 point]

[1.0 point]

d. c. b. a. pos

a a a a

0.003 0.003 0.001 0.001

gamma

LARGER SMALLER LARGER SMALLER

increase increase

SHORTER SHORTER LONGER LONGER

time to reach equilibrium. time to reach equilibrium.

1.0 point]

[1.0 point]

[1.0 point]

insertions of

d. c. b. a. Which of the following is

[1.0 point] [1.0 point] [1.0 point]

d. 14

c. 12

b. 10

a. 8

60 seconds 30 seconds 21 seconds 15 seconds

[1.0 point]

[1.0 point]

Number of Elements Installed	Detector A (cpm)	Detector B (cpm)
8	34	30
6	22	22
4	17	18
2	13	15
0	11	13

d. c. b. a. Reactivity is ... QUESTION A.19 ... b. a. the following reactor ...

equal to 5% ... negative ... K/K when the reactor is prompt critical.

σ_{sAl} = 3.79 barns, and ... the K ... the shutdown margin

$\Delta K/K$ ... value ... = 0.23 barns, ... margin, σ_{aAl} = 7.90 barns and σ_{aCu} = 1.49 barns, Which ONE of

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

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

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

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

[1.0 point]

[1.0 point]

[1.0 point]

d. c. b. a. Which

d. c. b. a. we

140 rem/hr temp

B.3

[1.0 point]

(B.2)

[2.0 points, ½ each]

(B.1)

[

d. c. b. a. mo

0.95 0.90 0.85 0.80

550 R

No, on

is less than ____ under all

(B.6)

(B.5)

(B.4)

[1.0 point]

[2.0 points, ½ each]

4. 3. 2. 1.

Very

Area

d. c. b. a. Ex

cryog

(B.10)

[1.0 point]

(B.9)

[2.0 points, ½ each]

(B.8)

[1.0 point]

(B.7)

[

Least Significant

1 1 1

2 2 2

Most Significant

3 3 3

d. c. b. a. one

40.6 18.6 5.2 6.3 hours

Initial

content of a ra

(B.14) (B.13) (B.12) (B.11

[1.0 point] [1.0 point] [1.0 point]

d. c. b. a. flow

(B.17) (B.16) (B.15

[1.0 point] [1.0 point]

e. d. c. b. a. col

Wide

as a

C.4 C.3 C.2 C.1

[2.0 points, ½ point each] [1.0 point] [1.0 point] [1

Question Deleted per Facility Comment

5. 3.4.2. 1.

Ion Cha

d. c. b. a. Which one of the following ... QUESTION ...

(tritium) at MURR?

release to the environment

Controlled ... Primary ... Low ... 80 85 90

has too short a half-life to require environmental monitoring.

C.8 [1.0 point]

C.7 [1.0 point]

C.6 [2.0 points, ½ each]

C.5 [1

d. c. b. a. tank

C.11

[1.0 point]

C.10

[2.0 points, ½ each]

C.9

[1

4. 3. 2. 1.

Filters

QUESTION

automatic mode

automatic mode

C.14

[1.0 point]

C.13

at 50% withdrawn.

and is being driven at 50% with bottom of travel.

[1.0 point]

C.12

[

Which ONE of the following is the design feature which prevents an **OVERPRESSURE** condition from damaging the reactor containment? The containment ...

a. contains a "seal trench" with a minimum of 4.6 feet of water which will blow out onto the floor of the laboratory basement relieving the overpressure condition.

b. contains a plug designed to blow out at a preset limit.

c. contains an air relief valve which starts opening at a preset limit.

d. exhaust damper is designed to open

d. c. b. a. The

in their

C.17

[1.0 point]

C.16

[1.0 point]

C.15

[

A.17 REF A.16 REF A.15 DOE REF A.14 REF A.13 REF A.12 REF A.11 REF A.10 REF A.9 REF A.8 REF A.7 REF A.6 REF A.5 REF A.4 REF A.3 REF A.2 REF A.1 Section

c DOE Fundamentals Handbook, Nuclear Physics and Reactor Theory, Volume

$\frac{1}{2}$ —> ln (2) = time ÷ 30 sec —> time = ln (2) x 30 sec.

Question Deleted per Facility Comment.

Question De

$$\frac{0.693 \times 30}{0.7 \times 30} \approx 21$$

REF: REF: REF: REF: Section A

DOE Fundamentals Handbook, Mathematics, Volume 1 of 2

REF.17 REF.16 REF.15 REF.14 REF.13 REF.12 REF.11 REF.10 REF.9 REF.8 REF.7 REF.6 REF.5 REF.4 REF.3 REF.2 REF.1 Section B

b, 1;

b, 3;

c, 3

c, 3;

b, LCO;

d, 4

c, LC

REC-17 REC-16 REC-15 REC-14 REC-13 REC-12 REC-11 REC-10 REC-9 REC-8 REC-7 REC-6 REC-5 REC-4 REC-3 REC-2 REC-1 Section C

FEP-1 SQP VI[illegible] ff, p. 9-13.

Question Deleted

b, 3;

b, R;

b, 1;

b, shut;

c, 1;

c, A;

c, 1;

c, open;

d, 4.

d, S

d, 2;

e, 3

d, open

All work done on this examination is my own. I have [illegible]

Category				
Value	60.00	20.00	20.00	20.00

% of Total	33.3	33.3	33.3	

CANDIDATE [illegible]

Candidates Score

% of

FINAL GRADE

____%

Category				
Value	____	____	____	

NON-POWER INITIAL R

U. S. NUCLEAR REGU

III

University of Missouri-

TJOK 06/12

Category	A.	B.	C.	

_____

Candidate's Signature

Radiological Characteristics | Facility and Radiation Monitoring Systems | Procedures and Facility Operatin

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 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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

$$T_{½} = \frac{0.693}{\lambda}$$

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

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

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

$$DR_1 d_1^{\,2} = DR_2 d_2^{\,2}$$

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

Section A

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 ___

Section B

B.1 a b c d ___

B.2a SL LSSS LCO ___

B.2b SL LSSS LCO ___

B.2c SL LSSS LCO ___

B.2d SL LSSS LCO ___

B.3 a b c d ___

B.4 a b c d ___

B.5a 1 2 3 4 ___

B.5b 1 2 3 4 ___

B.5c 1 2 3 4 ___

B.5d 1 2 3 4 ___

B.6 a b c d ___

B.7 a b c d ___

B.8 a b c d ___

B.9a 1 2 3 ___

B.9b 1 2 3 ___

B.9c 1 2 3 ___

B.10 a b c d ___

B.11 a b c d ___

B.12 a b c d ___

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 ___

Section C

C.1 a b c d ___

C.2 a b c d ___

C.3 a b c d ___

C.4a 1 2 3 4 5 ___

C.4b 1 2 3 4 5 ___

C.4c 1 2 3 4 5 ___

C.4d 1 2 3 4 5 ___

C.4e 1 2 3 4 5 ___

C.5 a b c d ___

C.6a S R A E ___

C.6b S R A E ___

C.6c S R A E ___

C.6d S R A E ___

C.7 a b c d ___

C.8 a b c d ___

C.9 a b c d ___

C.10a 1 2 3 4 ___

C.10b 1 2 3 4 ___

C.10c 1 2 3 4 ___

C.10d 1 2 3 4 ___

C.11 a b c d ___

C.12 a b c d ___

C.13 a b c d ___

C.14 a b c d ___

C.15a Open Shut ___

C.15b Open Shut ___

C.15c Open Shut ___

C.15d Open Shut ___

C.16 a b c d ___

C.17 a b c d ___

CAN THIS DOCUMENT BE DELETED? SUBJECT ACCESSION NU

NAME

INITIAL EXA

4. 3. 2. 1.

SECRETARY (Disapproved) LE

DATE

06/ /2006 06/ /2006

NO ___