May 9, 2012

Jeffrey A. Geuther, Ph.D.
Nuclear Reactor Manager
Kansas State University
112 Ward Hall
Manhattan, KS 66506

SUBJECT: EXAMINATION REPORT NO. 50-188/OL-12-02, KANSAS STATE UNIVERSITY

Dear Dr. Geuther:

During the week of March 26, 2012, the U.S. Nuclear Regulatory Commission (NRC) administered operator licensing examinations at your Kansas State University reactor. The examination was conducted according to NUREG-1478, "Operator Licensing Examiner Standards for Research and Test Reactors," Revision 2. Examination questions and preliminary findings were discussed at the conclusion of the examination with those members of your staff identified in the enclosed report.

In accordance with Title 10, Section 2.390 of the Code of Federal 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 Agencywide Documents Access and Management System (ADAMS). ADAMS is accessible from the NRC Web site at http://www.nrc.gov/reading-rm/adams.html (the Public Electronic Reading Room). The NRC is forwarding the individual grades to you in a separate letter which will not be released publicly. If you have any questions concerning this examination, please contact Mike Morlang at 301-415-4092 or via internet e-mail gary.morlang@nrc.gov.

Sincerely,
/RA by P. Isaac/

Johnny H. Eads, Jr., Chief
Research and Test Reactors Oversight Branch
Division of Policy and Rulemaking
Office of Nuclear Reactor Regulation

Docket No. 50-188

Enclosures:
1. Examination Report No. 50-188/OL-12-02
2. Written examination

cc without enclosures: see next page

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DISTRIBUTION w/ encls.:
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OFFICE	PROB:CE		IOLB:LA		PROB:BC	
NAME	MMorlang by CRR		CRevelle		JEads by PI	
DATE	05/08/2012		05/08/2012		05/09/2012	

OFFICIAL RECORD COPY

cc:

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State of Kansas
Topeka, KS 66612

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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.: 50-188/OL-12-02

FACILITY DOCKET NO.: 50-188

FACILITY LICENSE NO.: R-88

FACILITY: Kansas State University

SUBMITTED BY: **/RA/** 04/25/2011
Mike Morlang, Chief Examiner Date

SUMMARY:

During the week of March 26, 2012, the NRC administered license examinations to two Reactor Operator license applicants and one Senior Reactor Operator Upgrade candidate. The Senior Reactor Operator Upgrade candidate passed all applicable portions of the examination. The two Reactor Operator candidates passed the written examination and the operating test.

REPORT DETAILS

1. Examiner: Mike Morlang, 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:
Mike Morlang, NRC, Chief Examiner
Dr. Jeff Geuther, Director

The NRC Examiner thanked the facility for their support in the administration of the examinations.

ENCLOSURE 1

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

FACILITY: Kansas State University

REACTOR TYPE: TRIGA

DATE ADMINISTERED: 03/26/2012

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		_____	____%	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 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's

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

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

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

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

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

$$CR_1(1-K_{eff_1}) = CR_2(1-K_{eff_2})$$
$$CR_1(-\rho_1) = CR_2(-\rho_2)$$

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

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

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

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

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

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

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

EQUATION SHEET's

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

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

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

$$T_{½} = \frac{0.693}{\lambda}$$

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

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

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

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

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

EQUATION SHEET's

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

1 Curie = 3.7×10^{10} dis/sec

1 kg = 2.21 lbm

1 Horsepower = 2.54×10^{3} BTU/hr

1 Mw = 3.41×10^{6} BTU/hr

1 BTU = 778 ft-lbf

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

1 gal (H_2O) ≈ 8 lbm

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

$c_P = 1.0$ BTU/hr/lbm/$^{\circ}F$

$c_p = 1$ cal/sec/gm/$^{\circ}C$

Section A Reactor Theory, Thermo, and Facility Characteristics

Question: A.001 (1.00 point) {1.0}
Delayed neutrons are considered to be more "effective" than prompt neutrons because delayed neutrons have a:

a. higher reproduction factor.

b. higher fast non-leakage probability.

c. lower thermal utilization factor.

d. higher thermal utilization factor.

Answer: A.01 b.
Reference: DOE Fundamentals Handbook, Module 4, page 12.

Question: A.002 (1.00 point) {2.0}
The reactor is subcritical with a K_{eff} of 0.95. Which ONE of the following is the shutdown margin?

a. 5.00% ΔK/K

b. 5.26% ΔK/K

c. 19.0% ΔK/K

d. 20.0% ΔK/K

Answer: A.02 b.
Reference: SDM = $(1 - K_{eff})/K_{eff}$ = (1 – 0.95)/0.95 = 0.05/0.95 = 0.526

Question: A.003 (1.00 point, 0.25 each) {3.0}
Identify whether each of the following conditions will **INCR**EASE or **DECR**EASE the shutdown margin of a reactor.

a. Raising moderator temperature (Assume negative temperature coefficient).

b. Insertion of a positive reactivity worth experiment.

c. Burnout of a burnable poison.

d. Fuel depletion.

Answer: A.03 a. = INCR; b. = DECR; c. = DECR; d. = INCR
Reference: DOE Fundamentals Handbook, Volume 2, Module 4, Reactor Theory (Reactor Operations), Enabling Objective 3.6

Section A Reactor Theory, Thermo, and Facility Characteristics

Question: A.004 (1.00 point) {4.0}
Reactor power increased from 1 watt to 5 kW in 186 seconds. What was the period?

a. 10 secs.

b. 22 secs.

c. 30 secs.

d. 116 secs.

Answer: A.04 b
Reference: $P = P_0 e^{t/T}$ $\ln(P/P_0) = t/T$ $T = t/(\ln(P/P_0))$
$T = (186 \text{ sec})/(\ln 5000) = 21.8$ seconds

Question: A.005 (1.00 point) {5.0}
Which statement best describes Xe^{135} behavior immediately following a Reactor Scram?
Xenon^{135} concentration …

a. decreases due to production of I^{135} directly from fission stops.

b. decreases due to production from decay of I^{135} being less than Xe^{135} decay rate.

c. increases due to production from Te^{135} exceeding Xe^{135} decay.

d. increases due to production from decay of I^{135} exceeding Xe^{135} decay.

Answer: A.05 d.
Reference: DOE Fundamentals Handbook, Nuclear Physics and Reactor Theory,

Question: A.006 (1.00 point) {6.0}
Which factor of the Six Factor formula is most easily varied by the reactor operator?

a. Thermal Utilization Factor (f)

b. Reproduction Factor (η)

c. Fast Fission Factor (ε)

d. Fast Non-Leakage Factor (L_f)

Answer: A.06 a.
Reference: DOE Fundamentals Handbook, Nuclear Physics and Reactor Theory, Volume

Section A Reactor Theory, Thermo, and Facility Characteristics

Question: A.007 (1.00 point) {7.0}
In a reactor the thermal neutron flux (Ø) is 2.5×10^{12} fissions/cm^2/second, and the macroscopic cross-section (Σ_f) for fission is 0.1 cm^{-1}. The fission rate is

a. 2.5×10^{11} fissions/cm/second
b. 2.5×10^{13} fissions/cm/second
c. 2.5×10^{11} fissions/cm^3/second
d. 2.5×10^{13} fissions/cm^3

Answer: A.07 c.
Reference: DOE Fundamentals Handbook, Nuclear Physics and Reactor Theory,
Fission rate = thermal flux (Ø) $\times$ macroscopic cross-section (Σ_f) = $2.5 \times 10^{12} \times 0.1$ cm^{-1} = 2.5×10^{11} fissions/cm^3/second

Question: A.008 (1.00 point) {8.0}
An experimenter makes an error loading a rabbit sample. Injection of the sample results in a 100 millisecond period. If the scram which causes the reactor to shutdown is set at 1.5 MW and the scram delay time is 0.1 seconds, **WHICH ONE** of the following is the peak power of the reactor at shutdown.

a. 1.5 MW
b. 1.65 MW
c. 4.1 MW
d. 33 MW

Answer: A.08 c.
Reference: DOE Fundamentals Handbook, Nuclear Physics and Reactor Theory, Volume
$P = P_0 e^{t/\tau}$, P = 1.5 Mwatt $\times e^{0.1/0.1} = 1.5 \times e = 4.08$

Question: A.009 (1.00 point) {9.0}
The term "***PROMPT JUMP***" refers to:

a. the instantaneous change in power due to raising a control rod.
b. a reactor which has attained criticality on prompt neutrons alone.
c. a reactor which is critical using both prompt and delayed neutrons.
d. a negative reactivity insertion which is less than β_{eff}.

Answer: A.09 a.
Reference: DOE Fundamentals Handbook, Nuclear Physics and Reactor Theory

Section A Reactor Theory, Thermo, and Facility Characteristics

Question: A.010 (1.00 point) {10.0}
Which ONE of the following statements is the definition of REACTIVITY?

a. A measure of the core's fuel depletion.
b. A measure of the core's deviation from criticality.
c. Equal to 1.00 ΔK/K when the reactor is critical.
d. Equal to 1.00 ΔK/K when the reactor is prompt critical.

Answer: A.10 b.
Reference: DOE Fundamentals Handbook, Nuclear Physics and Reactor Theory, Volume

Question: A.011 (1.00 point) {11.0}
During the minutes following a reactor scram, reactor power decreases on a negative 80 second period, corresponding to the half-life of the longest lived delayed neutron precursor, which is approximately:

a. 20 seconds.
b. 40 seconds.
c. 55 seconds.
d. 80 seconds.

Answer: A.11 c.
Reference: DOE Reference, Module 4, Table 1 on page 12.

Question: A.012 (1.00 point) {12.0}
Which ONE statement below describes a positive fuel temperature coefficient?

a. When fuel temperature increases, positive reactivity is added.
b. When fuel temperature decreases, positive reactivity is added.
c. When fuel temperature increases, negative reactivity is added.
d. When fuel temperature increases, reactor power decreases.

Answer: A.12 a.
Reference: DOE Reference, Module 3, *Reactivity Coefficients and Reactivity Defects*, page 37.

Section A Reactor Theory, Thermo, and Facility Characteristics

Question: A.013 (1.00 point) {13.0}
Which ONE of the following is the principal source of energy (heat generation) in the reactor 15 minutes following a reactor shutdown from extended operation at 100% power?

a. Production of delayed neutrons.
b. Subcritical multiplication.
c. Spontaneous fission of U-238.
d. Decay of fission products.

Answer: A.13 d.
Reference: DOE Reference, Module 4, page 33. Exam 5

Question: A.014 (1.00 point) {14.0}
The reactor is to be pulsed. The projected pulse will add TWICE as much reactivity as the last pulse performed. In relation to the last pulse, for the projected pulse peak power will be:

a. about four times larger and the energy released will be about four times larger.
b. about two times larger and the energy released will be about four times larger.
c. about four times larger and the energy released will be about two times larger.
d. about two times larger and the energy released will be about two times larger.

Answer: A.14 c.
Reference: NRC Exam January, 2005.

Question: A.015 (1.00 point) {15.0}
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

Answer: A.15 d.
Reference: Reference 1, Module 2, *Neutron Moderation*, p. 23, Exam 7

Section A Reactor Theory, Thermo, and Facility Characteristics

Question: A.016 (1.00 point) {16.0}
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

Answer: A.16 d.
Reference: DOE Reference, Module 4, □ Theory (□ Operations), E.O. 1.4, pg. 7

Question: A.017 (1.00 point) {17.0}
Which **ONE** of the following is the definition of the term "Cross-Section?"

a. The probability that a neutron will be captured by a nucleus.
b. The most likely energy at which a charge particle will be captured.
c. The length a charged particle travels past the nucleus before being captured.
d. The area of the nucleus including the electron cloud.

Answer: A.17 a.
Reference: Reactor Training Manual - Cross Section.

Question: A.018 (1.00 point) {18.0}
As a reactor continues to operate over a period of months, for a constant power level, the average neutron flux:

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

Answer: A.18 b.
Reference: DOE Fundamentals Handbook, Module 2, Reaction Rates, pg 21.

Section A Reactor Theory, Thermo, and Facility Characteristics

Question: A.019 (1.00 point) {19.0}
The moderator-to-fuel ratio describes the relationship between the number of moderator atoms in a volume of core to the number of fuel atoms. A reactor which is:

a. undermoderated will have a positive moderator temperature coefficient.
b. undermoderated will have a negative moderator temperature coefficient.
c. overmoderated will have a constant moderator temperature coefficient.
d. overmoderated will have a negative moderator temperature coefficient.

Answer: A.19 b.
Reference: DOE Fundamentals Handbook, Module 3,
Reactivity Coefficients, page 25.

Question: A.020 (1.00 point) {20.0}
Inelastic scattering can be described as a process whereby a neutron collides with a nucleus and:

a. reappears with a higher kinetic energy, with the nucleus absorbing a gamma ray.
b. reappears with a lower kinetic energy, with the nucleus emitting a gamma ray.
c. is absorbed by the nucleus, with the nucleus emitting a gamma ray.
d. reappears with the same kinetic energy it had prior to the collision.

Answer: A.20 b.
Reference: DOE Fundamentals Handbook, Module 1, Neutron Interactions,
page 45.

Section B Normal/Emergency Procedures & Radiological Controls

Question B.001 [1.0 point] {1.0}

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

Answer: B.01 d.
Reference: Basic Radiological Controls knowledge:
"Half-Thickness and Tenth-Thickness". $2^{10} = 1024$

Question B.002 [1.0 point] {2.0}

Which ONE of the following conditions is permitted during reactor operation?

a. A pulse reactivity insertion of $3.75.

b. Startup with the period scram bypassed.

c. Fuel temperature monitoring is not available.

d. Operating in steady state mode with the linear power channel inoperable.

Answer: B.02 b.
Reference: Procedure No. 11 Reactor Start-up with Period SCRAM Bypassed.

Question B.003 [1.0 point, 0.25 each] {3.0}

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. If all fuel elements are stainless steel clad, the reactivity worth of any individual EXPERIMENT SHALL NOT exceed $2.00

b. Power level SHALL NOT exceed 1,250 $kW_{(th)}$ in STEADY STATE MODE of operation

c. Water temperature at the exit of the reactor pool SHALL NOT exceed 130°F with flow through the primary cleanup loop.

d. Steady state fuel temperature shall not exceed 750°C.

Answer: B.03 a. = LCO; b. = LSSS; c. = LCO d. = SL
Reference: Technical Specifications 3.6, 2.2, 2.1 and 3.8

Question B.004 [1.0 point, 0.25 each] {4.0}
The ventilation system is inoperable. Identify whether each of the listed evolutions is allowed, or not allowed per technical specifications.

a. Insertion of a $1.00 pulse from a subcritical power level.

b. Moving a new (unirradiated) fuel element in the reactor bay.

c. Operation of the reactor at 100% steady-state conditions, no experiments in the core.

d. Operation of the reactor at 50% steady-state conditions with an experiment which generates Xe135.

Answer: B.04 a. = NA; b. = A; c. = A; d. = NA
Reference: Technical Specification 3.5. Gaseous Effluent Control

Question B.005 [1.0 point] {5.0}
In accordance with Experiment No. 30, "Pulsed Operation, Amended," the reactor is pulsed starting from a subcritical configuration when:

a. it is desired to pulse over a wider range of power.

b. the reactor cannot be made critical.

c. the pulse rod shock absorber is set to stop the pulse rod after the total pulse rod worth is equal to the amount by which the reactor is subcritical.

d. the time required to reach criticality might adversely affect the purpose of the pulse experiment.

Answer: B.05 b.
Reference: Experiment No. 30.

Question B.006 [1.0 point] {6.0}
An accessible area within the facility has a general radiation level of 325 mrem/hour. What would be the EXPECTED posting for this area?

a. "Caution, Airborne Radioactivity Area"

b. "Caution, Radiation Area"

c. "Danger, High Radiation Area"

d. "Grave Danger, Very High Radiation Area"

Answer: B.06 c.
Reference: 10CFR20.

Question B.007 [1.0 point] {7.0}
Which ONE of the following is the 10 CFR 20 definition of TOTAL EFFECTIVE DOSE EQUIVALENT (TEDE)?

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

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

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

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

Answer: B.07 d.
Reference: 10 CFR 20.1003 Definitions

Question B.008 [1.0 point] {8.0}
Automatic scram signals are initiated by 1) loss of high voltage to nuclear instrumentation, 2) high linear channel power, 3) high safety channel power, 4) high fuel temperature, and 5) short reactor period. Of these, the scram signals required by the Technical Specifications for steady state power operation are:

a. High safety channel power

b. Short period, high safety channel power, loss of high voltage.

c. High linear channel power, loss of high voltage, short period

d. High safety channel power, high linear channel power, short period, high fuel temperature, loss of high voltage.

Answer: B.08 a.
REF: Technical Specifications, Table 2.

Question B.009 [1.0 point] {9.0}
In accordance with Procedure No. 1, “Biennial Control Rod Inspection,” upon reinstallation of the assembly:

a. rod-drop measurements from full withdrawal to full insertion must be made.

b. a new differential rod worth curve must be measured.

c. a new integral rod worth curve must be measured.

d. the reactivity insertion rate must be measured.

Answer: B.09 a.
Reference: Procedure No. 1, page 3.

Section B Normal/Emergency Procedures & Radiological Controls

Question B.010 [1.0 point] {10.0}
A radiation survey of an area reveals a general radiation reading of 1 mrem/hr. There is, however, a small pipe (treat this as a point source) which reads 10 mrem/hr at one (1) meter. Which ONE of the following defines the posting requirements for the area in accordance with 10CFR20?

a. Restricted Area.
b. Caution Radiation Area.
c. Caution High Radiation Area.
d. Grave Danger, Very High Radiation Area.

Answer: B.10 c.
Reference: $DR_1D_1^2 = DR_2D_2^2$;
10 mrem/hr at one meter (100 cm.)
results in 111.1 mrem/hr at 30 cm.

Question B.011 [1.0 point] {11.0}
In accordance with Procedure No. 16, "Reactor Shutdown," an intentional safety system scram is accomplished by:

a. removing the console key.
b. actuating the manual scram bar.
c. manually adjusting a scram setpoint.
d. manually interrupting current flow to the control rod drive magnets.

Answer: B.11 c.
Reference: Procedure No. 16.

Question B.012 [1.0 point] {12.0}
In accordance with 10CFR20.1301, individual members of the public are limited to a TEDE in one year of:

a. 10 mrem.
b. 100 mrem.
c. 500 mrem.
d. 1.25 rem.

Answer: B.12 b.
Reference: Radiation Protection Program

Question B.013 [1.0 point] {13.0}

A maintenance technician has completed an authorized modification to the control rod drive electrical system. Which ONE of the following staffing requirements applies to the subsequent startup?

a. A senior reactor operator may conduct the startup if the senior health physicist is in the facility.

b. A senior reactor operator may conduct the startup alone to verify operability prior to normal operations.

c. A reactor operator and a trainee may conduct the startup if the senior reactor operator is available in the facility or on call.

d. The maintenance technician may conduct the startup to evaluate proper response under direction of a senior reactor operator.

Answer: B.13 c.
Reference: Procedure No. 15.

Question B.014 [1.0 point] {14.0}

In accordance with Procedure No. 8, "Calibration of Continuous Air Monitors," Technicium-99 is used as a source because:

a. its decay particles and energies are similar to Ar-41.

b. its decay particles and energies are similar to I-131.

c. it produces count rates large enough to be measured.

d. its half-life is long enough so that it does not decay appreciably.

Answer: B.14 b.
Reference: Procedure No. 8, page 2.

Question B.015 [1.0 point] {15.0}

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

a. 0.33 Rem/hour.

b. 2.0 Rem/hour.

c. 6.0 Rem/hour.

d. 20.0 Rem/hour.

Answer: B.15 b.
Reference: Dose Rate = $6CiE/R^2$ = 6x25x1.33/100 = 2 Rem/hour.

Question B.016 [1.0 point] {16.0}
In accordance with the Emergency Plan, the “Site Boundary” is:

a. the reactor facility, Room 110 of Ward Hall.

b. Ward Hall and the adjacent fenced areas.

c. KSU campus boundary.

d. Facility Control Center.

Answer: B.16 b.
Reference: Emergency Plan, Section 1.1.

Question B.017 [1.0 point] {17.0}
In accordance with the Emergency Plan, which ONE of the following is the definition of an UNUSUAL EVENT classification? Events are in progress or have occurred which:

a. indicate a potential degradation of the safety of the reactor facility with no release of radioactive material requiring offsite response.

b. have resulted or could result in radiation levels in excess of 100 mrem/hr at the operations boundary.

c. have resulted or could result in exposures at the facility boundary in excess of 10CFR20 limits.

d. involve an actual or potential substantial degradation of the level of safety of the facility.

Answer: B.17 a.
Reference: Emergency Plan, Section 5.1.

Question B.018 [1.0 point] {18.0}
Which ONE of the following radiation detectors does not have an output intensity (current or pulse height) proportional to the incident radiation energy? (i.e., if the incident energy increases, the output intensity increase)

a. Ion chamber

b. GM

c. Proportional counter

d. Scintillation detector

Answer: B.18 b.
Reference: Facility supplied question bank

Section B Normal/Emergency Procedures & Radiological Controls

Question B.019 [1.0 point] {19.0}

Which ONE of the following situations would illustrate a time when the reactor is shutdown but NOT secured?

a. One of the control rod drives is removed for inspection; the rod is decoupled and is fully inserted into the core, all other rods are fully inserted and the console key is in the 'off' position and removed.

b. All control rods are fully inserted; the console key is in the 'off' position and removed, while fuel is being rearranged in the fuel storage racks.

c. An experiment having a reactivity of 50¢ is installed in the reactor with all control rods fully inserted and the key removed.

d. The control rods are withdrawn to a subcritical position, the core is subcritical by $1.20.

Answer B.19 d.
Reference: Technical Specifications § 1 Definitions.

Question B.020 [1.0 point] {20.0}

The 5 R/hr evacuation alarm has sounded. In addition, the gamma radiation level in the hallway outside the reactor control room is 150 mR/hr. Which ONE of the following actions should you take?

a. The Site Boundary area shall be evacuated.

b. All personnel in the Operations Boundary area shall assemble at Ward Hall Emergency Assembly Area 1 or 2.

c. Take no action until the University Radiation Safety Officer confirms the radiation levels.

d. All personnel in the Site Boundary area shall assemble in the Operations Boundary area.

Answer: B.20 a.
Reference: Emergency Plan, 3.5.

Section C Facility and Radiation Monitoring Systems

Question C.001 (1.00 point) {1.0}

For a standard control rod, the red light is OFF, the white light is OFF and the blue light is ON. This is an indication that the rod and drive are …

a. not in contact, and are somewhere between full up and full down.

b. in contact, and are somewhere between full up and full down.

c. in contact, and are both are full up.

d. in contact, and are both full down.

Answer: C.01 b.
Reference: Modification of facility supplied question

Question C.002 (1.00 point) {2.0}

The normal rods use electric drive motors for positioning. The transient rod operates by

a. pneumatics (air)

b. pneumatics (Nitrogen)

c. hydraulics (Water)

d. hydraulics (Oil)

Answer: C.02 a.
Reference: SAR Section 4.2.2

Question C.003 (1.00 points, 1/3 point each) {3.0}

Match the Nuclear Instrumentation Channel provided in column A, with the correct Detector from column B. Each choice is used only once.

Column A	Column B
a. Wide Range Logarithmic Channel	1. Compensated Ion Chamber
b. Wide Range Linear Channel	2. Fission Chamber
c. Pulse and Power Channel	3. Uncompensated Ion Chamber

Answer C.03 a. = 2; b. =1; c. = 3
Reference: Modification of three facility supplied questions.

Question C.004 (1.00 point) {4.0}
Which ONE of the following parameters is **NOT** measured in the Primary Cooling/Purification System Loops?

a. Temperature
b. Conductivity
c. Flow Rate
d. pH

Answer: C.04 d.
Reference: SAR § 5.1 *Summary Description*, Figure 5.1

Question C.005 (1.00 point) {5.0}
The purpose of the graphite slugs located at the top and bottom of each fuel rod is to …

a. reflect neutrons, thereby reducing neutron leakage from the core.
b. absorb neutrons, thereby reducing neutron leakage from the core.
c. couple neutrons from the core to the nuclear instrumentation, decreasing shadowing effects.
d. absorb neutrons, thereby reducing neutron embrittlement of the upper and lower guide plates.

Answer: C.05 a.
Reference: SAR § 4.2.1 , *Reactor Fuel*, Figure 4.3.

Question C.006 (1.00 point) {6.0}
The North-East Beam Port core-end terminates at:

a. The outer surface of the reflector container
b. The inner surface of the reflector container
c. The top of the Lazy Susan
d. The center of the core

Answer: C.06 b.
Reference: Facility Supplied Question modified to meet NRC requirements.

Question C.007 (1.00 point) {7.0}

According to the Kansas State SAR pool surface monitor radiation measurements at 250 kW directly above the pool surface are typically _____ from all sources with the primary cooling system operating.

a. 5 to 10 mR/hr
b. 10 to 20 mR/hr
c. 20 to 30 mR/hr
d. 30 to 40 mR/hr

Answer: C.07 b.
Reference: SAR Section 5.6

Question C.008 (1.00 point) {8.0}

Which of the following determines the amount of reactivity that is inserted by the Transient Control Rod during a pulse operation?

a. The position of the vent holes.
b. The anvil of the shock absorber.
c. The Drive Up switch on the cylinder.
d. The air pressure applied to the Transition Rod pneumatic piston.

Answer: C.008 b.
Reference: Safety Analysis Report, § 7.3, Figure 7.8

Question C.009 (1.00 point, 0.25 each) {9.0}

Match the purification system functions in column A with the purification component listed in column B. (Note items from column B may be used more than once, or not at all.)

Column A	Column B
a. remove floating dust, bug larvae, etc.	1. Demineralizer (Ion Exchanger)
b. remove dissolved impurities	2. Skimmer
c. remove suspended solids	3. Filter
d. maintain pH	

Answer: C.09 a. = 2; b. = 1; c. = 3; d.= 1
Reference: Standard NRC purification system question.

Section C Facility and Radiation Monitoring Systems

Question C.010 (1.00 point) {10.0}

Water returning to the pool from the primary system is ejected through an angled nozzle, which causes a swirling motion in the pool. Which ONE of the following is the PRIMARY purpose for this design?

a. To increase the heat transfer rate due to increased convective flow.

b. To increase the transport time for N^{16} to reach the surface of the pool.

c. To break up O^{16} bubbles in the pool thereby decreasing the production of N^{16}.

d. To decrease the activation rate of O^{16} to N^{16} due to a decrease in time within the core.

Answer: C.10 b.
Reference: SAR § 5.6 Nitrogen 16 Control System

Question C.011 (1.00 point) {11.0}

During PULSE MODE which automatic scram is required to be operable?

a. high fuel temperature.

b. short reactor period.

c. percent power.

d. none.

Answer: C.11 a.
Reference: Tech Spec's Table 1: Min Measuring Channel Complement &
Table 2: Required Safety System Channels

Question C.012 (1.00 point) {12.0}

Which ONE of the following Nuclear Instrumentation Channels also supplies Period Indication?

a. Startup Channel

b. Nuclear Power Pulse Channel (NPP-1000)

c. Nuclear Log Wide Range Channel (NLWR-1000)

d. Nuclear Multi-Range Power Channel (NMP-1000)

Answer: C.12 c.
Reference: SAR § 7.3.1 also Figure 7.5.

Question C.013 (1.0 point, 1/3 point each) {13.0}
Identify the heat transfer mechanism (Radiation, Forced Convection, Natural Convection or Conduction) for each of the following:

a. Cooling the Core

b. Cooling the Pool

c. Transfer of heat across the tubes of the heat exchanger.

Answer: C.13 a. = NC; b. = FC; c. = Con
Reference: Standard NRC question

Question C.014 (1.0 point) {14.0}
Which ONE of the following is the actual method used to generate the rod position indication, for the standard control rods on the control panel?

a. A ten-turn potentiometer linked to the rod drive motor.

b. Voltage changes generated by the movement of a lead screw between two coils of a transformer.

c. A series of several reed switches which as the rod moves up close to generate a current proportional to rod position.

d. A servo motor connected to the UP and DN buttons which when either button is depressed generates a signal proportional to rod speed.

Answer: C.14 a.
Reference: SAR § 7.3.4(a) Standard Control Rod Drives.

Question C.015 (1.0 point) {15.0}
Which ONE of the following is the neutron source utilized in the reactor?

a. ^{124}Sb — ^{9}Be

b. ^{210}Po — ^{9}Be

c. ^{239}Pu — ^{9}Be

d. ^{241}Am — ^{9}Be

Answer: C.15 d.
Reference: SAR § 4.2.4 Neutron Startup Source

Question C.016 (1.0 point) {16.0}
An approved alternative to discharging water from the reactor bay sump to sewerage is to instead pump it to …

a. the bulk water tank.
b. the secondary storage tank.
c. the primary makeup storage tank.
d. the primary purification system upstream of the filters.

Answer: C.016 b.
Reference: Procedure No. 24 Sump Water Discharge System

Question C.017 (1.0 point) {17.0}
Which ONE of the following methods is the normal procedure for preventing basin water in the cooling tower from freezing when temperature is below -10°F? (Assume primary is below 100°F.)

a. Heaters in the tower water sump energize.
b. The three way valve stops cooling tower flow.
c. The fans are intermittently operated in reverse.
d. A University steam heating supply to the tower basin opens.

Answer: C.17 b.
Reference: SAR § 5.3.2 Secondary Cooling Automatic Control System.

Question C.018 (1.0 point) {18.0}
The compressed air system supplies which ONE of the following?

a. Secondary water control system
b. Automatic fire control system
c. Exhaust air removal system
d. Shim rod drive system

Answer: C.18 a.
Reference: modified facility supplied question

Question C.019 (1.0 point) {19.0}

During a survey of the demineralizer ½ hour after shutdown, you note that the dose rate has increased by a factor of 10 over the previous day's reading. Is this normal or abnormal, and why?

a. Normal, due to N^{16} in the coolant.

b. Normal, due to Ar^{41} entrained in the coolant system.

c. Abnormal, due to fission products in the demineralizer.

d. Abnormal, due to the concentration of H^3 in the demineralizer.

Answer: C.19 c.
Reference: The demineralizer removes ionic impurities. N^{16}, has much too short a half-life, H^3 emits much too weak a beta to be detected, and Ar^{41} is a noble gas, it will NOT concentrate in the demineralizer.

Question C.020 (1.0 point) {20.0}

When the mode switch is placed in the “AUTO” position the …

a. period scram is bypassed.

b. regulating rod will not fall into the core following a scram.

c. regulating rod moves in response to the NPP-1000 Percent Power signal.

d. regulating rod moves in response to the NMP-1000 Multi-Range Linear Channel signal.

Answer: C.20 d.
Reference: Previous NRC Exam Question, Modified per Facility Comment