October 5, 2010

Dr. Jeffrey Geuther, Director
Nuclear Reactor Facility Manager
Kansas State University
112 Ward Hall
Manhattan, KS 66506-2500

SUBJECT: RETAKE EXAMINATION REPORT NO. 50-188/OL-10-03,
KANSAS STATE UNIVERSITY

Dear Dr. Geuther:

During the week of September 13, 2010, a retake written operator licensing examination was administered at your Kansas State University TRIGA reactor. The examinations were conducted according to NUREG-1478, "Operator Licensing Examiner Standards for Research and Test Reactors," Revision 2. 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 Title 10 of the Code of Federal Regulations Section 2.390, 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 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. Phillip T. Young at (301) 415-4094 or via internet e-mail phillip.young@nrc.gov.

Sincerely,

/RA/
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. Retake Examination Report No. 50-188/OL-10-03
2. Facility comments on written examination
3. Written examination with facility comments incorporated

cc w/o enclosures: Please see next page

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DISTRIBUTION w/ encls.:

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ADAMS ACCESSION #: ML102720657 **TEMPLATE #:NRR-074**

OFFICE	PRTB:CE		IOLB:LA	E	PRTB:SC	
NAME	PYoung		CRevelle		JEads	
DATE	09/29/2010		9/30 /2010		10/5/2010	

OFFICIAL RECORD COPY

cc:

Office of the Governor
State of Kansas
Topeka, KS 66612

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Mayor of Manhattan
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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-10-03

FACILITY DOCKET NO.: 50-188

FACILITY LICENSE NO.: R-88

FACILITY: Kansas State University TRIGA Reactor

EXAMINATION DATES: September 14, 2010

SUBMITTED BY: /RA/ 10/1/2010
Phillip T. Young, Chief Examiner Date

SUMMARY:

During the week of September 13, 2010, a retake written operator licensing examination was administered to three RO applicants. The three RO retake applicants passed the examination.

REPORT DETAILS

1. Examiners: Phillip T. Young, Chief Examiner, NRC

2. Results:

	RO PASS/FAIL	SRO PASS/FAIL	TOTAL PASS/FAIL
Written	3/0	N/A	3/0
Operating Tests	N/A	N/A	N/A
Overall	3/0	N/A	3/0

3. Exit Meeting:
The Retake Examination was conducted in accordance with NUREG-1478, "Operator Licensing Examiner Standards for Research and Test Reactors," Revision 2. By past practice on written examination retake exams, the written examination was mailed to the facility and administered under the ES-201N Enclosure 4, Examination Security Agreement.

The facility submitted comments on the examination via e-mail. These comments along with their resolutions are included as Attachment 2 to this report.

ENCLOSURE 1

Facility Comments with NRC Resolution.

Question A.008

Comment: Answers "A" and "B" are identical, and both are correct. I recommend that you accept both answers.

NRC Resolution: Comment accepted. Correct answer for A.008 changed to a. or b.

Question A.010

Comment: None of the possible answers is correct - Answer "C" was calculated based on a 100 second period, but the problem states that the period is 30 seconds. The correct answer should be about 21 seconds.

NRC Resolution: Comment accepted. This question is deleted from the examination.

Question C.003

Comment: The correct answer of "A - Reactor Instruments and Control Systems" was not listed in the question statement. I instructed the examinees that the question should have read "Battery backup power is used for all of the following EXCEPT _____. emergency lighting, the University fire alarm system, the evacuation alarm, and ~~the security system~~ reactor instruments and control systems." I believe that this explanation was necessary to clarify the intent of the question. I'm letting you know, because it might have been a "give-away," considering the correct answer was the one I told them to add, and you may elect to exclude the question. I tried not to telegraph the correct answer when providing the clarification.

NRC Resolution: This question is deleted from the examination.

Question C.017

Comment: The correct answer should be "A". When in AUTO mode, the regulating rod moves in response to the NMP-1000 multi-range channel. I looked back at the facility comments to the exam in 2008 used as a reference for this question ... The comment was that NLW-1000 should be accepted in addition to NMP-1000, because the NLW-1000 provided a period signal to the automatic flux control system, so either response should be acceptable answers when asking which indication channel was used in the automatic flux control system. However, the NPP-1000 is NOT used in the automatic flux control system.

NRC Resolution: Comment accepted. Correct answer for C.017 changed to a.

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

FACILITY: Kansas State University

REACTOR TYPE: TRIGA

DATE ADMINISTERED: 09/14/2010

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
19.00	33.3	_____	____	A. Reactor Theory, Thermodynamics and Facility Operating Characteristics
20.00	33.3	_____	____	B. Normal and Emergency Operating Procedures and Radiological Controls
19.00	33.3	_____	____	C. Facility and Radiation Monitoring Systems
58.00		_____	____% 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.

Section A Reactor Theory, Thermo, and Facility Characteristic

EQUATION SHEET's

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

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

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

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

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

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

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

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

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

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

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

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

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

Section A Reactor Theory, Thermo, and Facility Characteristic

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 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 Reactor Theory, Thermo, and Facility Characteristic

Question: A. 001 [1.00 point] {1.0}
A reactor is slightly supercritical, with the thermal utilization factor = 0.700. A control rod is inserted to bring the reactor back to critical. Assuming all other factors remain unchanged, the new value for the thermal utilization factor is:

a. 0.698.

b. 0.700.

c. 0.702.

d. 0.704.

Answer: A.001 a.
Reference: DOE Fundamentals Handbook, Module 3, page 10.

Question: A. 002 [1.00 point] {2.0}
During the neutron cycle from one generation to the next, several processes occur that may increase or decrease the available number of neutrons. Which ONE of the following factors 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. Fast fission factor.

Answer: A.002 d.
Reference: DOE Fundamentals Handbook, Module 3, page 10.

Section A Reactor Theory, Thermo, and Facility Characteristics

Question: A. 003 [1.00 point] {3.0}
An Integral Rod Worth (IRW) curve is _____, while a Differential Rod Worth (DRW) curve is _____.

a. the total reactivity worth added by the rod at any point of withdrawal;
the reactivity change per unit movement of the rod at the point of withdrawal.

b. at its maximum value when the rod is approximately half-way out of the core;
at its maximum value when the rod is fully withdrawn from the core.

c. the slope of the DRW curve at any point of withdrawal;
the area under the IRW curve at any point of withdrawal.

d. the reactivity change per unit movement of the rod at any point of withdrawal;
the total reactivity worth of the rod at any point of withdrawal.

Answer: A.003 a.
Reference: DOE Fundamentals Handbook, Module 3, Control Rods,

Question: A. 004 [1.00 point] {4.0}
A reactor is critical at 50% of rated power, with reactivity = zero. A control rod is withdrawn and the power increases to a higher steady-state value. The reactivity of the reactor at the higher power level is zero because:

a. the positive reactivity due to the fuel temperature decrease balances the negative reactivity due to the control rod withdrawal.

b. the negative reactivity due to the fuel temperature decrease equals the positive reactivity due to the control rod withdrawal.

c. the positive reactivity due to the fuel temperature increase balances the negative reactivity due to the control rod withdrawal.

d. the negative reactivity due to the fuel temperature increase equals the positive reactivity due to the control rod withdrawal.

Answer: A.004 d.
Reference: DOE Fundamentals Handbook, Module 4, page 28.

Section A Reactor Theory, Thermo, and Facility Characteristic

Question: A. 005 [1.00 point] {5.0}
Which ONE of the following does NOT affect the Effective Multiplication Factor $K_{eff?}$

a. The moderator-to-fuel ratio.

b. The moderator temperature.

c. The physical dimensions of the core.

d. The strength of an installed neutron source.

Answer: A.005 d.
Reference: DOE Fundamentals Handbook, Module 3, pages 2-9.

Question: A.006 [1.00 point] {6.0}
Which ONE of the following is the reason for operating with thermal neutrons rather than fast neutrons?

a. Probability of fission is increased since thermal neutrons are less likely to leak out of the core.

b. As neutron energy increases, neutron absorption in non-fuel materials increases exponentially.

c. The absorption cross-section of U-235 is much higher for thermal neutrons.

d. The fuel temperature coefficient becomes positive as neutron energy increases.

Answer: A.006 c.
Reference: DOE Fundamentals Handbook, Module 2, page 9.

Question: A. 007 [1.00 point] {7.0}
A reactor with an initial population of $1x10^8$ neutrons is operating with K_{eff} = 1.001. Considering only the <u>increase</u> in neutron population, how many neutrons (of the increase) will be prompt when the neutron population changes from the current generation to the next? Assume β = 0.007.

a. 700.

b. 7,000.

c. 99,300.

d. 100,000.

Answer: A.007 c.
Reference: DOE Fundamentals Handbook, Mod 2, Prompt and Delayed Neutrons,pg 29.Increase = $1.001x10^8 - 1x10^8 = 1x10^5$.
Prompt neutron population = $0.993x1x10^5$ = 99,300.

Section A Reactor Theory, Thermo, and Facility Characteristics

Question: A. 008 [1.00 point] {8.0}
Delayed neutron precursors decay by beta(-) decay. Which ONE reaction below is an example of beta(-) decay?

a. $_{35}Br^{87}$ -> $_{36}Kr^{87}$

b. $_{35}Br^{87}$ -> $_{36}Kr^{87}$

c. $_{35}Br^{87}$ -> $_{35}Kr^{88}$

d. $_{35}Br^{87}$ -> $_{35}Kr^{86}$

Answer: A.008 a. or b. per facility comment
Reference: DOE Fundamentals Handbook, Mod 1, Modes of Radioactive Decay,

Question: A.009 [1.00 point] {9.0}
Two critical reactors at low power are identical except that Reactor 1 has a beta fraction of 0.0072 and Reactor 2 has a beta fraction of 0.0060. An equal amount of positive reactivity is inserted into both reactors. Which ONE of the following will be the response of Reactor 2 compared to Reactor 1?

a. The resulting power level will be lower.

b. The resulting power level will be higher.

c. The resulting period will be longer.

d. The resulting period will be shorter.

Answer: A.009 d.
Reference: R. R. Burn, Introduction to Nuclear Reactor Operations, page 4-9.

Question: A.010 [1.0 point] {10.0} Question deleted from examination
~~Reactor power is rising on a 30 second period. Approximately how long will it take for power to double?~~
~~a. 35 seconds~~

~~b. 50 seconds~~

~~c. 70 seconds~~

~~d. 100 seconds~~
~~Answer: A.010 c~~
~~Reference: $P = P_0 e^{t/T}$ ---> ln(2) = time ÷ 100 seconds --> time = ln (2) x 100 sec.~~
~~0.693 x 100 ≈ 0.7 x 100 ≈ 70 sec.~~

Section A Reactor Theory, Thermo, and Facility Characteristic

Question: A.011 [1 points, ¼ each] {11.0}
Match the description of plant conditions in column A with resulting xenon conditions in column B.

Column A	Column B
a. 4 hours after a power increase	1. Xenon concentration is increasing to a peak
b. 2 hours after a power decrease	2. Xe concentration is decreasing to a trough
c. 16 hours after a "clean" startup	3. Xenon concentration is approximately zero (reactor is "clean")
d. 72 hours after a shutdown	4. Xenon concentration is "relatively" steady at a "non-zero" value

Answer: A.011 a. = 2; b. = 1; c. = 4; d. = 3
Reference: DOE Fundamentals Handbook, Nuclear Physics and Reactor Theory,

Question: A.012 [1.0 point] {12.0}
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)

Answer: A.012 c.
Reference: DOE Fundamentals Handbook, Nuclear Physics and Reactor Theory,

Question: A.013 [1.0 point] {13.0}
The neutron microscopic cross-section for absorption (σ_a) of an isotope 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

Answer: A.013 b.
Reference: DOE Fundamentals Handbook, Nuclear Physics and Reactor Theory,

Question: A.014 [1.0 point] {14.0}
A reactor contains three safety rods and a control rod. Which one of the following would result in a determination of the excess reactivity of this reactor?

a. The reactor is critical at a low power level, with all safety rods full out and the control rod at some position. The reactivity remaining in the control rod (i.e. its rod worth from its present position to full out) is the excess reactivity.

b. The reactor is shutdown. Two safety rods are withdrawn until the reactor becomes critical. The total rod worth withdrawn is the excess reactivity.

c. The reactor is at full power. The total worth of all rods withdrawn is the excess reactivity.

d. The reactor is at full power. The total worth remaining in all the safety rods and the control rod (i.e. their worth from their present positions to full out) is the excess reactivity.

Answer: A.014 a.
Reference: T.S. Definition 1.8,

Question: A.015 [1.0 point] {15.0}
You are assigned to check the operation of a new nuclear instrumentation channel. You know that the reactor will stabilize with a - 80 second period shortly after shutdown. To check the channel you measure the time for power to decrease by a factor of 10. This time should be approximately…

a. 45 seconds (¾ minute)

b. 90 seconds (1-½ minutes)

c. 135 seconds (2-¼ minutes)

d. 180 seconds (3 minutes)

Answer: A.015 d.
Reference: $P/P_0 = e^{-T/\tau} \ln(0.1) = - T(\text{time})/\tau(-80\text{sec})$
Time = ln (0.1) × -80 sec = 184 seconds ≈ 3 minutes

Question: A.016 [1.0 points. ¼ each] {16.0}
Match each term in column A with the correct definition in column B.

Column A	Column B
a. Prompt Neutron	1. A neutron in equilibrium with its surroundings.
b. Fast Neutron	2. A neutron born directly from fission.
c. Thermal Neutron	3. A neutron born due to decay of a fission product.
d. Delayed Neutron	4. A neutron at an energy level greater than its surroundings.

Answer: A.016 a. = 2; b. = 4; c. = 1; d. = 3
Reference: Burn, R., Introduction to Nuclear Reactor Operations, 8 1988, 3.2.2, p. 3 7

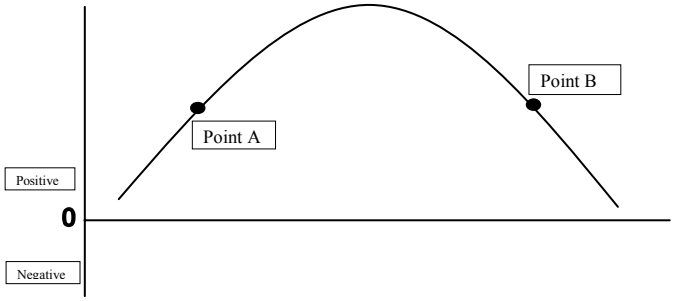
Question: A.017 [1.0 point] {17.0}
Shown below is a trace of reactor period as a function of time. Between points A and B reactor power is:

a. continually increasing.

b. continually decreasing.

c. increasing, then decreasing.

d. constant.



Answer: A.017 a.
Reference: Standard NRC Question[1]

Question: A.018 [1.0 point] {18.0}
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

Answer: A.018 a.
$0.1 \times 3.79 = 0.379$ $0.9 \times 0.23 = 0.207$ $0.1 \times 7.9 = 0.79$ $0.9 \times 1.49 = 1.34$
Reference: DOE Fundamentals Handbook, Nuclear Physics and Reactor Theory,

Question: A.019 [1.0 point] {19.0}
ELASTIC SCATTERING is the process by which a neutron collides with a nucleus and it

a. and the nucleus recoil with the same total kinetic energy as the neutron and nucleus had prior to the collision

b. and the nucleus recoil with less total kinetic energy than the neutron and nucleus had prior to the collision with the nucleus emitting a gamma ray.

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

d. and the nucleus recoil with a higher total kinetic energy than the neutron and nucleus had prior to the collision with the nucleus emitting a gamma ray.

Answer: A.019 a.
Reference: DOE Fundamentals Handbook, Nuclear Physics and Reactor Theory,

Question: A.020 [1.0 point] {20.0}
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

Answer: A.020 b.
Reference: DOE Fundamentals Handbook, Nuclear Physics and Reactor Theory,

Section B Normal/Emergency Procedures & Radiological Controls

Question B.001 [1.0 point] {1.0}
In accordance with the Technical Specifications, which ONE condition below is NOT permissible when the reactor is operating?

a. Maximum available reactivity above cold, clean condition = $4.50.
b. Primary water temperature = 110 deg. F.
c. Pool water conductivity = 2 micromho/cm.
d. Fuel temperature = 400 deg. C.

Answer: B.001 a.
Reference: Technical Specifications 3.1. 3.8

Question B.002 [1.0 point] {2.0}
When the reactor is operating, no person may enter the reactor bay:

a. unless he/she has signed in the log book.
b. when a beam port or thermal column is open.
c. without the permission of the senior reactor operator.
d. without the permission of the reactor operator on duty at the console.

Answer: B.002 d.
Reference: Procedure No. 9, page 1.

Question B.003 [1.0 point] {3.0}
In accordance with the KSU Fitness for Duty policy, which ONE of the following statements is NOT true?

a. An arrest for possession or distribution of a controlled substance will result in the permanent loss of access to the Nuclear Reactor Facility.

b. Extended use of prescription or over-the-counter drugs is to be reported to the examining physician during employment physicals.

c. Consumption of alcohol during an abstinence period need not necessarily preclude responding to an emergency.

d. Consumption of alcohol is prohibited for 5 hours preceding any scheduled activity within the facility.

Answer: B.003 a.
Reference: Training Manual, page A6-1.

Question B.004 [1.0 point] {4.0}
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.004 b.
Reference: Emergency Plan, Section 1.1.

Question B.005 [1.0 point] {5.0}
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.005 a.
Reference: Emergency Plan, Section 5.1.

Question B.006 [1.0 point] {6.0}
In accordance with Procedure No. 2, "Annual Power Level Calibration," after power level has been determined:

a. the linear power channel meter and recorder are adjusted to give the correct power indication.

b. the high voltage to the linear power channel detector is adjusted to give the correct power indication.

c. the compensating voltage of the compensated ion chamber is adjusted to give the proper power indication.

d. the position of the compensated ion chamber is adjusted to give the proper power indication.

Answer: B.006 d.
Reference: Procedure No. 2.

Question B.007 [1.0 point] {7.0}
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.007 d.
Reference: Technical Specifications § 1 Definitions.

Question B.008 [1.0 point, 0.25 each] {8.0}
Match the type of radiation in column A with its associated Quality Factor (10CFR20) from column B.

Column A	Column B
a. alpha	1
b. beta	2
c. gamma	5
d. neutron (unknown energy)	10
	20

Answer: B.008 a. = 20; b. = 1; c. = 1; d. = 10
Reference: 10CFR20.100x

Question B.009 [1.0 point, 0.25 each] {9.0}
Match the terms in column A with their respective definitions in column B.

Column A	Column B
a. Radioactivity	1. The thickness of a material which will reduce a gamma flux by a factor of two.
b. Contamination	2. An impurity which pollutes or adulterates another substance. In radiological safety, contamination refers to the radioactive materials which are the sources of ionizing radiations.
c. Dose	3. The quantity of radiation absorbed per unit mass by the body or by any portion of the body.
d. Half-thickness	4. That property of a substance which causes it to emit ionizing radiation. This property is the spontaneous transmutation of the atoms of the substance.

Answer: B.009 a. = 4; b. = 2; c. = 3; d. = 1
Reference: Standard NRC question

Question B.010 [1.0 point] {10.0}
Based on the Requalification Plan for licensed personnel, each licensed operator must complete a minimum of _____ reactivity manipulations during each 2 year cycle.

a. 5

b. 6

c. 10

d. 12

Answer: B.010 c.
Reference: Requalification Program --- License R-88, Chapter 3 Continuing Activities, § 3.1

Question B.011 [1.0 point, 0.25 each] {11.0}
Identify the PRIMARY source (irradiation of air, irradiation of water, or fission product) of EACH of the radioisotopes listed.

a. 1H3

b. 18Ar41

c. 7N16

d. $_{54}Xe^{135}$

Answer: B.011 a. = Water; b. = Air; c. = Water; d. = Fission
Reference: Standard NRC question.

Question B.012 [1.0 point] {12.0}
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.

Answer: B.012 d.
Reference: Standard Health Physics Definition.

Question B.013 [1.0 point] {13.0}
Which ONE of the following statements correctly describes the relationship between the Safety Limit (SL) and the Limiting Safety System Setting (LSSS)?

a. The SL is a maximum operationally limiting value that prevents exceeding the LSSS during normal operations.

b. The SL is a parameter that assures the integrity of the fuel cladding. The LSSS initiates protective actions to preclude reaching the SL.

c. The SL is a maximum setpoint for instrumentation response. The LSSS is the minimum number of channels required to be operable.

d. The LSSS is a parameter that assures the integrity of the fuel cladding. The SL initiates protective action to preclude reaching the LSSS.

Answer: B.013 b.
Reference: Standard NRC question on Safety Limits

Question B.014 [1.0 point] {14.0}
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

Answer: B.014 b.
Reference: 10CFR50.54(y)

Question B.015 [1.0 point] {15.0}

You initially remove a sample from the pool reading 1 R/hr at 30 cm from the source. You then replace the sample in the pool. An hour later you remove the sample and the reading is now 390 mR/hr at 30 cm. You again replace the sample back in the pool. How much **longer** should you wait to be able to bring out the sample without generating a high radiation area?

a. ½ hour

b. 1 hour

c. 1½ hours

d. 3 hours

Answer: B.015 c.

Reference: $I_t = I_0 e^{-\lambda t}$ 390 mR/hr ÷ 1000 mR/hr = $e^{-\lambda 1hr}$ ln(0.39) = -λ * 1 hr.
λ = 0.9416 $hour^{-1}$ SOLVING for additional time: $If = I_t e^{-\lambda t}$
100mR/hr = 390 mR/hr $e^{-0.9416 (time)}$ ln (0.25) = -0.9163 * time
time = 1.4454 hours

Question B.016 [1.0 point] {16.0}

The Total Effective Dose Equivalent (TEDE) is defined as the sum of the deep-dose equivalent and the committed effective dose equivalent. The deep-dose equivalent is related to:

a. the dose to organs or tissues.

b. the external exposure to the skin or an extremity.

c. the external exposure to the lens of the eye.

d. the external whole-body exposure.

Answer: B.016 d.

Reference: Training Manual, Part B1, Definitions.

Question B.017 [1.0 point] {17.0}

Which ONE of the following is expressly forbidden by the Operations Manual?

a. Acetone in the reactor.

b. Gasoline in the reactor bay.

c. Carbon tetrachloride in the reactor bay.

d. Mercury-glass thermometer in the reactor pool.

Answer: B.017 d.

Reference: Operations manual August, 2007, supplied for
(January 2008 NRC exam)

Question B.018 [1.0 point] {18.0}
The dose rate 10 feet from a point gamma source is 25 mR/hr. A person working for 1.5 hours at 3 feet from the source will receive a dose of:

a. 83 mR.

b. 125 mR.

c. 278 mR.

d. 417 mR.

Answer B.018 d.
Reference: Standard NRC Question
1st solve for dose rate at 3 feet:
$(DR_{10\ feet})/10^2 = (DR_{3\ feet})/3^2$ $DR_{3\ feet}$ = 25 mR/hr (100/9) = 277.778.
In 1.5 hours the worker will get 277.778 $\times$ 1.5 = 416.667

Question B.019 [1.0 point] {19.0}
According to Experiment No. 1, "Isotope Production," removal of any material from a region of significant neutron flux must be done in the presence of:

a. the Reactor Supervisor.

b. a Senior Reactor Operator.

c. a representative of the University Radiation Safety Office.

d. a person approved by the Reactor Supervisor who is trained in the safe handling of radioactive materials.

Answer: B.019 d.
Reference: Experiment No. 1, page 4.

Question B.020 [1.0 point] {20.0}
The Continuous Air Monitor (CAM) is set to alarm at the Maximum allowed Effluent Concentration of:

a. Te131

b. I131

c. Xe131

d. Cs^{131}

Answer: B.020 b.
Reference: Rewrite of facility supplied question.

Section C Facility and Radiation Monitoring Systems

Question C.001 [1.0 point] {1.0}
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.001 b.
Reference: SAR Section 5.6

Question C.002 [1.0 points 0.25 each] {2.0}
Match the part names listed as a. through d. with the locations numbered 1 through 4 on the attached drawing of the rod drive mechanism (from SAR figure 7.6).

Column A	Column B
a. Drive Motor	1.
b. Magnet	2.
c. Potentiometer	3.
d. Rod Down Limit Switch	4.

Answer: C.002 a. = 2; b. = 3; c. = 4; d. =1
Reference: SAR Figure 7.6

Question C.003 [1.0 point] {3.0} Question deleted from examination
~~Battery backup power is used for all of the following functions **EXCEPT** _____ . emergency lighting, the University fire alarm system, the evacuation alarm, and the security system~~

~~a. reactor instruments and control systems.~~

~~b. University fire alarm system~~

~~c. emergency lighting~~

~~d. evacuation alarm~~

~~Answer: C.003 a.~~
~~Reference: SAR Section 8.2~~

Question C.004 [1.0 point] {4.0}
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.004 b.
Reference: Safety Analysis Report, § 7.3, Figure 7.8

Question C.005 [1.0 points, 0.25 each] {5.0}
Match the action provided in column A, with the correct Nuclear Instrumentation Channel from column B. (Items in column B may be used once, more than once, or not at all. There should be only one answer per column A item.)

Column A	Column B
a. < 2 cps rod withdrawal inhibit	1. Wide Range Log
b. 1 kilowatt pulse	2. Multi-Range Linear
c. Period scram	3. Percent Power
d. Automatic Control	4. Pulse Channel

Answer: C.005 a. = 1; b. = 1; c. = 1; d. = 2
Reference: Modified question from OL-08-01 KSU Exam

Question C.006 [1.0 points, 0.25 each] {6.0}
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.006 a. = 2; b. = 1; c. = 3; d.= 1
Ref: Standard NRC purification system question.

Question C.007 [1.0 point] {7.0}
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.007 b.
Reference: SAR § 5.6 Nitrogen 16 Control System

Question C.008 [1.0 point] {8.0}
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.008 a.
Reference: TECHNICAL SPECIFICATIONS TABLE 1: MINIMUM MEASURING CHANNEL COMPLEMENT & TABLE 2: REQUIRED SAFETY SYSTEM CHANNELS

Question C.009 [1.0 point] {9.0}
Which ONE of the following Nuclear Instrumentation Channels also supplies Period Indication?

a. Startup Channel

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

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

d. Nuclear Power Pulse Channel (NPP-1000)

Answer: C.009 b.
Reference: SAR § 7.3.1 also Figure 7.5.

Section C Facility and Radiation Monitoring Systems

Question C.010 [1.0 point, 1/3 point each] {10.0}
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.010 a. = NC; b. = FC; c. = Con
REF: Standard NRC question

Question C.011 [1.0 point] {11.0}
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.011 a.
Reference: SAR § 7.3.4(a) Standard Control Rod Drives.

Question C.012 [1.0 point] {12.0}
Which ONE of the following is the neutron source utilized in the reactor?

a. ^{241}Am — ^{9}Be
b. ^{239}Pu — ^{9}Be
c. ^{210}Po — ^{9}Be
d. ^{124}Sb — ^{9}Be

Answer: C.012 a.
Reference: SAR § 4.2.4 Neutron Startup Source

Question C.013 [1.0 point] {13.0}
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.013 b.
Reference: Procedure No. 24 Sump Water Discharge System

Question C.014 [1.0 point] {14.0}
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.014 b.
Reference: SAR § 5.3.2 Secondary Cooling Automatic Control System.

Question C.015 [1.0 point] {15.0}
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.015 a.
Reference: modified facility supplied question

Question C.016 [1.0 point] {16.0}
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.016 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.017 [1.0 point] {17.0}
When the mode switch is placed in the "AUTO" position the …

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

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

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

d. period scram is bypassed.

Answer: C.017 ~~b.~~ a. per facility comment
Reference: Previous NRC Exam Question (OL-08-01)
Modified per Facility Comment

Question C.018 [1.0 point] {18.0}
WHICH ONE of the following detectors is used primarily to measure Ar^{41} released to the environment?

a. The Continuous Air Radiation Monitor at the 12 foot level.

b. NONE, Ar^{41} has too short a half-life to require environmental monitoring.

c. The Noble Gas Channel of the Air Monitoring System located above the pool.

d. The Particulate Channel of the Air Monitoring System located above the pool.

Answer: C.018 c.
Reference: SAR § 7.7, Figure 7.15.

Question C.019 [1.0 point] {19.0}
Upon entering the cleanup loop the water passes through the water box, which contains:

a. a temperature probe, a pressure probe, and a GM tube.

b. a temperature probe, a conductivity probe, and a pressure sensor.

c. a conductivity probe, a pressure sensor, and a GM tube.

d. a conductivity probe, a temperature probe, and a GM tube.

Answer C.019 d.
REF: SAR Section 5.4

Question C.020 [1.0 point] {20.0}
Which ONE of the following is the flow through the primary loop and the cleanup loop?

a. 120 gpm total flow with 10 gpm through the cleanup loop

b. 110 gpm total flow with 10 gpm through the cleanup loop

c. 120 gpm total flow with 20 gpm through the cleanup loop

d. 110 gpm total flow with 20 gpm through the cleanup loop

Answer: C.020 b.
Reference: SAR Section 5.2 and 5.4