May 29, 2014

Mr. Robert J. Agasie, Reactor Director
Nuclear Reactor Laboratory
University of Wisconsin-Madison
1513 University Avenue, Room 1209
Madison, WI 53706

SUBJECT: EXAMINATION REPORT NO. 50-156/OL-14-01, UNIVERSITY OF WISCONSIN

Dear Mr. Agasie:

During the week of May 12, 2014, the U.S. Nuclear Regulatory Commission (NRC) administered operator licensing examinations at your University of Wisconsin reactor facility. 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 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 electronic mail at phillip.young@nrc.gov.

Sincerely,

/RA/

Gregory T. Bowman, Chief
Research and Test Reactors Oversight Branch
Division of Policy and Rulemaking
Office of Nuclear Reactor Regulation

Docket No. 50-156

Enclosures:
1. Initial Examination Report
   No. 50-156/OL-14-01
2. Written Examination
   and Answer Key

cc w/o enclosures: See next page

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NAME	PYoung	CRevelle	GBowman
DATE	05/29/2014	05/29/2014	05/29/2014

OFFICIAL RECORD COPY

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Test, Research, and Training
Reactor Newsletter
University of Florida
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U. S. NUCLEAR REGULATORY COMMISSION
OPERATOR LICENSING INITIAL EXAMINATION REPORT

REPORT NO.: 50-156/OL-14-01

FACILITY DOCKET NO.: 50-156

FACILITY LICENSE NO.: R-74

FACILITY: University of Wisconsin

EXAMINATION DATES: May 14 and 15, 2014

SUBMITTED BY: **/RA/** 5/29/2014
Phillip T. Young, Chief Examiner Date

SUMMARY:

During the week of May 12, 2014, the U.S. Nuclear Regulatory Commission (NRC) administered a licensing examination to three Reactor Operator applicants. All applicants passed all portions of 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	0/0	3/0
Operating Tests	3/0	0/0	3/0
Overall	3/0	0/0	3/0

3. Exit Meeting:
Phillip T. Young, Chief Examiner, NRC
Robert Agasie, Reactor Director, University of Wisconsin

At the conclusion of the examinations the chief examiner thanked the facility for their support during the examinations. The Reactor Director provided preliminary comments on the written examination.

Enclosure 1

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

FACILITY: University of Wisconsin

REACTOR TYPE: TRIGA DATE ADMINISTERED: 05/14/2012
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
18.00	33.3	________	____	B.	Normal and Emergency Operating Procedures and Radiological Controls
18.00	33.3	________		C.	Facility and Radiation Monitoring Systems
56.00		______	____%		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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

$$T_{‰} = \frac{0.693}{\lambda}$$

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

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

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

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

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

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

1 Curie = 3.7×10^{10} dis/sec
1 Horsepower = 2.54×10^3 BTU/hr
1 BTU = 778 ft-lbf
1 gal (H_2O) ≈ 8 lbm
c_P = 1.0 BTU/hr/lbm/°F

1 kg = 2.21 lbm
1 Mw = 3.41×10^6 BTU/hr
°F = 9/5 °C + 32
°C = 5/9 (°F - 32)
c_p = 1 cal/sec/gm/°C

Question: A.001 [1.0 point] {1.0}
A 1/M curve is being generated as fuel is loaded into the core. After some fuel elements have been loaded, the count rate existing at that time is taken to be the new initial count rate, C_o. Additional elements are then loaded and the inverse count rate ratio continues to decrease. As a result of changing the initial count rate:

a. criticality will occur with the same number of elements loaded as if there were no change in the initial count rate.
b. criticality will occur earlier (i.e., with fewer elements loaded.)
c. criticality will occur later (i.e., with more elements loaded.)
d. criticality will be completely unpredictable.

Answer: A.01 a.
Reference: UWNR Operator Training Manual, Reactor Physics IV, Critical Experiment.

Question: A.002 [1.0 point] {2.0}
A reactor is critical at 18.1 inches on a controlling rod. The controlling rod is withdrawn to 18.4 inches. The reactivity inserted is 14.4 cents. What is the differential rod worth?

a. 14.4 cents/inch at 18.25 inches.
b. 48 cents/inch at 18.25 inches.
c. 48 cents/inch at 18.4 inches.
d. 14.4 cents/inch only between 18.1 and 18.4 inches.

Answer: A.02 b.
Reference: UWNR Operator Training Manual, Reactor Physics IV, Control Rod Calibration. $\Delta\rho$ = 14.4 cents; Δx = 18.4 - 18.1 = 0.3 inches; $\Delta\rho/\Delta x$ = 48 cents/inch at the midpoint (18.25 inches).

Question: A.003 [1.0 point] {3.0}
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.03 d.
Reference: Equation Sheet. $\tau = (\ell^*/\rho) + [(\beta-\rho)/\lambda_{eff}\rho]$

Question: A.004 [1.0 point] {4.0}
Which ONE of the following describes the response of the subcritical reactor to equal insertions of positive reactivity as the reactor approaches critical? Each reactivity insertion causes:

a. a SMALLER increase in the neutron flux, resulting in a LONGER time to reach equilibrium.
b. a LARGER increase in the neutron flux, resulting in a LONGER time to reach equilibrium.
c. a SMALLER increase in the neutron flux, resulting in a SHORTER time to reach equilibrium.
d. a LARGER increase in the neutron flux, resulting in a SHORTER time to reach equilibrium.

Answer: A.04 b.
Reference: UWNR Operator Training Manual, Reactor Physics IV, Critical Experiment.

Question: A.005 [1.0 point] {5.0}
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. Fast fission factor.
c. Thermal non-leakage probability.
d. Resonance escape probability.

Answer: A.05 b.
Reference: UWNR Operator Training Manual, Reactor Physics I.

Question: A.006 [1.0 point] {6.0}
The effective neutron multiplication factor, K_{eff}, is defined as:
a. absorption/(production + leakage)
b. (production + leakage)/absorption
c. (absorption + leakage)/production
d. production/(absorption + leakage)

Answer: A.06 d.
Reference: UWNR Operator Training Manual, Reactor Physics I.

Question: A.007 [1.0 point] {7.0}
Which ONE of the following parameter changes will require control rod INSERTION to maintain constant power level following the change?

a. Removal of an experiment containing cadmium.
b. Insertion of a void into the core.
c. Pool water temperature decrease.
d. Buildup of samarium in the core.

Answer: A.07 a.
Reference: Insertion of a control rod inserts negative reactivity to balance the positive reactivity added when removing a neutron absorber. All other answers add negative reactivity.

Question: A.008 [1.0 point] {8.0}
Which ONE of the following is the time period during which the MAXIMUM amount of Xenon-135 will be present in the core?

a. 8 to 10 hours after a startup to 100% power.
b. 8 to 10 hours after shutdown from 100% power.
c. 4 to 6 hours after a power decrease from 100% to 50%.
d. 4 to 6 hours after a power increase from 50% to 100%.

Answer: A.08 b.
Reference: UWNR Operator Training Manual, Reactor Physics I.

Question: A.009 [1.0 point] {9.0}
The reactor is operating in the automatic mode at 50% power. A problem in the secondary cooling system causes the primary coolant temperature to increase by 5 degrees F. Given that the primary coolant temperature coefficient is 7.0×10^{-5} Δ k/k/deg. F and the differential rod worth of the regulating rod is 8.75×10^{-5} Δk/k/inch, the change in the position of the regulating rod will be:

a. eight (8) inches inserted.
b. eight (8) inches withdrawn.
c. four (4) inches inserted.
d. four (4) inches withdrawn.

Answer: A.09 c.
Reference: UWNR Operator Training Manual, Reactor Physics II. Since coolant temperature increased, negative reactivity was added. Therefore, the rod must add positive reactivity, i.e. withdraw. (5 deg. F)x(7×10^{-5} delta k/k/deg. F) / (8.75×10^{-5} delta k/k/inch) = 4 inches.

Question: A.010 [1.0 point] {10.0}
Reactor period is at 26 seconds. How long will it take to increase power from 10 kilowatts to 100 kilowatts?

a. 10 seconds
b. 1 minute
c. 10 minutes
d. 1 hour

Answer: A.10 b.
Reference: *Math and Physics,* p. 12

Question: A.011 [1.0 point] {11.0}
Which ONE of the following is an example of alpha (α) decay?

a. ${}_{35}Br^{87} \rightarrow {}_{33}As^{83}$
b. ${}_{35}Br^{87} \rightarrow {}_{35}Br^{86}$
c. ${}_{35}Br^{87} \rightarrow {}_{34}Se^{86}$
d. ${}_{35}Br^{87} \rightarrow {}_{36}Kr^{87}$

Answer: A.11 a.
Reference: NEEP 234, *Physics I,* p. 23

Question: A.012 [1.0 point] {12.0}
K_{eff} for the reactor is 0.95. What is the shutdown margin for this condition? (I am NOT looking for Technical Specification definition)

a. 5.00% ΔK/K
b. 5.26% ΔK/K
c. 5.00%
d. 5.26%

Answer: A.12 b. SDM = $(1 - K_{eff})/K_{eff}$ = (1 - 0.95)/0.95 = 0.05/0.95 = 0.0526
Reference: NEEP 234, *Reactor Physics II,* p. 102

Question: A.013 [1.0 point] {13.0}
The reactor had a shutdown margin of 1.75% Δk/k, and a source range count rate of 15 counts per minute. After placing samples in the reactor the count rate increased to 30 counts per minute. What is the worth of the sample?

a. -0.44%Δk/k
b. +0.44%Δk/k
c. -0.88%Δk/k
d. +0.88%Δk/k

Answer: A.13 d.
Reference: SDM = 1.75% Δk/k = 0.0175 Δk/k $K_{eff} = 1/(1.0175) = 0.9828$
$1 - K_{eff2} = (1 - K_{eff1}) \times CR_1/CR_2 \rightarrow K_{eff2} = 1 - [(1 - K_{eff1})CR_1/CR_2]$
$K_{eff2} = 1 - [(1 - 0.9828) \times ½] = 1 - [\ 0.0172 \times 0.5\ ] = 1 - 0.0086 = 0.9914$
$\rho = (0.9828 - 0.9914)/(0.9828 \times 0.9914) = 0.008826\ \Delta k/k = +0.883\%\ \Delta k/k$

Question: A.014 [1.0 point] {14.0}
The main source of heat in the reactor one hour after shutdown is due to:

a. Decay of fission products
b. Fission due to delayed neutrons
c. Spontaneous fission within the core
d. Decay of radioactive structural materials

Answer: A.14 a.
Reference: NEEP 234, *Reactor Physics III,* p. 113.

Question: A.015 [1.0 point] {15.0}
For U^{235}, the thermal fission cross-section is 582 barns, and the capture cross-section is 99 barns. When a thermal neutron is absorbed by U^{235}, the probability that a fission will occur is:

a. 0.146
b. 0.170
c. 0.830
d. 0.855

Answer: A.15 d.
Reference: NEEP 234, p. 86 (Scope)

Question: A.016 [1.0 point] {16.0}
Which ONE of the following factors is the most significant in determining the differential worth of a control rod?

a. The rod speed.
b. Reactor power.
c. The flux shape.
d. The amount of fuel in the core.

Answer: A.16 c.
Reference: Standard NRC Question.

Question: A.017 [1.0 point] {17.0}
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

Answer: A.17 c.
Reference: NEEP 234, *Reactor Physics III,* p. 103

Question: A.018 [1.0 point, 0.25 each] {18.0}
Match each type of neutron 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.18 a. = 2; b. = 4; c. = 1; d. = 3
Reference: NEEP 234, p. 87.

Question: A.019 [1.0 point] {19.0}
A reactor is subcritical with a K_{eff} of 0.955. A positive reactivity of 4.9% delta k/k is inserted into the core. At this point, the reactor is:

a. subcritical.
b. exactly critical.
c. supercritical.
d. prompt critical.

Answer: A.19 c.
Reference: UWNR Operator Training Manual, Reactor Physics II. When k_{eff} = 0.955, ρ = -0.047 delta k/k; 4.9% delta k/k = + 0.049 delta k/k - 0.047 + 0.049 delta k/k = + 0.002 delta k/k, therefore reactor is supercritical.

Question: A.020 [1.0 point] {20.0}
A characteristic peculiar to TRIGA fuel is that it has a relatively large (and quickly acting):

a. pressure coefficient.
b. void coefficient.
c. bath temperature coefficient.
d. fuel temperature coefficient.

Answer: A.20 d.
Reference: NEEP 234, pp. 112–114.

Question: B.001 [1.00 point] {1.0}
An Emergency Action Level is:

a. a condition which calls for immediate action, beyond the scope of normal operating procedures, to avoid an accident or to mitigate the consequences of one.
b. a class of accidents for which predetermined emergency measures should be taken or considered.
c. a procedure that details the implementation actions and methods required to achieve the objectives of the emergency plan.
d. a specific instrument reading or observation which may be used as a threshold for initiating appropriate emergency procedures.

Answer: B.01 d.
Reference: UWNR Procedure 006.

Question: B.002 [1.00 point] {2.0}
Equipment that is tagged with “Do Not Operate” tags (other than cognizance tags) may be operated with the approval of the:

a. Reactor Director.
b. Reactor Operator.
c. Reactor Supervisor.
d. Individual who signed the tag.

Answer: B.02 d.
Reference: UWNR 001 – Standing Operating Instructions – Rev 16

Question: B.003 [1.00 point] {3.0}
When a major radioactive spill on the floor occurs (without injury to personnel), the operator must immediately:

a. Perform a radiation survey of the area
b. Flush the floor area with water
c. Attempt to clean up the spill
d. Assure that the reactor is secured

Answer: B.03 d.
Reference: UWNR Procedure 150

Question: B.004 [1.00 point] {4.0}
Which ONE of the following locations is the normal (no evacuation required) Emergency Support Center per the Emergency Plan?

a. Reactor Control Room
b. Reactor Shop
c. Reactor Director's Office
d. Lobby of the Mechanical Engineering Building.

Answer: B.04 c.
Reference: Emergency Plan, 8.0 FACILITIES AND EQUIPMENT

Question: B.005 [1.00 point] {5.0}
Which statement accurately describes the stated mode of operation and its associated conditions/restrictions?

a. In the manual mode, the selected rod can be used to control power as long as actual power is within 5% of scheduled power.
b. In square wave mode the transient rod can be fired if power level is greater than 1kW. The transient rod returns to its pre-fire position 20 seconds after being fired.
c. In automatic mode, power is automatically controlled by the servo amplifier driving the selected blade or rod as long as the period, supplied from the Log N-period channel, is less than a pre-selected value.
d. In pulse mode, the transient rod can be fired from any position and will remain in its final position. The high level pulsing channel is connected to readout peak power of the pulse on a fast digital recorder. This channel also provides input to the safety channels because high voltage is removed from all other neutron monitoring channels.

Answer: B.05 c.
Reference: SAR Section 7.3

Question: B.006 [1.00 point] {6.0}
Argon-41 is produced by neutron absorption of argon-40. Argon-41 decays by:

a. a 1.3 Mev gamma with a half-life of 1.8 hours.
b. a 6.1 Mev gamma with a half-life of 7 seconds.
c. neutron emission with a half-life of 1.8 hours.
d. a 1.3 Mev beta with a half-life of 7 seconds.

Answer: B.06 a.
Reference: Chart of the Nuclides

Question: B.007 [1.00 point] {7.0}
The ***Quality Factor*** is used to convert ….

a. dose in rads to dose equivalent in rems.
b. dose in rems to dose equivalent in rads.
c. contamination in rads to contamination equivalent in rems
d. contamination in rems to contamination equivalent in rads.

Answer: B.07 a.
Reference: 10CFR20.1004

Question: B.008 [1.00 point] {8.0}
A radiation survey instrument was used to measure an irradiated experiment. The results were 100 mrem/hr with the window open and 60 mrem/hr with the window closed. What was the beta dose rate?

a. 40 mrem/hr
b. 60 mrem/hr
c. 100 mrem/hr
d. 140 mrem/hr

Answer: B.08 a.
Reference: Betas do not penetrate the closed window.

Question: B.009 [1.00 point] {9.0}
Which ONE of the following is the definition for "Annual Limit on Intake (ALI)"?

a. The concentration of a radio-nuclide in air which, if inhaled by an adult worker for a year, results in a total effective dose equivalent of 100 millirem.
b. 10CFR20 derived limit, based on a Committed Effective Dose Equivalent of 5 Rems whole body or 50 Rems to any individual organ, for the amount of radioactive material inhaled or ingested in a year by an adult worker.
c. The effluent concentration of a radio-nuclide in air which, if inhaled continuously over a year, would result in a total effective dose equivalent of 50 millirem for noble gases.
d. Projected dose commitment values to individuals, that warrant protective action following a release of radioactive material.

Answer: B.09 b.
Reference: 10CFR20.1003

Question: B.010 [1.00 point] {10.0}
Which ONE of the following conditions is allowable during steady-state reactor operation?

a. 1 picoammeter operable.
b. Continuous air monitor inoperable.
c. An experiment containing 2 curies of I-131.
d. A shutdown margin of 0.15% delta k/k.

Answer: B.10 b.
Reference: Training Manual Controls & Instrumentation V (SAM, CAM, Area Radiation)

Question: B.011 [1.00 point] {11.0}
Question deleted due to multiple partially correct answers.
~~According to Technical Specifications, which ONE of the following situations is NOT PERMISSIBLE during reactor operations?~~

~~a. Scram time for a control element = 3 seconds~~
~~b. A pulse reactivity insertion of 1.4% ΔK/K~~
~~c. The ventilation system is inoperable for 24 hours.~~
~~d. A single experiment reactivity worth of 1.5% ΔK/K.~~

~~Answer: B.11 d.~~
~~Reference: UWNR Technical Specifications~~

Question: B.012 [1.00 point] {12.0}
Which ONE of the following correctly defines a **Safety Limit**?

a. The lowest functional capability of performance levels of equipment required for safe operation of the facility.
b. The limiting availability of systems, including their associated input and actuation circuits, which are designed to protect the reactor to guard against the uncontrolled release of radioactivity.
c. The limit(s) 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.
d. The lowest initiating settings for automatic protective systems, related to those variables having significant safety functions, to reasonably protect the integrity of certain physical barriers which guard against the uncontrolled release of radioactivity.

Answer: B.12 c.
Reference: UWNR Technical Specifications, Section 1.0, Definitions

Question: B.013 [1.00 point] {13.0}
Which ONE of the following statements concerning emergency exposure limits is correct?

a. the volunteers over age 55 can receive a 50 Rem one time emergency exposure dose.
b. an individual may be authorized to receive up to 25 REM to deal with situations which are likely to lead to life-threatening situations.
c. an individual can be authorized to receive up to 25 REM to deal with situations which are **not** life-threatening **nor** are likely to lead to life-threatening situations.
d. the volunteers over age 60 can receive a 75 Rem one time emergency exposure dose, if they have a life time dose less than 15 Rem and have adequate records of their radiation exposure history.

Answer: B.13 b.
Reference: UWNR 006 Section 7 pg 6; 10 CFR 20.1206; NEEP 234 Definitions (i) pg 33

Question: B.014 [1.00 point] {14.0}
Technical Specification 5.5 "Fuel Storage" requires all fuel elements shall be stored in a geometrical array where the value of K_{eff} is less than ___ for all conditions of moderation.

a. 0.80
b. 0.85
c. 0.90
d. 0.95

Answer: B.14 a.
Reference: UWNR Technical Specifications 5.6 Fissionable Material Storage

Question: B.015 [1.00 point] {15.0}
Question deleted due to discrepancy between half life used in stem verses that used in answer solution.
~~A small experiment sample reads 200 mR/hr with the sample 1 foot under water and the meter at the surface of the water. A reading taken ½ hour ago with both the sample and the meter in the same positions was 400 mR/hr. Approximately how long will it take for the reading to drop to 20 mR/hr with the sample and the meter in the same positions?~~

~~a. 40 minutes~~
~~b. 70 minutes~~
~~c. 100 minutes~~
~~d. 130 minutes~~

~~Answer: B.15 c.~~
~~Reference: NEEP 234 Physics I page 24~~ $\cancel{A = A_0 e^{-\lambda t}}$
~~Solve for λ~~ $\cancel{200 = 400 e^{-\lambda 30min}}$ ~~ln (200/400) = -λ× 30minutes ln(½)/30 minutes = -λ = 0.0231~~
~~Next solve for time~~ $\cancel{20 = 200 e^{(-0.0231 \times time)}}$ ~~ln (1/10)/-0.0231 = time = 99.7 minutes ≈ 100 minutes~~

Question: B.016 [1.0 points, 0.25 point each] {16.0}
Identify each of the following actions as either a channel **CHECK**, a channel **TEST**, or a channel **CAL**ibration.

a. Prior to startup you place a known radioactive source near a radiation detector, noting meter movement and alarm function operation.
b. During startup you compare all of your nuclear instrumentation channels ensuring they track together.
c. At power, you perform a heat balance (calorimetric) and determine you must adjust Nuclear Instrumentation readings.
d. During a reactor shutdown you note a -80 second period on Nuclear Instrumentation.

Answer: B.16 a. = Test; b. = Check; c. = Cal; d. = Check
Reference: Technical Specification 1.3 Definitions, p. 2.

Question: B.017 [1.00 point] {16.0}
Which ONE of the following Measuring Channels is required to be operable in ALL modes of operation per Technical Specifications?

a. Fuel Temperature
b. Log Power
c. Linear Power
d. Startup Count Rate

Answer: B.17 a.
Reference: Tech Spec 3.2.8 Table 3.2.8 - SAR 14-17

Question: B.018 [1.00 point] {16.0}
Which ONE of the listed emergency classifications is the ONLY applicable at University of Wisconsin?

a. Notification of Unusual Event
b. General Emergency
c. Site Emergency
d. Alert

Answer: B.18 d.
Reference: Emergency Plan, Table 2

Question: B.019 [1.00 point] {19.0}
Which of the following states the immediate actions for a POOL Level annunciator during reactor operations?

a. SCRAM the reactor, initiate abnormal or emergency pool fill, and notify Police and Security of response.
b. Run in all control blades, notify Police and Security that laboratory is manned and corrective action is taking place.
c. SCRAM the reactor if automatic scram did not occur, notify Police and Security laboratory is manned and corrective action is taking place.
d. Determine the status of the pool level, if level is rapidly changing then SCRAM the reactor and notify Police and Security , otherwise investigate the cause of the change and restore the pool to normal level.

Answer: B.19 c.
Reference: UWNR 155

Question: B.020 [1.00 point] {20.0}
Based on the Requalification Plan for licensed personnel, each licensed operator must complete a minimum of ______ significant reactivity change(s) during each quarter.

a. 1
b. 4
c. 7
d. 10

Answer: B.20 a
Reference: UNWR 004 Reactor Operator Proficiency Maintenance Program § B 3rd ¶.

Question: C.001 [1.0 point] {1.0}
Question deleted due to multiple partially correct answers.

~~For a safety blade, the "magnet engaged" light is illuminated when:~~
~~a. current is provided to the electromagnet.~~
~~b. a limit switch within the scram magnet closes.~~
~~c. the blade "out" limit light is illuminated.~~
~~d. all scrams are reset.~~

~~Answer: C.01 b.~~
~~Reference: UWNR SAR~~

Question: C.002 [1.0 point] {2.0}
Which ONE of the following will result in a transient rod fire inhibit?

a. Fission chamber count rate < 2 CPS
b. Reactor power = 500 watts
c. Fission chamber in motion
d. Picoammeter on 1000 watt range

Answer: C.02 d.
Reference: UWNR Operator Training Manual, Controls and Instrumentation V.

Question: C.003 [1.0 point] {3.0}
Just prior to the plant shifting to Square-Wave Mode operation at 300 watts, compensating voltage to the Safety Channel compensated ion chambers was lost. What was the plant response to this event?

a. The reactor scrammed due to high flux greater than 125%.
b. Reactor power was reduced by the automatic control mode.
c. The peak power read out on the fast digital recorder was lost.
d. An interlock prevented switching from auto mode to the square-wave mode.

Answer: C.03 a.
Reference: NEEP 234 page 178, SAR 7.4

Question: C.004 [1.0 point] {4.0}
Which ONE of the following detectors is used primarily to measure N^{16} release to the environment?

a. NONE, N^{16} has too short a half-life to require environmental monitoring.
b. Stack Gas Monitor
c. Stack Particulate Monitor
d. Bridge Area Monitor

Answer: C.04 a
Reference: SAR-2000, 11.1.1.1, page 11-2

Question: C.005 [1.0 point] {5.0}
How much of a pool temperature rise, during reactor operation, will result in a one inch increase in pool level?

a. 10°F
b. 15°F
c. 20°F
d. 25°F

Answer: C.05 c.
Reference: UWNR 105 CAUTION below step 1 on page 1

Question: C.006 [1.0 point] {6.0}
Which of the following is the reason for an elevated ventilation release?

a. to maintain the Reactor Lab at a pressure lower than the atmosphere.
b. to allow the heavier particles and isotopes to be removed prior to release.
c. to reduce concentrations of radioactive materials, in non-restricted areas, compared to a ground release.
d. to provide a common collection point for all exhaust from the facility so that a composite effluent sample can be drawn.

Answer: C.06 c.
Reference: Technical Specification 5.6 Bases

Question: C.007 [1.0 point] {7.0}
What do the thermocouples in each of the instrumented fuel elements measure?

a. The temperature of the fuel reflector end pieces.
b. The temperature of the fuel cladding.
c. The temperature of the fuel's surface.
d. The temperature of the fuel's interior.

Answer: C.07 d.
Reference: SAR, 2.1 Reactor Core, page 2-6

Question: C.008 [1.0 point] {8.0}
Question deleted – no correct answer (sealed gas proportional)
~~What type of detector does the Continuous Air Monitor particulate activity channel use to measure radiation?~~

~~a. Gamma scintillator.~~
~~b. Geiger-Mueller.~~
~~c. Ionization chamber.~~
~~d. Beta scintillator.~~

~~Answer: C.08 b.~~
~~Reference: NEEP 234 Controls and Instrumentation VI, page 203~~

Question: C.009 [1.0 point] {9.0}
A thermocouple operates on the principle that an electromotive force (EMF) is generated in a closed circuit if:

a. two similar metals when their junctions are at the same temperature.
b. two similar metals when their junctions are at different temperatures.
c. two dissimilar metals when their junctions are at the same temperature.
d. two dissimilar metals when their junctions are at different temperatures.

Answer: C.09 d.
Reference: UWNR OTM, Contols & Instrumentation VII, "Temperature Measurement"

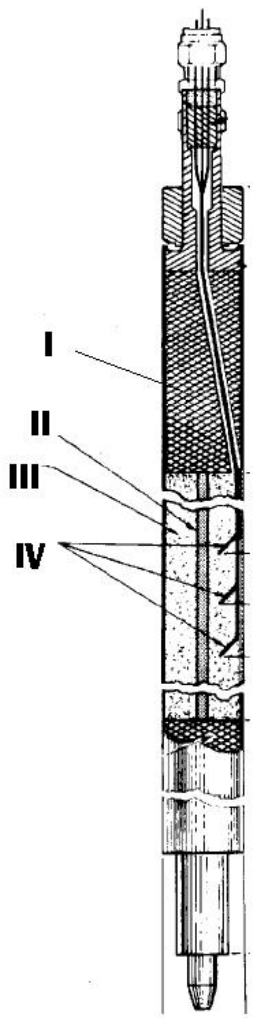
Question: C.010 [1.0 point] {10.0}
What is the composition of the regulating rod?

a. Stainless Steel
b. Boron Carbide (BC)
c. Boral Plate
d. Borated graphite in a stainless steel clad

Answer: C.10 a.
Reference: UWNR TS, Section 5.5

Question: C.011 [1.0 point] {11.0}
Using the following diagram of an instrumented fuel element match the correct position locator (Column A) to the correct component (Column B).

Column A	Column B
I	A. Zirconium Hydride-Uranium
II	B. Stainless steel
III	C. Erbium Burnable Poison
IV	D. Graphite Reflector
	E. Zirconium Rod
	F. Spacer
	G. Thermocouples



a. I.A, II.E, III.C, IV.G

b. I.D, II.G, III.A, IV.F

c. I.D, II.E, III.A, IV.G

d. I.C, II.A, III.B, IV.G

Answer: C.11 c
Reference: UWNR SAR, Fig 4-6, NEEP 234 “Fuel and Core Arrangement”

Question: C.012 [1.0 point] {12.0}
When in AUTO, the diffuser pump will start when reactor power reaches…..

a. 100 kW
b. 150 kW
c. 250 kW
d. 1 MW

Answer: C.12 a.
Reference: NEEP 234, pg. 5

Question: C.013 [1.0 point] {13.0}
When in AUTO mode, what is the period limited to with regulating rod motion?

a. 20 seconds
b. 25 seconds
c. 30 seconds
d. 45 seconds

Answer: C.13 a.
Reference: NEEP 234 “Controls and Instrumentation”

Question: C.014 [1.0 point] {14.0}
Which ONE of the following is the method used to minimize mechanical shock to the safety blades on a scram?

a. A small spring located at the bottom of the rod.
b. An electrical-mechanical brake energizes when the rod down limit switch is energized.
c. A piston enters a special dashpot as the rod reaches five inches of the fully inserted position.
d. An electromagnet energizes as the blade approaches the last few inches of travel slowing the decent of the blade.

Answer: C.14 c.
Reference: SAR 2.2.1, pp. 2-16 – 2-19.

Question: C.015 [1.0 point] {15.0}
Which ONE of the following control elements can NOT be used for automatic control of the reactor?

a. #2 Shim Blade
b. Transient Rod
c. Regulating Blade
d. #3 Shim Blade

Answer: C.15 d.
Reference: UWNR OTM, Contols & Instrumentation V, Mode Switch

Question: C.016 [1.0 point] {16.0}
Which ONE of the following is the actual design feature which prevents siphoning of pool water on a failure of the purification system?

a. A valve upstream of the primary pump will shut automatically.
b. A valve downstream of the primary pump will shut automatically.
c. The Emergency Fill system will automatically maintain pool level.
d. "Vacuum breaks" in the system, prevent draining the pool below the 1 foot from "full" line.

Answer: C.16 d.
Reference: OTM, Water Systems

Question: C.017 [1.0 point] {17.0}
WHICH ONE of the following detectors is used primarily to measure Ar^{41} released to the environment?

a. NONE, Ar^{41} has too short a half-life to require environmental monitoring.
b. Stack Gas Monitor
c. Stack Particulate Monitor
d. Area Radiation Monitor above pool

Answer: C.17 b.
Reference: SAR § 2.5.9, pages 2-54, 2-55.

Question: C.018 [1.0 point] {18.0}
During reactor operation, a leak develops in the primary to intermediate heat exchanger. Which ONE of the following conditions correctly describes how the system will react? Pool level will …

a. increase, the automatic level control will Pool maintain level within an 1 and ½ inches of normal.
b. increase, an alarm will occur at the Security and Police Headquarters two inches above normal.
c. decrease, the reactor will scram if level decreases by two inches.
d. decrease, the intermediate loop pump will trip due to low pressure.

Answer: C.18 b.
Reference: UWNR Reactor Cooling System Description (from addendum to 2003-2004 Annual Report); UWNR SAR2000 Section 7.6 Control Console and Display Instruments

Question: C.019 [1.0 point, 0.25 each] {19.0}
Match the purification system conditions listed in column A with their respective causes listed in column B. Each choice is used only once.

Column A	Column B
a. High Radiation Level at demineralizer.	1. Channeling in demineralizer.
b. High Radiation Level downstream of demineralizer.	2. Fuel element failure.
c. High flow rate through demineralizer.	3. High temperature in demineralizer system
d. High pressure upstream of demineralizer.	4. Clogged demineralizer

Answer: C.19 a. = 2; b. = 3; c. = 1; d. = 4
Reference: Standard NRC cleanup loop question.

Question: C.020 [1.0 point] {20.0}
When the "Experimental Facility Radiation Level High" annunciator alarms:

a. an evacuation alarm sounds after 20 seconds.
b. the reactor scrams.
c. the emergency exhaust fan is started.
d. no automatic actions occur.

Answer: C.20 d.
Reference: UWNR OTM, Controls & Instrumentation VI, "Area Radiation Monitor System" C.16, also facility supplied question