November 1, 2012

Dr. Sean O'Kelly, Deputy Director
NIST Center for Neutron Research
National Institute of Standards and Technology
U. S. Department of Commerce
100 Bureau Drive, Mail Stop 8561
Gaithersburg, MD 20899-8561

SUBJECT: INITIAL EXAMINATION REPORT NO. 50-184/OL-13-01,
NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY

Dear Dr. O'Kelly:

During the week of October 22, 2012, the NRC administered operator licensing examinations at your National Institute of Standards and Technology 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/

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

Docket No. 50-184

Enclosures: 1. Examination Report No. 50-184/OL-12-03
2. Written examination as administered

cc w/o enclosures: See next page

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DISTRIBUTION w/ encls.:
PUBLIC PROB r/f RidsNRRDPRPRTA
RidsNRRDPRPRTB Facility File (CRevelle) O-7 F-08

ADAMS ACCESSION #: ML12305A213 **TEMPLATE #:NRR-074**

OFFICE	PRTB:CE		IOLB:LA		PRTB:BC	
NAME	PYoung		CRevelle		GBowman	
DATE	11/01/2012		11/01 /2012		11/01/2012	

OFFICIAL RECORD COPY

cc:

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Test, Research, and Training
Reactor Newsletter
University of Florida
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Gainesville, FL 32611

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

REPORT NO.: 50-184/OL-13-01

FACILITY DOCKET NO.: 50-184

FACILITY LICENSE NO.: TR-5

FACILITY: NSBR

EXAMINATION DATES: October 22, 2012

SUBMITTED BY: _____ _____
Phillip T. Young, Chief Examiner Date

SUMMARY:

During the week of October 22, 2012 the NRC administered licensing examinations to one Senior Reactor Operator-Instant (SROI) applicants. The applicant 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	0/0	1/0	1/0
Operating Tests	0/0	1/0	1/0
Overall	0/0	1/0	1/0

3. Exit Meeting:
Phillip T. Young, Chief Examiner, NRC
Thomas Myers, NIST

At the conclusion of the examinations the chief examiner thanked the facility for their support during the examinations.

ENCLOSURE 1

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

FACILITY: National Institute of Standards and Technology

REACTOR TYPE: TEST

DATE ADMINISTERED: 10/22/2012

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		_____	____% FINAL GRADE	TOTALS

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

_____
Candidate's Signature

ENCLOSURE 2

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

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

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

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

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

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

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

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

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

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

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

°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 [1.0 point] (1.0)
A thin foil target of 10% aluminum atoms and 90% copper atoms is placed into a thermal neutron beam. Given σ_s = 1.49 and σ_a = 0.23 for aluminum and σ_s = 7.9 and σ_a = 3.79 for copper, determine the reaction with the highest probability. A neutron …

a. scattering reaction with aluminum
b. scattering reaction with copper
c. absorption in aluminum
d. absorption in copper

Answer: A.001 b.
Reference: Standard NRC Reactor Theory Question

Question: A.002 [1.0 point] (2.0)
A reactor scram has resulted in the instantaneous insertion of .003 ΔK/K of negative reactivity. Which ONE of the following is the stable negative reactor period resulting from the scram?

a. 45 seconds
b. 56 seconds
c. 80 seconds
d. 112 seconds

Answer: A.002 c
Reference: Lamarsh, J.R., Introduction to Nuclear Engineering, Addison-Wesley Publishing, Reading, Massachusetts, 1983. § 7.1, p. 289

Question: A.003 [1.0 point] (3.0)
Which ONE of the following is true concerning the differences between prompt and delayed neutrons?

a. Prompt neutrons account for less than 1% of the neutron population while delayed neutrons account for approximately 99% of the neutron population.

b. Prompt neutrons are released during fast fissions while delayed neutrons are released during thermal fissions.

c. Prompt neutrons are released during the fission process while delayed neutrons are released during the decay process.

d. Prompt neutrons are the dominating factor in determining the reactor period while delayed neutrons have little effect on the reactor period.

Section A Reactor Theory, Thermo, and Facility Characteristics

Answer: A.003 c.
Reference: Intro to Nuc Eng, John R. Lamarsh © 1983, § 3.7 pp. 73 – 75.

Section A Reactor Theory, Thermo, and Facility Characteristic

Question: A.04 [1.0 point] (4.0)
Which condition below describes a critical reactor?

a. K = 1, ΔK/K = 1

b. K = 1, ΔK/K = 0

c. K = 0, ΔK/K = 1

d. K = 0, ΔK/K = 0

Answer: A.004 b.
Reference: Intro to Nuc Eng, John R. Lamarsh © 1983, § 7.1, p. 282.

Question: A.005 [1.0 point] (5.0)
The reactor is shutdown by 0.05 ΔK/K, this would correspond to K_{eff} of:

a. 0.9995.

b. 0.9524.

c. 0.7750.

d. 0.0500.

Answer: A.005 b.
Reference: Lamarsh, J.R., Introduction to Nuclear Engineering, Addison-Wesley Publishing, Reading, Massachusetts, 1983. § 4,1, p. 102 & § 7.1, p. 282. p=(k-1)/k; p= -0.05; -0.05k = k-1; 1 = k-(-0.05k) = k(1+0.05); k=1/1.05; k=0.9524

Question: A.006 [1.0 point] (6.0)
Which statement best describes Xe-135 behavior following a Reactor Scram?

a. Xenon concentration decreases due to production rate from fission stops.

b. Xenon concentration decreases due to production rate from I-135 decay increasing.

c. Xenon concentration increases due to production rate from Pm-149 increasing.

d. Xenon concentration increases due to I-135 decay exceeding Xe-135 decay.

Answer: A.006 d.
Reference: Standard NRC Reactor Theory Question

Section A Reactor Theory, Thermo, and Facility Characteristics

Question: A.007 [1.0 point] (7.0)
An initial count rate of 100 is doubled five times during startup. Assuming an initial K_{eff} = 0.950, what is the new K_{eff}?

a. 0.957

b. 0.979

c. 0.988

d. 0.998

Answer: A.007 d.
Reference: $CR1/CR2 = (1 - K_{eff2})/(1 - K_{eff1})$ $1/32\ (1 - 0.95) = 1 - K_{eff2}$
$1 - 0.05/32 = Keff2$ $K_{eff2} = 0.9984$

Question: A.008 [1.0 point] (8.0)
K_{eff} is K_∞ times the

a. fast fission factor (ε)

b. reproduction factor (η)

c. total non-leakage factor ($\mathcal{L}_f \times \mathcal{L}_{th}$)

d. resonance escape probability (p)

Answer: A.0008 c.
Reference: Standard NRC Question[1]

Question: A.009 [1.0 point] (9.0)
Which ONE of the following is the reason for an installed neutron source within the reactor? A startup without a neutron source …

a. is impossible as there would be no neutrons available to start the fission process.

b. would be very slow due to the long time to build up neutron population from so low a level.

c. could result in a very short period due to the reactor going critical before neutron population can build up high enough to be read on nuclear instrumentation.

d. can be compensated for by adjusting the compensating voltage on the source range detector.

Answer: A.009 c.
Reference: Standard NRC Reactor Theory

Section A Reactor Theory, Thermo, and Facility Characteristic

Section A Reactor Theory, Thermo, and Facility Characteristics

Question: A.010 [1.0 point] (10.0)
Which ONE of the following describes "EXCESS REACTIVITY"?

a. Extra reactivity into the core due to the presence of the source neutrons.

b. A measure of the resultant reactivity if all of the control elements were withdrawn.

c. The combined reactivity worth of control rods and other poisons needed to keep the reactor shutdown.

d. The maximum reactivity insertion with the reactor shutdown with control rods fully inserted under peak Xenon conditions.

Answer: A.010 b.
Reference: Standard NRC Reactor Theory Question

Question: A.011 [1.0 point] (11.0)
Which ONE of the following is an example of beta (β) decay?

a. $_{35}Br^{87}$ —> $_{33}As^{83}$

b. $_{35}Br^{87}$ —> $_{35}Br^{86}$

c. $_{35}Br^{87}$ —> $_{34}Se^{86}$

d. $_{35}Br^{87}$ —> $_{36}Kr^{87}$

Answer: A.011 d.
Reference: Standard NRC Reactor Theory Question, Chart of the Nuclides

Question: A.012 [1.0 point] (12.0)
If reactor power is increasing by a decade every minute, it has a period of:

a. 13 sec

b. 26 sec

c. 52 sec

d. 65 sec

Answer: A.012 b.
Reference: Glasstone, S. and Sesonske, A, Nuclear Reactor Engineering, Kreiger Publishing, Malabar, Florida, 1991, § 5.18, p. 234.

Section A Reactor Theory, Thermo, and Facility Characteristic

Question: A.013 [1.0 point] (13.0)
Which ONE of the following conditions would increase shutdown margin?

a. An experiment which added positive reactivity.

b. Depletion of the burnable poison added to the uranium fuel.

c. Depletion of uranium fuel.

d. Decreasing fuel temperature.

Answer: A.013 c.
Reference: Adding negative reactivity increases the shutdown margin.

Question: A.014 [1.0 point] (14.0)
Which ONE of the following statements describes the difference between Differential (DRW) and Integral (IRW) rod worth curves?

a. DRW relates the worth of the rod per increment of movement to rod position. IRW relates the total reactivity added by the rod to the rod position.

b. DRW relates the time rate of reactivity change to rod position. IRW relates the total reactivity in the core to the time rate of reactivity change.

c. IRW relates the worth of the rod per increment of movement to rod position. DRW relates the total reactivity added by the rod to the rod position.

d. IRW is the slope of the DRW at a given rod position

Answer: A.014 a.
Reference: Lamarsh, Introduction to Nuclear Engineering, 1975, Page 270

Question: A.015 [1.0 point] (15.0)
The fuel temperature coefficient of reactivity is -1.25×10^{-4} $\Delta K/K/°C$. When a control rod with an average rod worth of 0.1 % $\Delta K/K$/inch is withdrawn 10 inches, reactor power increases and becomes stable at a higher level. At this point, the fuel temperature has:

a. increased by 80°C

b. decreased by 80°C

c. increased by 8°C

d. decreased by 8°C

Answer: A.015 a.
Reference: Lamarsh, Introduction to Nuclear Engineering, 2nd Edition, Page 306
Reactivity added by control rod = +(0.001 $\Delta k/k$/inch)(10 inches) = 0.01 $\Delta k/k$.

Section A Reactor Theory, Thermo, and Facility Characteristics

Fuel temperature change = -Reactivity added by rod / fuel temperature coefficient
Fuel temperature change = (-0.01 Δk/k) / (-1.25x10^{-4} Δk/k/□C) = 80□C.

Section A Reactor Theory, Thermo, and Facility Characteristic

Question: A.016 [1.0 point] (16.0)
Which one of the following characteristics of a material would result in the most efficient thermalization of neutrons?

a. LOW atomic mass number and HIGH scattering cross section.
b. HIGH atomic mass number and LOW scattering cross section.
c. LOW neutron absorption and LOW scattering cross section.
d. LOW neutron absorption and HIGH atomic mass number.

Answer: A.016 a.
Reference: Intro to Nuc Eng, John R. Lamarsh © 1983, § 3.5, pp. 59-60.

Question: A.017 [1.0 point] (17.0)
Which factor in the six factor formula is represented by the ratio:

$$\frac{\text{number of neutrons that reach thermal energy}}{\text{number of neutrons that start to slow down}}$$

a. fast non-leakage probability (L_f)
b. resonance escape probability (p)
c. reproduction factor (η)
d. thermal utilization factor (f)

Answer: A.017 b.
Reference: *Intro to Nuc Eng,* John R. Lamarsh © 1983, § 6.5 p. 239.

Question: A.018 [1.0 point] (18.0)
In a reactor at full power, the thermal neutron flux ( ) is 2.5×10^{12} neutrons/cm^2/sec., and the macroscopic fission cross-section Σ_f is 0.1 cm^{-1}. The fission rate is:

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

Answer: A. 18 c.
Reference: Standard EQB question. $R = \Sigma_f = (2.5 \times 10^{12}) \times 0.1 = 2.5 \times 10^{11}$

Section A Reactor Theory, Thermo, and Facility Characteristics

Question: A.019 [1.0 point] (19.0)
The term "Prompt Critical" refers to:

a. the instantaneous jump in power due to a rod withdrawal

b. a reactor which is supercritical using only prompt neutrons

c. a reactor which is critical using both prompt and delayed neutrons

d. a reactivity insertion which is less than β_{eff}

Answer: A.019 b.
Reference: Lamarsh, Introduction to Nuclear Engineering, 1975, Page 250

Question: A.020 [1.0 point] (20.0)
Which ONE of the following describes the difference between reflectors and moderators?

a. Reflectors decrease core leakage while moderators thermalize neutrons

b. Reflectors shield against neutrons while moderators decrease core leakage

c. Reflectors decrease thermal leakage while moderators decrease fast leakage

d. Reflectors thermalize neutrons while moderators decrease core leakage

Answer: A.020 a.
Reference: Lamarsh, Introduction to Nuclear Engineering, 1975, Pages 57, 214

Section B Normal/Emergency Procedures & Radiological Controls

Question: B.001 [1.0 point, 0.25 each] (1.0)
Identify each of the following Technical Specification Requirements as being either a Limiting Safety System Setting (LSSS) or a Limiting Condition for Operation (LCO).

a. Minimum Coolant Flow (outer plenum) 235 gpm/MW

b. reactivity insertion rate for all four shim safety arms, does not exceed 5.0×10^{-4} Δρ/sec.

c. D_2 concentration in the helium sweep system of greater than 4%.

d. Maximum Reactor power 130%

Answer: B.001 a. = LSSS; b. = LCO; c. = LCO; d. = LSSS
Reference: Tech Spec's, 2.2 1st and 4th spec, 3.2.1. (3) spec and 3.3.1. (2) spec.

Question: B.002 [1.0 point, 0.333 each] (2.0)
Match each of the Technical Specification Limits in column A with its corresponding value in column B. (Each limit has only one answer, values in Column B may be used more once, more than once or not at all.)

Column A	Column B
a. Absolute worth of any individual experiment	15% Δρ
b. Maximum Core Excess Reactivity	4.0% Δρ
c. The sum of the absolute Value of all experiments	2.6% Δρ
	1.0% Δρ
	0.5% Δρ

Answer: B.002 a. = 0.5% Δρ; b. = 15% Δρ; c. = 2.6% Δρ
Reference: Technical Specifications § 3.1.2 (1) and 3.8.1 (1) and 3.8.1 (2)

Question: B.003 [1.0 point] (3.0)
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?

a. 40 mrem/hr

b. 60 mrem/hr

c. 100 mrem/hr

d. 140 mrem/hr

Answer: B.003 a.
Reference: Instrument reads only γ dose with window closed. Instrument reads both β and γ dose with window open. Therefore, β dose is window open dose less window closed dose.

Section B Normal/Emergency Procedures & Radiological Controls

Question: B.004 [1.0 point] (4.0)
Which **ONE** of the following statements correctly defines the term "Channel Test?"

a. The introduction of a signal into a channel and observation of the proper channel response.

b. The qualitative verification of acceptable performance by observation of channel behavior.

c. An arrangement of sensors, components and modules as required to provide a single trip or other output signal relating to a reactor or system operating parameter.

d. The adjustment of a channel such that its output corresponds with acceptable accuracy to known values of the parameter which the channel measures.

Answer: B.004 a.
Reference: TS, § 1.3.2.3

Question: B.005 [1.0 point, 0.25 each] (5.0)
Match the allowable voluntary radiation exposure limit authorized during an emergency listed in column B with the correct condition from column A.

	Column A	Column B
a.	Lifesaving; without approval of Emergency Director	5 REM
b.	Other Serious Events; without approval of Emergency Director	10 REM
c.	Lifesaving; with approval of Emergency Director	25 REM
d.	Other Serious Events; with approval of Emergency Director	50 REM
		100 REM

Answer B.005 a. = 25; b. = 5; c. = 100; d. = 25
Reference: Emergency Instruction 3.6, Essential Personnel Evacuation,
IV. Voluntary Exposure Limits

Section B Normal/Emergency Procedures & Radiological Controls

Question: B.006 [1.0 point] (6.0)
Per 10CFR55.53, an SRO who has not maintained active status must have an authorized representative of the facility licensee certify the following:

a. a minimum of **six** hours of shift functions under the direction of an operator or senior operator as appropriate and in the position to which the individual will be assigned has been completed.

b. a minimum of **four** hours of shift functions under the direction of an operator or senior operator as appropriate and in the position to which the individual will be assigned has been completed.

c. a minimum of **six** hours of shift functions under the direction of an operator or senior operator as appropriate and in the position to which the individual will be assigned has been completed and, that in part, the individual is current in all of the facility requalification program requirements.

d. a minimum of **four** hours of shift functions under the direction of an operator or senior operator as appropriate and in the position to which the individual will be assigned has been completed and, that in part, the individual has completed a requalification program written examination and operating test within the current calendar quarter.

Answer: B.006 c.
Reference: 10CFR55.53 and 10CFR55.59

Question: B.007 [1.0 point] (7.0)
During shipment of spent fuel, the truck door was closed whenever time was spent loading baskets in the pool. The truck door was closed to.....

a. safeguard the fuel.
b. establish confinement integrity.
c. limit the spread of contamination.
d. prevent an unauthorized entry point.

Answer: B.007 b.
Reference: TS, § 3.4.2
NBSR Reactor Operations Training Guide
8.1 Reactor Building And Confinement System

Section B Normal/Emergency Procedures & Radiological Controls

Question: B.008 [1.0 point] (8.0)
A gamma source reads 125 mR/hr @ 1 foot. How far from the source must you post a barrier for a radiation area?

a. 35 feet
b. 25 feet
c. 15 feet
d. 5 feet

Answer: B.008 d.
Reference: $A_f = A_0 (d_0/d_f)^2 \Rightarrow d_f^2 = A_0/A_f \times d_0^2 = 125/5 \times 1^2 = 25 \quad d_0 = 5$

Question: B.009 [1.0 point] (9.0)
Which ONE of the following is the ***LOWEST*** level of NIST management who may authorize reactor startup (to previous shim position) following a scram, where the cause of the scram remains unknown?

a. Reactor Operator
b. Senior Reactor Operator
c. Reactor Supervisor
d. Deputy Chief Engineer

Answer: B.009 b.
Reference: O.I. 1.1B (Checklist B) step I.B.

Question: B.010 [1.0 point] (10.0)
According to Emergency Instructions, which one of the following lists the two individuals (by title) who may serve as Emergency Director until relieved by higher authority?

a. Reactor Supervisor, or in his absence the Reactor Operator on the console
b. Reactor Supervisor, or in his absence the Senior Reactor Operator.
c. Deputy Chief Engineer, or in his absence the Reactor Supervisor
d. Deputy Chief Engineer, or in his absence the Senior Reactor Operator

Answer: B.010 a.
Reference: E.I. Figure 6.1 NBSR Emergency And Support Organizations

Section B Normal/Emergency Procedures & Radiological Controls

Question: B.011 [1.0 point, 0.25 point each] (11.0)
For Research and Test reactors we primarily worry about two isotopes N^{16} and Ar^{41}. Identify the approximate half-life and gamma energy for each. (Each item has only one answer.)

Isotope	Radiological Parameters			
a. Ar^{41} half-life	1) 1.8 sec	2) 1.8 min	3) 1.8 hour	4) 1.8 day
b. Ar^{41} gamma energy	1) 10 KeV	2) 100 KeV	3) 1 MeV	4) 10 MeV
c. N^{16} half-life	1) 7 sec	2) 7 min	3) 7 hour	4) 7 day
d. N^{16} gamma energy	1) 6 kev	2) 60 keV	3) 600 keV	4) 6 Mev

Answer: B.011 a. = 3; b. = 3; c. = 1; d. = 4
Reference: Standard NRC Rad Question

Question: B.012 [1.0 point] (12.0)
You use a ***Geiger-Müller detector*** at the same distance from two point sources having the ***same curie strength***. Source A's gammas have an energy of 1.0 MeV, while Source B's gammas have an energy of 2.0 MeV. Which ONE of the following would you expect for the readings due to each source?

a. The reading from source B is four times that of source A.
b. The reading from source B is twice that of source A.
c. Both readings are the same.
d. The reading from source B is half that of source A.

Answer: B.012 c.
Reference: Geiger-Müller detector output is independent of incident energy.

Question: B.013 [1.0 point] (13.0)
According to the Administrative Rules, the ***MINIMUM*** number of nuclear instruments required for refueling is …

a. one on-scale instrument with trip safety function
b. two on-scale instruments with trip safety function
c. one on-scale instrument
d. two on-scale instruments

Answer: B.013 d.
Reference: Administrative Rule 3.0, § III.A, also Administrative Rule 6.0 § I.B.

Section B Normal/Emergency Procedures & Radiological Controls

Question: B.014 [1.0 point] (14.0)
Which ONE of the following is the definition for ***"Annual Limit on Intake (ALI)"***? A 10CFR20 derived limit based on …

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. 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.014 b.
Reference: 10CFR20

Question: B.015 [1.0 point] (15.0)
Which ONE of the following correctly completes the sentence. While the reactor is OPERATING, the process test switch may be placed in the "2 of 2" position …

a. for not longer than 8 hours to allow the checking of a channel's operability.

b. indefinitely if power is reduced below 10 MW before changing the selector's position.

c. up to a maximum of 12 hours if no experiments are inserted into the reactor.

d. while maintaining a steady power level but must be returned to the "1 of 2" position prior to changing power.

Answer: B.015 a.
Reference: Operation Instructions Manual, O.I. 5.7. "Operation of the Process Instrumentation Safety System", Page 2 of 3

Question: B.016 [1.0 point] (16.0)
While operating one of the shim arms falls to its lower stop. Per Annunciator Procedure 0.4 *"Stuck or Faulty Operation of Shim Arms"* you should …

a. maintain the reactor as is (subcritical) until Reactor Supervisor directs corrective action.

b. continue to operate if able to latch and shim out the fallen shim arm.

c. continue to operate using the remaining shim arms to stay critical.

d. shutdown the reactor.

Answer: B.016 d.
Reference: Annunciator Procedures, A.P. 0.4.

Section B Normal/Emergency Procedures & Radiological Controls

Question: B.017 [1.0 point] (17.0)
The fission products monitor located in the helium sweep gas will give an indication of a …. ?

a. A “pin-hole” breach in the cladding.
b. Activation of argon in air from the reactor.
c. Disassociation of water and nitrogen 16 production.
d. Activation of aluminum from reactor and primary piping materials.

Answer: B.017 a.
Reference: TS 3.7.1 Monitoring Systems and Effluent Limits

Question: B.018 [1.0 point] (18.0)
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) state that this may be authorized by a senior operator. Per the note in the front of the Operating Instructions, the minimum level of management who may authorize a deviation from the Operating Instructions is …

a. a licensed SRO
b. the Reactor Supervisor
c. the Chief of Reactor Operations
d. the highest level of management available at the time.

Answer: B.018 d.
Reference: Note in the front of the Operating Instructions

Question: B.019 [1.0 point] (19.0)
The total exposure from effluents from the reactor facility to a person at the site boundary shall not exceed ……

a. 100 mrem per 24 hour period
b. 100 mrem per calendar year
c. 500 mrem per 24 hour period
d. 500 mrem per calendar year

Answer: B.019 b.
Reference: TS 3.7.2 Effluents

Section B Normal/Emergency Procedures & Radiological Controls

Question: B.020 [1.0 point] (20.0)
During Reactor Startup, per SOP 0.1, the minimum allowable period allowed is …

a. 10 seconds

b. 20 seconds

c. 30 seconds

d. 56 seconds

Answer: B.020 b.
Reference: Standard Operating Instructions O.I.1.1, *Reactor Startup*: § II.C.

Section C Facility and Radiation Monitoring Systems

Question: C.001 [1.0 point] (1.0)
Which ONE of the following is the material used as a neutron poison in the Regulating Rod?

a. Erbium

b. Cadmium

c. Aluminum

d. Boron

Answer: C.001 c.
Reference: NBSR Reactor Operations Training Guide, § 1.1.5 2nd ¶.

Question: C.002 [1.0 point, 0.25 points each] (2.0)
Identify the valves listed below as either Motor Operated (MO)or Air Operated (AO).

a. DWV-1 Inner Plenum Flow Control (D_2O Main Cooling System)

b. DWV-2 Outer Plenum Flow Control (D_2O Main Cooling System)

c. DWV-40 D_2O supply to Emergency Tank (D_2O Auxiliary System)

d. DWV-19 Isolation between Core and Main Pump Piping (D_2O Main Cooling System)

Answer: C.002 a. = MO; b. = MO; c. = AO; d. = MO
Reference: NBSR Operations Training Guide, § 2.2.4 and Drawing 2.1

Question: C.003 [1.0 point] (3.0)
Question deleted from examination – changes to facility resulted in no correct answer to the question.
~~WHICH ONE of the following correctly describes the lineup of Secondary Valves 1, 2 and 3?~~
~~a. SCV 1 & 2 supply suction to pumps 4, 5 and 6, SCV 3 supplies suction to pumps 1, 2 and 3.~~
~~b. SCV 2 & 3 supply suction to pumps 4, 5 and 6, SCV 1 supplies suction to pumps 1, 2 and 3.~~
~~c. SCV 1 & 2 supply suction to pumps 1, 2 and 3, SCV 3 supplies suction to pumps 4, 5 and 6.~~
~~d. SCV 2 & 3 supply suction to pumps 4, 5 and 6, SCV 1 supplies suction to pumps 1, 2 and 3.~~
~~Answer: C.003 a.~~
~~Reference: NBSR Operations Training Guide, Figure 3.1.~~

Section C Facility and Radiation Monitoring Systems

Question: C.004 [1.0 point] (4.0)
During a reactor startup, the 123 Strainer Inlet Isolation valve SCV-200 is inadvertently left closed. As the startup progresses, the reactor receives a rundown signal, the signal was due to

a. low secondary flow
b. low thermal shield flow
c. high inlet temperature
d. high outlet temperature

Answer: C.004 d.
Reference: NIST SAR Sections 5.2.2.7.1 Strainer & 5.2.4.1 Removal of Heat from the Fuel

Question: C.005 [1.0 point] (5.0)
Which ONE of the following correctly describes where Critical Panel 1 (CP-1) receives power from?

a. Directly from MCCA-7
b. Directly from the 20 kVA uninterruptible power supplies (UPS)
c. Directly from either Scott Transformer T9 or T10.
d. Directly from the battery

Answer: C.005 c.
Reference: NBSR Reactor Operations Training Guide, § 5.0 NBSR Electrical Systems

Question: C.006 [1.0 point] (6.0)
Reactor level is increasing above 168 inches. Which ONE of the following is the AUTOMATIC reactor scram which will occur?

a. High reactor D_2O level.
b. High flux on NC-6, NC-7 or NC-8.
c. Low reactor D_2O level.
d. High Reactor ΔT

Answer: C.006 c.
Reference: Annunicator Procedure AN.3.1 “Hi Reactor D_2O level”

Section C Facility and Radiation Monitoring Systems

Question: C.007 [1.0 point] (7.0)
Which ONE of the following is the actual method that negative building pressure is maintained following a containment building isolation and normal ventilation shutdown due to high radiation? (Assume AC power is available, no operator action, and the containment building pressure is being maintained by the emergency exhaust system.)

a. automatic fan cycling on and off to maintain a pressure of -0.25".
b. manual fan cycling on and off to maintain a pressure of -0.25".
c. automatic fan cycling on and off to maintain a pressure of -0.1".
d. manual fan cycling on and off to maintain a pressure of -0.1".

Answer: C.007 a.
Reference: NBSR Training Guide, § 4.10.3, “Ventilation System Under accident conditions”.

Question: C.008 [1.0 point, 0.25 each] (8.0)
Match the Storage Pool cooling system components with their primary responsibiities.

a. Suspended Solids	1. Pre and Post Filters
b. Dissolved Solids	2. Ultraviolet Treatment Unit
c. Kill Biological Impurities	3. Collection Basin
d. Floating Detritus (Mosquito Larvae, dust etc.)	4. HOH Ion Exchanger

Answer: C.008 a. = 1; b. = 4; c. = 2; d. = 3
Reference: NBSR Training Guide, figure 4.10.

Question: C.009 [1.0 point] (9.0)
What type of detector does the T^3 channel use?

a. Ion chamber
b. Geiger Counter
c. Scintillation Detector
d. Proportional Counter

Answer: C.009 a.
Reference: NBSR Training Guide, § 6.4.7.

Section C Facility and Radiation Monitoring Systems

Question: C.010 [1.0 point] (10.0)
In order to detect neutrons the Nuclear Instrumentation ion chambers are coated with 96% enriched …

a. Be^{10}
b. Be^{11}
c. B^{10}
d. B^{11}

Answer: C.010 c.
Reference: NBSR Training Guide, § 6.2.3 and 6.2.4.

Question: C.011 [1.0 point, ¼ point each] (11.0)
Using the simplified diagram of the pneumatic tube (rabbit) system provided, identify the position of valves A through D as either **OPEN** or **CLOSED**, on a sample ***INSERTION***.

a. A
b. B
c. C
d. D

Answer: C.011 a. = Closed; b. = Open; c. = Open; d. = Closed
Reference: NBSR Reactor Operations Training Guide, Figure 8.3

Question: C.012 [1.0 point] (12.0)
Which ONE of the following is the gas used to move the samples in the *Rabbit* systems?

a. He
b. Air
c. CO_2
d. N_2

Answer: C.012 c.
Reference: NBSR Operations Training Guide, § 8.2.5

Section C Facility and Radiation Monitoring Systems

Question: C.013 [1.0 point] (13.0)
Which ONE of the following is the purpose of the Bismuth shield within the Thermal Column? Reduce _____ within the graphite region of the thermal column.

a. gamma radiation intensity
b. Intermediate neutron flux
c. Fast neutron flux
d. Thermal neutron flux

Answer: C.013 a.
Reference: NBSR Operations Training Guide, § 8.2.4.

Question: C.014 [1.0 point] (14.0)
Which ONE of the following core components bear all impact loads associated with the safety- shims?

a. Thermal Shield
b. Upper grid plate
c. Biological Shield
d. Lower grid plate

Answer: C.014 c.
Reference: NBSR Operations Training Guide, § 1.3.5

Question: C.015 [1.0 point] (15.0)
Question deleted from examination – changes to facility resulted in no correct answer to the question.
~~If a Secondary cooling pump trips off due to an overload, prior to restarting you must …~~

~~a. place the control room switch to off to reset the pump electrically.~~
~~b. place the control room switch to the on position (the pump resets itself electrically).~~
~~c. have an auxiliary operator push a reset button on the controller locally at the pump.~~
~~d. have an auxiliary operator take the local, auto switch to local to reset the pump, then return the switch to auto.~~

~~Answer: C.015 a.~~
~~Reference: NBSR Training Manual, § 3.2.1.~~

Section C Facility and Radiation Monitoring Systems

Question: C.016 [1.0 point] (16.0)
How long is the D2O system designed to provide cooling on a once-through basis?

a. 1 hour

b. 1.5 hours

c. 2 hours

d. 2.5 hours

Answer: C.016 d.
Reference: TS 3.3.2 Emergency Core Cooling

Question: C.017 [1.0 point] (17.0)
How much negative reactivity does the moderator dump provide?

a. The most reactive shim arms fully withdrawn.

b. Two shims arms fully withdrawn.

c. Three shims arms fully withdrawn and the regulating rod fully withdrawn.

d. All four shims arms fully withdrawn.

Answer: C.017 d.
Reference: TS 3.3.3 Moderator Dump System

Question: C.018 [1.0 point] (18.0)
The emergency exhaust system is designed to pass reactor building effluents through high-efficiency particulate filters capable of removing particles of ____ µm or greater with an efficiency of at least 99% and the charcoal filters are capable of removing greater than ____ of the Iodine from the air.

a. 0.3 µm 99%

b. 0.1 µm 98%

c. 0.2 µm 95%

d. 0.5 µm 96%

Answer: C.018 a.
Reference: TS 3.5 Ventilation System

Section C Facility and Radiation Monitoring Systems

Question: C.019 [1.0 point] (19.0)
The purpose of the fuel element latching bar is to prevent an element from lifting out of the lower grid plate resulting in ……

a. A reduction in flow to the element.
b. Changes in the neutron flux to experiments.
c. Restrictions that could prevent a shim arm from operating.
d. Changes to the radial and axial flux pattern that could damage the fuel.

Answer: C.019 a.
Reference: TS 3.9.2 Fuel Handling

Question: C.020 [1.0 point] (20.0)
With tritium concentrations of greater than 4 Ci/l, how often is the primary water required to be sampled?

a. Annually
b. Semi-annually
c. Quarterly
d. Monthly

Answer: C.020 c.
Reference: TS 4.7 Radiation Monitoring System and Effluents