March 13, 2014

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

SUBJECT: EXAMINATION REPORT NO. 50-184/OL-14-01,
NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY

Dear Dr. O'Kelley:

During the week of February 17, 2014, the U.S. Nuclear Regulatory Commission (NRC) administered an operator licensing examination at your National Institute of Standards and Technology reactor. The examination was conducted according to NUREG-1478, "Operator Licensing Examiner Standards for Research and Test Reactors," Revision 2. Examination questions and preliminary findings were discussed 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. Mike Morlang at (301) 415-4092 or via e-mail gary.morlang@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-14-01
2. Facility Comments with NRC Resolution
3. Written examination as administered

cc: Mr. Daniel Hughes, Chief of Reactor Operations
cc w/o enclosures: See next page

March 13, 2014

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National Institute of Standards
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U. S. Department of Commerce
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DISTRIBUTION:

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ADAMS ACCESSION #: ML14064A486 **NRR-079**

OFFICE	PRTB:CE	IOLB:LA	PRTB:BC
NAME	GMorlang	CRevelle	GBowman
DATE	03/03/2014	03/12/2014	03/13/2014

OFFICIAL RECORD COPY

cc:

Director, Department of State Planning
301 West Preston Street
Baltimore, MD 21201

Director, Air & Radiation Management
Administration
Maryland Dept of the Environment
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Baltimore, MD 21230

Director, Department of Natural Resources
Power Plant Siting Program
Energy and Coastal Zone Administration
Tawes State Office Building
Annapolis, MD 21401

President
Montgomery County Council
100 Maryland Avenue
Rockville, MD 20850

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.: 50-184/OL-14-01

FACILITY DOCKET NO.: 50-184

FACILITY LICENSE NO.: TR-5

FACILITY: NCNR

EXAMINATION DATES: February 20-21, 2014

SUBMITTED BY: **/RA/** **03/03/2014**
Mike Morlang, Chief Examiner Date

SUMMARY:

During the week of February 17, 2014 the NRC administered a licensing examination to one Senior Reactor Operator-Instant (SROI) applicant. The applicant passed all portions of the examination.

REPORT DETAILS

1. Examiner: Mike Morlang, 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:
Mike Morlang, Chief Examiner, NRC
Warren Eresian, NIST

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

ENCLOSURE 1

Facility Comments:

Question B.20

The question refers to Annunciator Procedure 0.7. This procedure has been withdrawn and replaced by A.P. Simplex – Priority 2. This directs you Annunciator Procedure 2.27 for domestic water low pressure. In accordance with this procedure, the set point is 20 psig. The answer sheet identifies the answer as c., 25 psig. Answer d., 15 psig, is the "more correct" answer.

We request that the answer sheet be corrected to identify d. as the correct answer.

NRC Resolution:

Comment accepted. Answer sheet changed to show d. as the correct answer.

Question C.01

The answer key identifies the condition of a. as a rundown. In actuality, a scram occurs when the period on NC-6 is at 5 seconds, at < 10% power.

Reference: Annunciator Procedure 4-4, "Period Scram," and Annunciator Procedure 6-1, "Scram"

We request that the answer sheet be corrected to identify a. as a scram.

NRC Resolution:

Comment accepted. Answer sheet changed to show condition a. as a scram.

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

FACILITY: National Institute of Standards and Technology

REACTOR TYPE: Heavy Water cooled and moderated Tank

DATE ADMINISTERED: 2/21/2014

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.

% of Category Value	% of Total	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
19.00	33.3	_____	____	C. Facility and Radiation Monitoring Systems
59.00		_____	____%	TOTALS
				FINAL GRADE

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

_____
Candidate's Signature

ENCLOSURE 3

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.

$$\dot{Q} = \dot{m}\, c_{\bar{p}}\, \Delta T = \dot{m}\, \Delta H = UA\, \Delta T$$

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

$$SUR = 26.06\left[\frac{\lambda_{eff}\,\rho}{\beta - \rho}\right] \qquad SCR = \frac{S}{-\rho} \approx \frac{S}{1 - K_{eff}} \qquad CR_1(1 - K_{eff_1}) = CR_2(1 - K_{eff_2})$$

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

$$M = \frac{1 - K_{eff_0}}{1 - K_{eff_1}} \qquad M = \frac{1}{1 - K_{eff}} = \frac{CR_1}{CR_2}$$

$$P = P_0\, 10^{SUR(t)} \qquad P = P_0\, e^{\frac{t}{T}} \qquad P = \frac{\beta(1-\rho)}{\beta - \rho} P_0$$

$$SDM = \frac{(1 - K_{eff})}{K_{eff}} \qquad T = \frac{\ell^*}{\rho - \bar{\beta}} \qquad T = \frac{\ell^*}{\rho} + \left[\frac{\bar{\beta} - \rho}{\lambda_{eff}\,\rho}\right]$$

$$\Delta\rho = \frac{K_{eff_2} - K_{eff_1}}{k_{eff_1}\, x\, K_{eff_2}} \qquad T_{‰} = \frac{0.693}{\lambda} \qquad \rho = \frac{(K_{eff} - 1)}{K_{eff}}$$

$$DR = DR_0\, e^{-\lambda t} \qquad DR = \frac{6CiE(n)}{R^2} \qquad DR_1 d_1^{\,2} = DR_2 d_2^{\,2}$$

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

ANSWER SHEET

MULTIPLE CHOICE (Circle or X your choice) If you change your answer, write your selection in the blank.

A.01	A	B	C	D	____
A.02	A	B	C	D	____
A.03	A	B	C	D	____
A.04	A	B	C	D	____
A.05	A	B	C	D	____
A.06a	1	2	3	4	____
A.06b	1	2	3	4	____
A.06c	1	2	3	4	____
A.06d	1	2	3	4	____
A.07	A	B	C	D	____
A.08	A	B	C	D	____
A.09	A	B	C	D	____
A.10	A	B	C	D	____
A.11	A	B	C	D	____
A.12	A	B	C	D	____
A.13	A	B	C	D	____
A.14	A	B	C	D	____

ANSWER SHEET

MULTIPLE CHOICE (Circle or X your choice) If you change your answer, write your selection in the blank.

A.15	A	B	C	D	____
A.16	A	B	C	D	____
A.17	A	B	C	D	____
A.18	A	B	C	D	____
A.19	A	B	C	D	____
A.20	A	B	C	D	____

ANSWER SHEET

MULTIPLE CHOICE (Circle or X your choice) If you change your answer, write your selection in the blank.

B.01	A	B	C	D	____
B.02	A	B	C	D	____
B.03	A	B	C	D	____
B.04	A	B	C	D	____
B.05	A	B	C	D	____
B.06	A	B	C	D	____
B.07	A	B	C	D	____
B.08	A	B	C	D	____
B.09a	FP	Air	D20		____
B.09b	FP	Air	D20		____
B.09c	FP	Air	D20		____
B.09d	FP	Air	D20		____
B.10	A	B	C	D	____
B.11a	1	2	3	4	____
	5	6			
B.11b	1	2	3	4	____
	5	6			
B.11c	1	2	3	4	____
	5	6			
B.11d	1	2	3	4	____
	5	6			

ANSWER SHEET

MULTIPLE CHOICE (Circle or X your choice) If you change your answer, write your selection in the blank.

B.12	A	B	C	D	____
B.13	A	B	C	D	____
B.14	A	B	C	D	____
B.15	A	B	C	D	____
B.16	A	B	C	D	____
B.17	A	B	C	D	____
B.18	A	B	C	D	____
B.19	A	B	C	D	____
B.20	A	B	C	D	____

ANSWER SHEET

MULTIPLE CHOICE (Circle or X your choice) If you change your answer, write your selection in the blank.

C.01a	S	RD	N		____	
C.01b	S	RD	N		____	
C.01c	S	RD	N		____	
C.01d	S	RD	N		____	
~~C.02a~~	~~1~~	~~2~~	~~3~~	~~4~~	~~5~~	- ____
~~C.02b~~	1	2	3	4	5	____
~~C.02c~~	1	2	3	4	5	____
~~C.02d~~	1	2	3	4	5	____
C.03	A	B	C	D	____	
C.04a	S	MS	E		____	
C.04b	S	MS	E		____	
C.04c	S	MS	E		____	
C.04d	S	MS	E		____	
C.05	A	B	C	D	____	
C.06	A	B	C	D	____	
C.07	A	B	C	D	____	
C.08	A	B	C	D	____	
C.09	A	B	C	D	____	

ANSWER SHEET

MULTIPLE CHOICE (Circle or X your choice) If you change your answer, write your selection in the blank.

C.10	A	B	C	D	____
C.11	A	B	C	D	____
C.12	A	B	C	D	____
C.13	A	B	C	D	____
C.14	A	B	C	D	____
C.15	A	B	C	D	____
C.16	A	B	C	D	____
C.17	A	B	C	D	____
C.18	A	B	C	D	____
C.19	A	B	C	D	____
C.20	A	B	C	D	____

Question A.001 [1.0 point] (1.0)
In a subcritical reactor, Keff is increased from 0.861 to 0.946. Which ONE of the following is the amount of reactivity that was added to the reactor core?

a. 0.085 ΔK/K
b. 0.104 ΔK/K
c. 0.161 ΔK/K
d. 0.218 ΔK/K

Question A.002 [1.0 point] {2.0}
You enter the control room and note that ALL nuclear instrumentation show a STEADY NEUTRON LEVEL, and no rods are in motion. Which ONE of the following conditions CANNOT be true?

a. The reactor is critical.
b. The reactor is sub-critical.
c. The reactor is super-critical.
d. The neutron source has been removed from the core.

Question A.003 [1.0 point] {3.0}
The neutron microscopic cross-section for absorption σ_a generally…

a. increases as neutron energy increases.
b. decreases as neutron energy increases.
c. increases as the mass of the target nucleus increases.
d. decreases as the mass of the target nucleus increases.

Question A.004 [1.0 point] (4.0)
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}

Question A.005 [1.0 point] (5.0)
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

Question A.006 [1.0 points, 0.25 each] {6.0}
Match type of radiation (Column A) with the proper penetrating power (Column B).

Column A	Column B
a. Gamma	1. Stopped by thin sheet of paper
b. Beta	2. Stopped by thin sheet of metal
c. Alpha	3. Best shielded by light (low-z) material
d. Neutron	4. Best shielded by heavy (high-z) material

Question A.007 [1.0 point] {7.0}
Given that the NBSR is shutdown with a K_{eff} of 0.84, and β_{eff} is 0.008. Calculate the amount of reactivity required to achieve criticality.

a. 12.8$

b. 16$

c. 24$

d. 30$

Question A.008 [1.0 point] {8.0}
Which ONE of the following is the reason that Xenon Peaks after a shutdown?

a. Iodine decays faster than Xenon decays

b. Promethium decays faster than Xenon decays

c. Xenon decays faster than Iodine decays

d. Xenon decays faster than Promethium

Question A.009 [1.0 point] {9.0}
To make a just critical reactor "PROMPT CRITICAL", by definition you must add reactivity equal to …

a. τ_{eff}
b. λ_{eff}
c. β_{eff}
d. K_{eff}

Question A.010 [1.0 point] (10.0)
Which ONE of the following is the time period in which the maximum amount of Xe^{135} will be present in the core?

a. 7 to 11 hours after a startup to 100% power
b. 3 to 6 hours after a power increase from 50% to 100%.
c. 3 to 6 hours after a power decrease from 100% to 50%.
d. 7 to 11 hours after a scram from 100%

Question A.011 [1.0 point] (11.0)
Which ONE of the following statements describes the Nuclear Instrumentation response for a rod withdrawal while the reactor is subcritical? (Assume the reactor remains subcritical)

a. Count rate will rapidly increase (prompt jump), then gradually increase to a new stable value.
b. Count rate will rapidly increase (prompt jump), then gradually decrease to the initial value.
c. Count rate will rapidly increase (prompt jump) to a new stable value.
d. Count rate will not change until criticality is reached.

Question A.012 [1.0 point] (12.0)
Which ONE of the four listed factors (of the six-factor formula) is greater than one for the NIST reactor?

a. Fast Fission Factor (ε)
b. Thermal Utilization Factor (f)
c. Thermal Non-Leakage probability ($£_{th}$)
d. Resonance Escape probability (p)

Question A.013 [1.0 point] {130}
NI-1 is indicating 50 cps. An experimenter inserts an experiment into the core, and NI-1 indication decreases to 25 cps. Given the initial K_{eff} of the reactor was 0.8, what is the worth of the experiment?

a. negative 0.42
b. positive 0.42
c. negative 0.21
d. positive 0.21

Question A.014 [1.0 point] {14.0}
Given the lowest of the high power scrams is 124%, and the scram time is 0.5 sec. Approximately how high will reactor power get with a 20 second period? (NOTE: this is a theory question, there is no relation to Tech. Spec. limit.)

a. 124%
b. 127%
c. 131%
d. 200%

Question A.015 [1.0 point] {15.0}
Which ONE of the following is the dominant factor in determining differential rod worth?

a. Rod speed
b. Total Reactor Power
c. Axial and Radial Flux
d. Delayed neutron fraction

Question A.016 [1.0 point] {16.0}
With the reactor on a CONSTANT period, which ONE of the following transients will take the LONGEST time to complete? A reactor increase from …

a. 1 to 5% of full power.
b. 10 to 20% of full power.
c. 20 to 35% of full power.
d. 40 to 60% of full power.

Question A.017 [1.0 point] {17.0}
Which ONE of the following is the MAJOR source of energy released from the fission process?

a. Kinetic energy of the fission fragments

b. Kinetic energy of the fission neutrons

c. Decay of the fission fragments

d. Prompt gamma rays

Question A.018 [1.0 point] {18.0}
The term PROMPT JUMP refers to …

a. the instantaneous change in power due to moving a control element.

b. a reactor which has attained criticality on prompt neutrons alone.

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

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

Question A.019 [1.0 point] {19.0}
Most nuclear text books list the delayed neutron fraction (β) as being 0.0065Δρ. Most research reactors however have an effective delayed neutron fraction ($\beta_{effective}$) of 0.0070 Δρ. Which ONE of the following is the reason for this difference?

a. Delayed neutrons are born at higher energies than prompt neutrons resulting in a greater worth for the neutrons.

b. Delayed neutrons are born at lower energies than prompt neutrons resulting in a greater worth for the neutrons.

c. The fuel includes U^{238} which via neutron absorption becomes Pu^{239} which has a larger β for fission.

d. The fuel includes U^{238} which has a relatively large β for fast fission.

Question A.020 [1.0 point] {20.0}
A fast neutron will lose the most energy in a collision with which ONE of the following atoms?

a. H^1

b. H^2

c. C^{12}

d. U^{238}

Question B.001 [1.0 point] (1.0)
The emergency plan allows the operator to take action which deviates from emergency procedures during an emergency. Which ONE of the following is the minimum level of staff that may authorize this action?

a. Reactor Operator
b. Senior Reactor Operator
c. Emergency Director
d. Emergency Coordinator

Question B.002 [1.0 point] (2.0)
Which of the following radioisotopes is considered a fission product?

a. N^{16}
b. Ar^{41}
c. H^{3}
d. I^{135}

Question B.003 [1.0 point] (3.0)
What is the definition of Emergency Action Level(s) …

a. projected radiological dose or dose commitment values to individuals that warrant protective action following a release of radioactive material.

b. the person or persons appointed by the Emergency Coordinator to ensure that all personnel have evacuated the facility or a specific part of the facility.

c. a condition or conditions which call(s) for immediate action, beyond the scope of normal operating procedures, to avoid an accident or to mitigate the consequences of one.

d. specific instrument readings, or observations; radiological dose or dose rates; or specific contamination levels of airborne, waterborne, or surface- deposited radioactive materials that may be used as thresholds for establishing emergency classes and initiating appropriate emergency measures.

Question B.004 [1.0 point] (4.0)
Annunciator 4-6 BUILDING EXHAUST ACTIVITY HIGH is in alarm, investigation reveals that RD1-13 is also in alarm. Given this information, which of the following areas is the probable source of the activity?

a. Rabbit transfer blower
b. Elevator machinery room
c. Upper trench around the reactor top
d. Reactor face on the experimental level

Question B.005 [1.0 point] (5.0)
During a loss of potable water, if potable water cannot be restored, another source of emergency makeup water for the core shall be found. If the supervisor can confirm that a source would be available within ____ minutes of making such a request, then continue operations, otherwise shutdown the reactor.

a. 10
b. 20
c. 30
d. 40

Question B.006 [1.0 point] (6.0)
During periods of low cooling tower temperature, procedures state “do not allow secondary flow through heat exchangers if temperature is below ____ °F.

a. 45
b. 40
c. 36
d. 32

Question B.007 [1.0 point] (7.0)
If a moderator dump is initiated, the switch shall be left in the Open position until _____ .

a. reactor power is under control
b. clutch current monitor shows zero current
c. Main D_2O pumps are tripped
d. Reactor vessel level is normal

Question B.008 [1.0 point] (8.0)
The reactor is considered "Shutdown" if it contains less than …

a. 2.2 lbm of U^{235}
b. 2.2 Kg of U^{235}
c. 10 lbm of U^{235}
d. 10 Kg of U^{235}

Question B.009 [1.0 points, 0.25 each] (9.0)
Identify the source (Irradiation of Air, Coolant (D_2O) or Fission Product (FP)) for each of the radioisotopes listed below.

a. Xe^{135}
b. Ar^{41}
c. N^{16}
d. H^3

Question B.010 [1.0 point] (10.0)
A Radiation Work Permit (RWP) has been written to perform a non-repetitive task on potentially contaminated equipment. How long will this RWP remain in effect?

a. Until the job is completed.
b. 8 hours or until the end of the current shift.
c. A maximum of 24 hours.
d. Indefinitely, if reviewed daily by Health Physics.

Question B.011 [1.0 points, 0.25 each] (11.0)
Match the 10CFR55 requirements for an active operator license in column A with the appropriate time periods in column B.

Column A (License requirement)	Column B (years)
a. Renewal of license	1
b. Medical Examination	2
c. Requalification Written Examination	3
d. Requalification Operating Test	4
	5
	6

Question B.12 [1.0 point] (12.0)

Rescue personnel, are authorized to receive a pre-established radiation exposure **WITHOUT** Emergency Director (ED) approval in order to save someone's life. What is this limit?

a. 5 Rem
b. 25 Rem
c. 50 Rem
d. 75 Rem

Question B.13 [1.0 point] (13.0)
Total Effective Dose Equivalent (TEDE) is defined as the sum of the deep dose equivalent and the committed dose equivalent. The deep dose equivalent is related to the …

a. dose to organs or tissues.
b. external exposure to the skin or an extremity.
c. external exposure to the lens of the eye.
d. external whole-body exposure.

Question B.14 [1.0 point] (14.0)
Two sheets of ¼ inch thick lead reduce a radiation beam from 200 mR/hr to 100 mR/hr at one foot. Which ONE of the following will be the radiation measurement at 1 foot if you add another two (for a total of 4) ¼ inch lead sheets?

a. 71
b. 50
c. 35
d. 17

Question B.15 [1.0 point] (15.0)
Which ONE of the following conditions would require an immediate halt to any fuel handling in progress?

a. Calculations determine that the shutdown margin has decreased to twenty-five cents ($0.25) above the most reactive shim arm.
b. The reactor supervisor approves a request for 2 personnel to enter the Process Room.
c. The Control Room Operator notes a step change while reading NC-1, from 10 cps to 150 cps that steadies out at 90 cps.
d. Nuclear Instrumentation channel NC-3 fails down scale with NC-1, 2 and 4 still operable.

Question B.016 [1.0 point] (16.0)
Beam shutter keys are only issued to:

a. the Beam Coordinator.
b. the principal experimenter.
c. Reactor Operations and Health Physics.
d. authorized users of the specific beam tube or guide tube.

Question B.017 [1.0 point] (17.0)
An RWP was prepared and signed by Health Physics to perform maintenance work in a High Radiation Area. For the RWP to be valid, approval of _____ must also be obtained.

a. None, only Health Physics Approval is required.
b. The Chief, or Deputy Chief, Reactor Operations.
c. The licensed Senior Operator.
d. The duty Reactor Supervisor

Question B.018 [1.0 point] (18.0)
Which ONE of the following Reactor Run-Downs is REQUIRED by Technical Specifications?

a. High Thermal Power (BTUR)
b. High Reactor Outlet Temperature
c. Low Reactor Vessel Level.
d. Low Thermal Shield Cooling System Flow.

Question B.019 [1.0 point] (19.0)
An individual receives 100 mRem of Beta (ß), 25 mRem of gamma (γ), and 5 mRem of neutron radiation. What is his/her total dose?

a. 275 mRem
b. 205 mRem
c. 175 mRem
d. 130 mRem

Question B.020 [1.0 point] (20.0)
Per Annunciator Procedure 0.7, you must shutdown the reactor if emergency cooling H_2O pressure drops below …

a. 45 psig
b. 35 psig
c. 25 psig
d. 15 psig

Question C.001 [1.0 point] (1.0)
Identify each of the following conditions as either a **S**cram, **R**un**D**own or **N**either.

a. Period on NC-6 at 5 sec (currently <10% of full power.)
b. Thermal power at 22 MW.
c. Reactor outlet temperature at 135ºF
d. Reactor level at 142”

Question ~~C.002 [1.0 point, 0.25 each] (2.0)~~
~~Identify each of the parts of the Thermal Column from the **figure provided**. (Ignore cooling gap.)~~

~~Column A~~	~~Column B~~
~~a. A~~	~~1. Bismuth~~
~~b. B~~	~~2. Boral~~
~~c. C~~	~~3. D_2O~~
~~d. D~~	~~4. Graphite~~
	~~5. H_2O~~

Question deleted prior to start of exam as Thermal Column internals have been removed.

Question C.003 [1.0 point] (3.0)
Which ONE of the following reactor instrumentation channels ***WILL NOT*** cause a reactor rundown, prior to activating a reactor scram?

a. Nuclear Power Channels
b. Nuclear intermediate channel (Log-N)
c. Reactor Primary Outlet Flow
d. Reactor Vessel Level

Question C.004 [1.0 point, 0.25 each] (4.0)
Identify whether each of the listed signals will cause a Scram (**S**), a Major Scram (**MS**) or may cause either (**E**) type.

a. High flux level (2 of 3 or 1 of 2 logic only)
b. High activity effluent air exhaust
c. Low Reactor Vessel D_2O Level.
d. Manual Pushbuttons in the control room.

Question C.005 [1.0 point] (5.0)
Which ONE of the following is the material used as a ***NEUTRON POISON*** in the safety-shim arms?

a. Erbium
b. Cadmium
c. Aluminum
d. Boron

Question C.006 [1.0 point] (6.0)
You notice that when a shim arm is driven in, it stops at about two to three degrees, yet when you scram, the shim arm stops below one degree. Which ONE of the following is the reason for this?

a. A scram is spring assisted, pushing the shim arm lower.
b. The weak shim arm motor has too little torque to overcome the shock absorber.
c. Shim drive stop lower limit switches are designed to prevent damage due to driving the shim arm in continuously.
d. Deenergizing the scram magnet causes a change in impedance causing the readout for the shim arm to be more accurate at lower levels.

Question C.007 [1.0 point] (7.0)
During a transient, the reactor fails to scram, the operator uses moderator dump to shutdown the reactor. Which ONE of the following actions does NOT occur when the moderator dump valve is taken to the ***OPEN*** position?

a. Reactor primary coolant drains to the D_2O storage tank.
b. Main Secondary Cooling Pumps trip
c. Reactor Scram Signal is initiated
d. Main D_2O Pumps trip

Question C.008 [1.0 point] (8.0)
During a loss of ALL AC power, the battery (by design) will supply power for at least …

a. 2 hours
b. 4 hours
c. 8 hours
d. 16 hours

Question C.009 [1.0 point] (9.0)
Emergency D_2O cooling is being provided by the inner reserve and emergency tanks. All water is directed into the core through the top feed. Which ONE of the following is the approximate time coolant will be provided by both tanks?

a. ½ hour
b. 2½ hours
c. 5 hours
d. 7½ hours

Question C.010 [1.0 point] (10.0)
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

Question C.011 [1.0 point] (11.0)
The reactor has been operating at full power for a week, when all commercial power is lost. How is decay heat removed from the core?

a. Natural Circulation flow due to large ΔT across core and inlet higher than outlet.
b. Natural Circulation flow due to large ΔT across core and outlet higher than inlet.
c. DC Shutdown pumps powered from the emergency battery.
d. D_2O injection from the emergency tank.

Question C.012 [1.0 point] (12.0)
Assuming no operator action, approximately how long will the Inner Reserve Tank supply water to the top of the core?

a. 10 minutes
b. 30 minutes
c. 1 hour
d. 3 hours

Question C.013 [1.0 point] (13.0)
Which ONE of the following is the pressure at which the 100# air compressor starts?

a. 95 psi
b. 90 psi
c. 85 psi
d. 80 psi

Question C.014 [1.0 point] (14.0)
The operation mode will switch from automatic to manual if the regulating rod reaches its upper or lower limit or if the operator uses the withdraw/insert reg. rod switch or if there is a power deviation equal to or greater than …

a. 2%
b. 5%
c. 10%
d. 15%

Question C.015 [1.0 point] (15.0)
Which ONE of the following is the design feature which reduces the activation of the fuel transfer mechanisms?

a. Poisoned Hold-down Tubes
b. Experimental Thimbles
c. Top Grid Plate Insert
d. Top D_2O Reflector

Question C.016 [1.0 point] (16.0)
A ventilation Radiation Monitor located on the B1 level is supplied with air drawn by a blower from 10 points within the ventilation system. The primary purpose of this monitor is to monitor the concentration of

a. H^3
b. Ar^{41}
c. Xe^{133} & I^{135} (Fission Gases)
d. N^{16}

Question C.017 [1.0 point] (17.0)
Even though virtually no fission products are found in the helium sweep system, the fission products monitor, in the helium sweep system, usually indicates greater than 10,000 cpm at full power. This indication is mainly caused by:

a. Radiolytic gasses.
b. Nitrogen-16 formation.
c. Argon-41 formation from trapped air.
d. Tritium vapor from the primary coolant.

Question C.018 [1.0 point] (18.0)
Which of the following instruments provide the best backup for the primary outlet flow for both information and trip function?

a. Primary inlet and outlet temperature.
b. HE-1A and HE-1B primary flow.
c. Overflow.
d. Inner and outer plena flows.

Question C.019 [1.0 point] (19.0)
Subcritical and critical are indicated on the log-N and linear channels charts by.....

a. A continuous vertical line for both subcritical and critical for both channels.

b. A continuous vertical line for log-N and an exponential curve for linear for both subcritical and critical.

c. A slopping straight line in the negative for subcritical and a vertical line for critical for both channels.

d. A slopping straight line in the negative for subcritical and a slopping straight line in the positive for critical for both channels.

Question C.020 [1.0 point] (20.0)
On a loss of commercial power, the emergency diesel generators normally will **NOT** supply power to which of the following equipment?

a. Helium blowers.

b. Thermal shield cooling pumps.

c. Primary shutdown cooling pumps.

d. Primary main cooling pumps.

Answer: A.01 b.

Answer: A.02 c.

Answer: A.03 b.

Answer: A.04 b.

Answer: A.05 a.

Answer: A.06 a. = 4; b. = 2; c. = 1; d. = 3

Answer: A.07 c.

Answer: A.08 a.

Answer: A.09 c.

Answer: A.10 d.

Answer: A.11 a.

Answer: A.12 a.

Answer: A.13 a.

Answer: A.14 b.

Answer: A.15 c.

Answer: A.16 a.

Answer: A.17 a.

Answer: A.18 a.

Answer: A.19 b.

Answer: A.20 a.

Answer: B.01 c.

Answer: B.02 d.

Answer: B.03 d.

Answer: B.04 b.

Answer: B.05 c.

Answer: B.06 b.

Answer: B.07 a.

Answer: B.08 b.

Answer: B.09 a. = FP; b. = Air; c. = D_2O; d. = D_2O

Answer: B.10 a.

Answer: B.11 a. = 6; b. = 2; c. = 2; d. = 1

Answer: B.12 b.

Answer: B.13 d.

Answer: B.14 b.

Answer: B.15 c.

Answer: B.16 c.

Answer: B.17 d.

Answer: B.18 b

Answer: B.20 ~~c~~. Answer d accepted per facility comment.

Answer: C.01 a. = ~~RD~~ SC correct answer accepted from facility comment;

b. = N; c. = RD; d. = RD

~~Answer:C.02 a. = 3; b. = 1; c. = 2; d. = 4~~ Question deleted prior to start of exam.

Answer: C.03 c.

Answer: C.04 a. = S; b. = MS; c. = S; d. = E

Answer: C.05 b.

Answer: C.06 c.

Answer: C.07 b.

Answer: C.08 b.

Answer: C.09 b.

Answer: C.10 c.

Answer: C.11 c.

Answer: C.12 b.

Answer: C.13 b.

Answer: C.14 c.

Answer: C.15 a.

Answer: C.16 a.

Answer: C.17 c.

Answer: C.18 d.

Answer: C.19 a.

Answer: C.20 d.