November 9, 2016

Mr. Al Queirolo, Director of Reactor Operations
Massachusetts Institute of Technology
138 Albany Street
Cambridge, MA 02139

SUBJECT: EXAMINATION REPORT NO. 50-020/OL-17-01, MASSACHUSETTS INSTITUTE OF TECHNOLOGY

Dear Mr. Queirolo:

During the week of Otcober 17, 2016, the U.S. Nuclear Regulatory Commission (NRC) administered an operator licensing examination at your Massachusetts Institute of 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 you and 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 enclosure 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 Mrs. Paulette Torres at (301) 415-5656 or via e-mail Paulette.Torres@nrc.gov.

Sincerely,

/RA/
Anthony J. Mendiola, Chief
Research and Test Reactors Oversight Branch
Division of Policy and Rulemaking
Office of Nuclear Reactor Regulation

Docket No. 50-020
Enclosures: 1. Examination Report No. 50-020/OL-17-01
2. Facility Comments with NRC Resolution
3. Written Examination
cc: w/o enclosure: See next page

Mr. Al Queirolo, Director of Reactor Operations
Massachusetts Institute of Technology
138 Albany Street
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DISTRIBUTION w/ encl.
Public AMendiola JEads AAdams PBoyle

ADAMS Accession No. ML1613A009 **NRR-074**

OFFICE	NRR/DPR/PROB/CE	NRR/DIRS/PROB/OLA	NRR/DPR/PROB/BC
NAME	PTorres	CRevelle	AMendiola
DATE	10/25/2016	11/07/2016	11/09/2016

OFFICIAL RECORD COPY

cc:

City Manager
City Hall
Cambridge, MA 02139

Department of Environmental Protection
One Winter Street
Boston, MA 02108

Mr. Jack Priest, Director
Radiation Control Program
Department of Public Health
529 Main Street
Schrafft Center, Suite 1M2A
Charlestown, MA 02129

Mr. John Giarrusso, Chief
Planning and Preparedness Division
Massachusetts Emergency Management Agency
400 Worcester Road
Framingham, MA 01702-5399

Test, Research and Training
Reactor Newsletter
P.O. Box 118300
University of Florida
Gainesville, FL 32611-8300

Ms. Sarah M. Don (Interim) Superintendent
Massachusetts Institute of Technology
Nuclear Reactor Laboratory
Research Reactor
138 Albany Street, MS NW12-116A
Cambridge, MA 02139

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

REPORT NO.: 50-020/OL-17-01

FACILITY DOCKET NO.: 50-020

FACILITY LICENSE NO.: R-37

FACILITY: Massachusetts Institute of Technology Reactor

EXAMINATION DATE: October 18, 2016

SUBMITTED BY: **/RA/** **11/08/2016**
Paulette Torres, Chief Examiner Date

SUMMARY:

During the week of October 17, 2016 the NRC administered a licensing examination to one Reactor Operator (RO) candidate. The candidate passed all applicable portions of the examinations.

REPORT DETAILS

1. Examiner: Paulette Torres, Chief Examiner, NRC

2. Results:

	RO PASS/FAIL	SRO PASS/FAIL	TOTAL PASS/FAIL
Written	1/0	0/0	1/0
Operating Tests	1/0	0/0	1/0
Overall	1/0	0/0	1/0

3. Exit Meeting:

Paulette Torres, Chief Examiner, NRC
Frank Warmsley, Training Supervisor, MIT
Al Queirolo, Director of Reactor Operations, MIT

The facility licensee agreed to email their comments on the written examination which were incorporated into the examination report (see Enclosure 2).

FACILITY COMMENTS ON THE WRITTEN EXAM WITH NRC RESOLUTION

QUESTION A.07 [1.0 point]
As the moderator temperature increases, the resonance escape probability _____.

a. Increases, since the moderator becomes less dense.

b. Decreases, since neutrons are more likely to be absorbed by U-238 and Pu-240.

c. Remains constant, since the effect of moderator temperature change is relatively small.

d. Increases, since the moderator-to-fuel ratio increases.

Answer: c
REF: ~~Burns, Section 3.3.2, pg. 3-18~~
Per facility/NRC comment

Facility Comments &
Recommendations: We believe at our reactor with our high enrichment, that Answer C, is the appropriate answer.

NRC Resolution: The NRC agrees with the facility comment and accepts answer (c) to be correct for question A.07.

QUESTION B.04 [1.0 point]
The Containment Building will be evacuated, either completely or partially, if:

a. A fire occurs.

b. A radiation emergency is declared.

c. There is a criticality event in a fuel storage vault.

d. General area radiation levels are such that occupants could receive exposures approaching 10 CFR 20 limits.

Answer: d
REF: Emergency Plan and Procedures, Section 4.7.4.1.2, pg. 56 of 76

Facility Comments &
Recommendations: There are multiple correct answers for this question, we ask that this question be removed from this exam and reworded for future exams.

NRC Resolution: The NRC agrees with the facility comment and question B.04 will be deleted from the examination.

QUESTION C.15 [1.0 point]
Which ONE of the following alarm and interlock functions is initiated by the containment differential pressure switch XPS-2?

a. Provides a reactor building overpressure scam alarm and an automatic scram at an overpressure of 2.0 ± 0.5 inches of water.

b. Trips the ventilation fans if the differential pressure exceeds -0.38 ± 0.02 inches of water.

c. Trips the ventilation fans at an overpressure of 1.0 ± 0.2 inches of water.

d. Differential pressure switch no longer in service.

Answer: b
REF: Facility Description Manual, Section 6.7, pg. RSM 6-9

Facility Comments &
Recommendations: We believe that the knowledge of auxiliary system detectors, while important, do not need to be memorized. We ask that this question be deleted from this exam.

NRC Resolution: The NRC agrees with the facility comment and question C.15 will be deleted from the examination.

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

FACILITY: Massachusetts Institute of Technology

REACTOR TYPE: MITR II Research

DATE ADMINISTERED: 10/18/2016

CANDIDATE: _____

INSTRUCTIONS TO CANDIDATE:
Answers are to be written on the Answer sheet provided. Attach all Answer sheets to the examination. Point values are indicated in parentheses for each question. A 70% in each category is required to pass the examination. Examinations will be picked up three (3) hours after the examination starts.

CATEGORY VALUE	% OF TOTAL	CANDIDATE'S SCORE	% OF CATEGORY VALUE	CATEGORY
20.00	33.3	_____	_____	A. REACTOR THEORY, THERMODYNAMICS AND FACILITY OPERATING CHARACTERISTICS
19.00 ~~20.00~~	33.3	_____	_____	B. NORMAL AND EMERGENCY OPERATING PROCEDURES AND RADIOLOGICAL CONTROLS
19.00 ~~20.00~~	33.3	_____	_____	C. FACILITY AND RADIATION MONITORING SYSTEMS
58.00 ~~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 3

A. Reactor Theory, Thermohydraulics & Facility Operating Characteristics

A N S W E R S H E E T

Multiple Choice (Circle or X your choice)
If you change your Answer, write your selection in the blank.

A01 a b c d ___

A02 a b c d ___

A03 a b c d ___

A04 a b c d ___

A05 a b c d ___

A06 a b c d ___

A07 a b c d ___

A08 a b c d ___

A09 a b c d ___

A10 a b c d ___

A11 a b c d ___

A12 a b c d ___

A13 a b c d ___

A14 a b c d ___

A15 a b c d ___

A16 a b c d ___

A17 a b c d ___

A18 a b c d ___

A19 a b c d ___

A20 a b c d ___

(***** END OF SECTION A *****)

B. Normal/Emergency Procedures and Radiological Controls

A N S W E R S H E E T

Multiple Choice (Circle or X your choice)
If you change your Answer, write your selection in the blank.

B01 a b c d ___

B02 a b c d ___

B03 a b c d ___

~~B04 a b c d ___~~ (deleted per facility/NRC comment)

B05 a b c d ___

B06 a b c d ___

B07 a b c d ___

B08 a b c d ___

B09 a b c d ___

B10 a b c d ___

B11 a b c d ___

B12 a b c d ___

B13 a b c d ___

B14 a b c d ___

B15 a b c d ___

B16 a b c d ___

B17 a b c d ___

B18 a b c d ___

B19 a b c d ___

B20 a b c d ___

(***** END OF SECTION B *****)

C. Facility and Radiation Monitoring Systems

A N S W E R S H E E T

Multiple Choice (Circle or X your choice)
If you change your Answer, write your selection in the blank.

C01 a b c d ___

C02 a b c d ___

C03 a b c d ___

C04 a b c d ___

C05 a b c d ___

C06 a b c d ___

C07 a b c d ___

C08 a b c d ___

C09 a b c d ___

C10 a b c d ___

C11 a b c d ___

C12 a b c d ___

C13 a b c d ___

C14 a b c d ___

~~C15 a b c d ___~~(deleted per facility/NRC comment)

C16 a b c d ___

C17 a b c d ___

C18 a b c d ___

C19 a b c d ___

C20 a b c d ___

(***** END OF SECTION C *****)
(********** END OF EXAMINATION **********)

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.

Section C Facility and Radiation Monitoring Systems

EQUATION SHEET

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

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

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

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

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

$$\lambda^* = 1 \times 10^{-4} \text{ sec}$$

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

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

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

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

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

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

$$M = \frac{1 - K_{eff_1}}{1 - K_{eff\,2}}$$

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

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

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

$$T_{\frac{1}{2}} = \frac{0.693}{\lambda} \quad \Delta\rho = \frac{K_{eff_2} - K_{eff_1}}{K_{eff_1} K_{eff_2}}$$

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

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

$$DR_1 \, d_1^{\,2} = DR_2 d_2^{\,2}$$

$$DR = \frac{6 Ci \, E(n)}{R^2}$$

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

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

1 Curie = 3.7 x 10^{10} dis/sec

1 kg = 2.21 lbm

1 Horsepower = 2.54 x 10^3 BTU/hr

1 Mw = 3.41 x 10^6 BTU/hr

1 BTU = 778 ft-lbf

°F = 9/5 °C + 32

1 gal (H_2O) ≈ 8 lbm

°C = 5/9 (°F - 32)

c_P = 1.0 BTU/hr/lbm/°F

c_p = 1 cal/sec/gm/°C

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

Operator Licensing Examination

Week of October 17, 2016

QUESTION A.01 [1.0 point]
All atoms of a given element have the same _____.

a. Atomic Mass

b. Mass Number

c. Atomic Number

d. Number of Neutrons

QUESTION A.02 [1.0 point]
The use of a reflector results in _____.

a. The production of neutrons.

b. A high neutron absorption cross section.

c. A decrease in the critical mass of fissile material.

d. The decrease of the average power output for a given peak neutron flux.

QUESTION A.03 [1.0 point]
_____ is the total distance in centimeters traveled in 1 second by all the neutrons present in 1 cm^3.

a. Neutron Flux

b. Neutron Density

c. Neutron Diffusion

d. Neutron Cross Section

QUESTION A.04 [1.0 point]
The reactor is critical at 5 watts. Which ONE of the following correctly describes the reactor behavior when a reactivity worth of 0.50 % ΔK/K is IMMEDIATELY inserted to the reactor core?

a. Critical

b. Subcritical

c. Supercritical

d. Delayed critical

QUESTION A.05 [1.0 point]
Which ONE of the following is the MAJOR source of energy released during fission?

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.06 [1.0 point]
Most text books list β for a U^{235} fueled reactor as 0.0065 ΔK/K and β_{eff} as being 0.0075 ΔK/K. Why is β_{eff} larger than β?

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

b. Delayed neutrons are born at lower energies than prompt neutrons resulting in a less loss due to leakage for these neutrons.

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

d. Some U^{238} in the core becomes Pu^{239} (by neutron absorption) which has a larger for fission.

QUESTION A.07 [1.0 point]
As the moderator temperature increases, the resonance escape probability _____.

e. Increases, since the moderator becomes less dense.

f. Decreases, since neutrons are more likely to be absorbed by U-238 and Pu-240.

g. Remains constant, since the effect of moderator temperature change is relatively small.

h. Increases, since the moderator-to-fuel ratio increases.

QUESTION A.08 [1.0 point]
Two minutes following shutdown, reactor power is at 10 kW and decreases with a constant reactor period. Which ONE of the following is the correct power for three minutes later?

a. 0.5 kW

b. 1.1 kW

c. 3.3 kW

d. 6.7 kW

QUESTION A.09 [1.0 point]
The term _____ defines the condition where no delay neutrons are required.

a. Prompt Jump

b. Prompt Drop

c. Asymptotic Period

d. Prompt Critical

QUESTION A.10 [1.0 point]
Which one of the following correctly describes the relationship between differential rod worth (DRW) and integral rod worth (IRW)?

a. DRW is the slope of the IRW curve at a given location.

b. DRW is the area under the IRW curve at a given location.

c. DRW is the square root of the IRW curve at a given location.

d. There is no relationship between DRW and IRW.

QUESTION A.11 [1.0 point]
During a Subcritical Multiplication "1/M" plot, data is required to be taken. What does the 1/M represent?

a. The inverse of fuel elements presented in the core.

b. The inverse of the moderator coefficient of reactivity.

c. The inverse migration length of neutrons of varying energies.

d. The inverse multiplication of the count rate between generations.

QUESTION A.12 [1.0 point]
INELASTIC scattering is the process by which a neutron collides with a nucleus and:

a. Is absorbed, with the nucleus emitting a gamma ray.

b. Recoils with the same kinetic energy it had prior to the collision.

c. Recoils with a lower kinetic energy than it had prior to the collision, with the nucleus emitting a gamma ray.

d. Recoils with a higher kinetic energy than it had prior to the collision, with the nucleus emitting a gamma ray.

QUESTION A.13 [1.0 point]

The reaction ${}_1^3H \rightarrow {}_2^3He^+ + \_\_\_ + \overline{\upsilon_e}$ is an example of:

a. Alpha Decay

b. Beta Decay

c. Electron Capture

d. Gamma Emission

QUESTION A.14 [1.0 point]

Core Excess Reactivity changes with:

a. Fuel Element Burnup

b. Control Rod Height

c. Neutron Energy Level

d. Reactor Power Level

QUESTION A.15 [1.0 point]

A reactor is operating at 5 kW. 0.5% $\Delta K/K$ of positive reactivity is added to the reactor. What is the resulting period? β=0.007

a. 2.47 sec

b. 4.02 sec

c. 40.0 sec

d. 740 sec

QUESTION A.16 [1.0 point]
Which ONE of the following types of neutrons has a neutron generation time of ~13 seconds?

a. Fast

b. Prompt

c. Delayed

d. Thermal

QUESTION A.17 [1.0 point]
Which ONE of the following factors describes the bases for limits on rod configuration?

a. Rod Speed

b. Total Reactor Power

c. Delayed Neutron Fraction

d. Axial and Radial Flux Shaping

QUESTION A.18 [1.0 point]
Which ONE of the following parameters for a finite reactor has a value greater than one?

a. Fast Fission factor (ε)

b. Thermal Utilization Factor (f)

c. Resonance escape probability (p)

d. Thermal Non-Leakage probability (L_{Th})

QUESTION A.19 [1.0 point]
Which ONE of the following is the best approximation of the amount of energy released by the fission of one atom of U-235?

a. 5 - 10 MeV

b. 50 - 70 MeV

c. 100 - 120 MeV

d. 180 - 210 MeV

QUESTION A.20 [1.0 point]
Which ONE of the following is the time period in which the maximum amount of Xe^{135} will be present in the core?

a. 3 to 6 hours after a power increase from 50% to 100%.

b. 3 to 6 hours after a power decrease from 100% to 50%.

c. 4 to 8 hours after a startup to 100%.

d. 4 to 8 hours after a shutdown from 100%.

********** End of Section A **********

QUESTION B.01 [1.0 point]
The Emergency Plan defines "Derived Air Concentration (DAC)" as:

a. The concentration of a given radionuclide in the air which, if breathed by the reference man for a working year of 2,000 hours under conditions of light work, results in an intake of one ALI.

b. The derived limit for the amount of radioactive material taken into the body of an adult worker by inhalation or ingestion in a year.

c. The dose equivalent to organs or tissues of reference (T) that will be received from an intake of radioactive material by an individual during the 50-year period following the intake.

d. The sum of the effective dose equivalent (for external exposures) and the committed effective dose equivalent (for internal exposures).

QUESTION B.02 [1.0 point]
Proposed quantities of explosive materials greater than the equivalent of 25 milligrams of TNT require approval by the:

a. USNRC

b. Reactor Supervisor

c. Reactor Safeguards Committee

d. Licensed Senior Reactor Operator

QUESTION B.03 [1.0 point]
The Emergency Plan allows the emergency workers to incur exposures limits of _____ Rem for the safety or protection of major equipment not vital for the nuclear safety of the reactor and _____ Rem for establishing the nuclear safety of the reactor.

a. 5 and 10

b. 5 and 50

c. 10 and 25

d. 25 and 50

~~**QUESTION B.04 [1.0 point]** (deleted per facility/NRC comment)~~
~~The Containment Building will be evacuated, either completely or partially, if:~~

~~e. A fire occurs.~~

~~f. A radiation emergency is declared.~~

~~g. There is a criticality event in a fuel storage vault.~~

~~h. General area radiation levels are such that occupants could receive exposures approaching 10 CFR 20 limits.~~

QUESTION B.05 [1.0 point]
A radioactive sample which initially was reading 50 R/hr has decayed over 8 hours to 25 R/hr. What will the sample read in another 4 hours?

a. 12.5 R/hr

b. 17.7 R/hr

c. 18.8 R/hr

d. 22.9 R/hr

QUESTION B.06 [1.0 point]
The dose rate from a mixed beta-gamma point source is 100 mrem/hour at a distance of 1 foot, and is 0.1 mrem/hour at a distance of 20 feet. What percentage of the source consists of beta radiation?

a. 20%

b. 40%

c. 60%

d. 80%

QUESTION B.07 [1.0 point]
Based on 10 CFR 55, which ONE of the following is the MINIMUM requirement that must be met to retain an active Reactor Operator license? Must perform license duties:

a. A minimum of 8 hours per month.

b. At least 40 hours per calendar year.

c. A minimum of 4 hours per calendar quarter.

d. A minimum of 5 eight-hour shifts per calendar quarter.

QUESTION B.08 [1.0 point]
10 CFR 20 requires that dose equivalent to the embryo/fetus during the entire pregnancy, due to the occupational exposure of a declared pregnant woman, does not exceed _____.

a. 0.5 rem

b. 5.0 rem

c. 0.1 rem

d. 1.0 rem

QUESTION B.09 [1.0 point]
A Site Area Emergency may be initiated when events projected off-site radiological consequences exceed either all of the following EXCEPT:

a. 250 mrem for unrestricted areas when averaged over 24 hours.

b. 375 mrem whole body accumulated in 24 hours.

c. 500 mrem thyroid dose at the site boundary.

d. 100 mrem/hour for 1 hour whole body.

QUESTION B.10 [1.0 point]
Which ONE of the following monitors uses a charcoal filter as a mean to collect iodine?

a. Plenum/Stack particulate monitors

b. Plenum/Stack gas monitors

c. Core Purge Monitor

d. Stack Area Monitor

QUESTION B.11 [1.0 point]
Which ONE of following types of radiation has the HIGHEST Quality Factor specified in 10CFR20?

a. Beta

b. Gamma

c. Alpha Particles

d. Neutron of unknown energy

QUESTION B.12 [1.0 point]
Technical Specifications defines the Safety Limit Factor value as:

a. 0.86

b. 1.173

c. 2.0

d. 2.4

QUESTION B.13 [1.0 point]
Evaluation of core operating conditions to prevent incipient boiling should be performed and approved after each _____.

a. Reactor Startup

b. Reactor Shutdown

c. Refueling Operations

d. Restart Following an Unanticipated Shutdown

QUESTION B.14 [1.0 point]
Which ONE of the following terms defines “the output of an instrument used in the safety system will not be influenced by interaction with the control system”?

a. Operable

b. Separate

c. Chanel Check

d. Protective Actions

QUESTION B.15 [1.0 point]
The Primary Coolant Flow Rate channel for 1 Primary Pump is _____ gpm.

a. 50

b. 75

c. 900

d. 1800

QUESTION B.16 [1.0 point]
The _____ alarm is generated by nuclear instrument channel #8.

a. Withdraw Permit Circuit Open

b. Low Voltage Chamber Power Supply

c. Period Channel Level Signal Off-Scale

d. High Level Emergency-Power Channel

QUESTION B.17 [1.0 point]
Which ONE of the following individuals wear Blue dosimetry?

a. MITR escorted visitor

b. General Employee Radiological Training

c. Radiation Worker I

d. Radiation Worker II

QUESTION B.18 [1.0 point]
What is the minimum freezing temperature of Heavy Water (D_2O)?

a. 0 °C

b. 2 °C

c. 4 °C

d. 6 °C

QUESTION B.19 [1.0 point]
Which ONE of the followings is an immediate action of the High or Low Pressure Graphite CO_2 alarm? Check the _____ radiation monitors.

a. Area

b. Argon-41

c. Gaseous and Particulate Stack

d. Gaseous and Particulate Plenum

QUESTION B.20 [1.0 point]
A Safety Review Form is intended to expedite the review and approvals required for all of the following EXCEPT:

a. Class B plans

b. Class C plans

c. Procedures

d. Equipment Changes

********** End of Section B **********

QUESTION C.01 [1.0 point]
Which ONE of the following Technical Specifications applies to the heavy-water reflector system?

a. Coolant Temperature

b. Core Configurations

c. Back Up Shutdown Mechanism

d. Emergency Coolant Requirements

QUESTION C.02 [1.0 point]
Which ONE of the following parameters IS NOT displayed in the control room console?

a. Period

b. Neutron Flux Level

c. Shim Blade Position

d. Building ΔP

QUESTION C.03 [1.0 point]
Per Technical Specifications, which ONE of the following is required to establish containment integrity?

a. Safeguard the fuel.

b. Truck airlock inner door is closed.

c. Limit the spread of contamination.

d. Prevent an unauthorized entry point.

QUESTION C.04 [1.0 point]
Which ONE of the following analyses of the primary, D_2O, and secondary coolant for radioactivity shall be done with a DAILY frequency any day that the reactor is operating?

a. D_2O Tritium

b. Primary Gross Activity

c. Secondary Gross Activity

d. Primary Isotopic Identification

QUESTION C.05 [1.0 point]
Per Technical Specifications, a test of the charcoal filters in the pressure relief system shall be performed annually to determine their efficiency for the removal of:

a. Tritium

b. Elemental Iodine

c. Nitrogen-16

d. Fluorine-17

QUESTION C.06 [1.0 point]
Which ONE of the following radiation monitors needs to be channel tested using a source at least monthly and each time before startup?

a. Area Radiation

b. Secondary Coolant

c. Core Purge Monitor

d. Plenum Gas and Particulate

QUESTION C.07 [1.0 point]
Per Technical Specifications, which ONE of the following is the maximum single experiment worth of a non-secured experiment?

a. 0.2% ΔK/K

b. 0.5% ΔK/K

c. 1.5% ΔK/K

d. 1.8% ΔK/K

QUESTION C.08 [1.0 point]
Which ONE of the following One Inch Pneumatic Tube Systems terminates in a hot cell in the reactor basement?

a. 1PH1

b. 1PH2

c. 1PH3

d. 1PH4

QUESTION C.09 [1.0 point]
The Low Flow Transfer Pump alarm indicates low flow:

a. Through the D_2O system cleanup.

b. In the reflector system has decrease below the scram point.

c. Through the primary system cleanup loop at or below 2.0 gpm.

d. Through the medical water shutter loop is at or below 0.7 gpm.

QUESTION C.10 [1.0 point]
The B-ring is composed of a group of _____ fuel elements.

a. 3

b. 9

c. 12

d. 15

QUESTION C.11 [1.0 point]
Which ONE of the following design features provides protection against loss of water level?

a. The capacity of the De-Ionized Water Make-Up system.

b. Four natural convection valves located at the bottom of the core tank.

c. Two spray nozzles for emergency core cooling located above the core.

d. Two anti-siphon valves located in the core tank at the level of the coolant inlet pipes.

QUESTION C.12 [1.0 point]
Which ONE of the following sections that surrounds the reactor tank and radial reflector, has seven radial penetrations to accommodate the shim blade drives and the regulating rod drive?

a. Upper Shield Ring

b. Lower Annular Ring

c. Upper Annular Ring

d. Upper Shield Access Ring

QUESTION C.13 [1.0 point]
All free surfaces of the D_2O in the reflector system are blanketed with _____.

a. CO_2

b. Helium

c. Nitrogen

d. Oxygen

QUESTION C.14 [1.0 point]
To withdraw the shim blades, as long as each is still above the subcritical interlock position, the _____ pushbutton must be depressed.

a. Reactor Start

b. Automatic Control

c. Manual Control

d. All Rods In (ARI)

~~**QUESTION C.15 [1.0 point]** (deleted per facility/NRC comment)~~
~~Which ONE of the following alarm and interlock functions is initiated by the containment differential pressure switch XPS-2?~~

~~e. Provides a reactor building overpressure scam alarm and an automatic scram at an overpressure of 2.0 ± 0.5 inches of water.~~

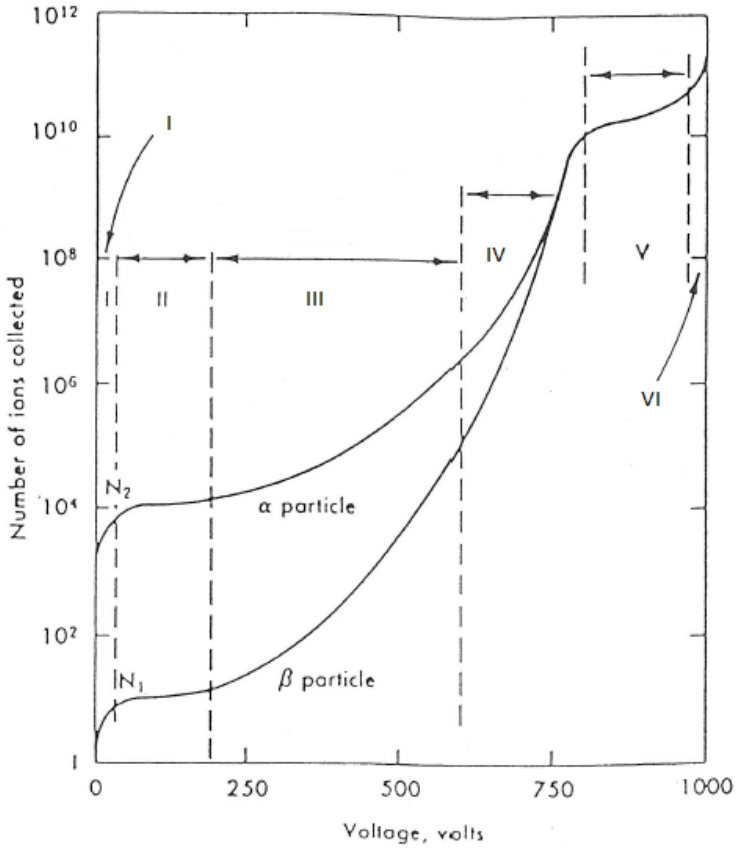
~~f. Trips the ventilation fans if the differential pressure exceeds -0.38 ± 0.02 inches of water.~~

~~g. Trips the ventilation fans at an overpressure of 1.0 ± 0.2 inches of water.~~

~~h. Differential pressure switch no longer in service.~~

QUESTION C.16 [1.0 point]

The figure below is an example of the gas ionization curve for gas-filled detectors.
Which ONE of the following Regions corresponds to the GEIGER-MUELLER Region?



a. Region II

b. Region III

c. Region IV

d. Region V

QUESTION C.17 [1.0 point]
Which ONE of the following variables monitored by the Pneumatic Instrumentation System has a remote indicator located in the control room?

a. Shield Secondary Flow

b. Reflector Secondary Flow

c. Med H_2O Shutter Tank Level

d. Med D_2O Shutter Tank Level

QUESTION C.18 [1.0 point]
Which ONE of the following area radiation monitors has a high range detector of 1.0 to 100K mR/h?

a. Reactor Top

b. Spent Fuel Pool

c. Secondary Hot Cell

d. Fission Converter Room

QUESTION C.19 [1.0 point]
Which ONE of the following effluent monitors has a gamma sensitive scintillation detector?

a. Plenum Gas

b. Stack Gas

c. Sewer Monitor

d. Core Purge Monitor

QUESTION C.20 [1.0 point]

When a condition has been corrected at the Annunciator Alarm panel, a low pitch bell sounds and the alarm plate flashes _____.

a. Slowly

b. Rapidly

c. Brightly

d. Continually

********** End of Section C **********
********** End of the Exam **********

A.01
Answer: c
REF: DOE Handbook, Volume 1, Module 1, pg. 4

A.02
Answer: c
REF: Glasstone & Sesonske, Nuclear Reactor Engineering, Section 4.46-4.48, pg. 170-171

A.03
Answer: a
REF: Glasstone & Sesonske, Nuclear Reactor Engineering, Section 2.118, pg. 72

A.04
Answer: c
REF: Burn, Section 4.2, Figure 4-1, pg. 4-2
0.5 % $\Delta K/K = 0.005$ $\Delta K/K = \rho$, $\rho > 0$
$\rho = (k_{eff} - 1) / k_{eff}$, then $k_{eff} = 1.005$
When $k > 1$, $\rho > 0$ and reactor is supercritical

A.05
Answer: a
REF: Burns, Section 3.2.1, and Table 3.2, pg. 3-4 and 3-5

A.06
Answer: b
REF: Burns, Section 3.2.4, pg. 3-12

A.07
Answer: c
REF: ~~Burns, Section 3.3.2, pg. 3-18~~
Per facility/NRC comment

A.08
Answer: b
REF: $P = P_o e^{t/\tau}$
$P = 10\ kW^* e^{180/-80}$
$P = 10\ kW * 0.105 = 1.05\ kW$

A.09
Answer: d
REF: Knief, Nuclear Engineering, 2nd ed., pg. 142

A.10
Answer: a
REF: DOE Handbook, Volume 2, Module 3, "Integral and Differential Control Rod Worth", pg. 52

A.11
Answer: d
REF: DOE Handbook, Volume 2, Module 4, "Subcritical Multiplication", pg. 1-9

A.12
Answer: c
REF: DOE Handbook, Volume1, Module 1, "Inelastic Scattering", pg. 45

A.13
Answer: b
REF: DOE Handbook, Volume 1, Module 1, pg. 24

A.14
Answer: a
REF: Harrer, Nuclear Reactor Control Engineering, pg. 398-399
Burns, Section 6.1, pg. 6-1 and Example 6.2.1(a), pg. 6-2

A.15
Answer: b
REF: $T = (\beta-p)/\lambda p$
$T = (0.007-0.005)/(0.1/sec)(0.005)$
$T = 0.002/5E^{-4}$
$T = 4$ sec

A.16
Answer: c
REF: Burns, Section 3.3.7, pg. 3-27

A.17
Answer: d
REF: Burns, Example 7.4 (b), pg. 7-11

A.18
Answer: a
REF: DOE Handbook, Volume 2, Module 3, Figure 1, pg. 11

A.19
Answer: d
REF: Lamarsh, Table 3.6, pg. 88
Foster and Wright, Basic Nuclear Engineering, 4th ed., table 4.2, pg. 76, "The energy release per fission is approximately 200 MeV."

A.20

Answer: d

REF: ~~Lamarsh 3rd ed., Figure 7.14, pg. 381~~
Xenon worth curves per MIT discussion with Frank Warmsley

B.01
Answer: a
REF: Emergency Plan and Procedures, Section 4.2.1 d), pg. 4 of 76

B.02
Answer: c
REF: TS 6.1, Specification 3. b), pg. 6-2

B.03
Answer: c
REF: Emergency Plan and Procedures, Table 4.7.5.1-1, pg. 61 of 76

~~**B.04**~~ (deleted per facility/NRC comment)
~~Answer: d~~
~~REF: Emergency Plan and Procedures, Section 4.7.4.1.2, pg. 56 of 76~~

B.05
Answer: b
REF: $A = A_0 e^{-(\lambda t)}$
$25 = 50\ e^{-(\lambda \times 8 \times 3600)}$
$\lambda = 2.4 \times 10^4$ sec
$A = 25e^{(-2.4 \times 104 \times 4 \times 3600)}$
A = 17.7 R/hr

B.06
Answer: c
REF: At 20 feet, there is no beta radiation. Gamma at 20 feet = 0.1 mrem/hour, gamma at 1 foot = 40 mrem/hour. Therefore beta at 1 foot = 60 mrem /hour = 60%.

B.07
Answer: c
REF: 10 CFR 55.53(e)

B.08
Answer: a
REF: 10 CFR 20.1208 (a)

B.09
Answer: a
REF: Emergency Plan and Procedures, Section 4.4.1.3, pg. 21 of 76

B.10
Answer: a
REF: Emergency Plan and Procedures, Table 4.7.2.1-1, pg. 41 of 76

B.11
Answer: c
REF: 10 CFR 20.1004

B.12
Answer: d
REF: TS 2.1 Basis, pg. 2-4
TS 3.1.4, Specification 4. a), pg. 3-6 and TS 3.1.4, Basis 4. a), pg. 3-8

B.13
Answer: c
REF: TS 3.1.4, 4. b), pg. 3-6

B.14
Answer: b
REF: TS 3.2.2, Definitions 2, pg. 3-16
TS 6.4, Facility Specific Definitions 2, pg. 6-10

B.15
Answer: c
REF: TS 3.2.3, Table 3.2.3-1, #10, pg. 3-19

B.16
Answer: d
REF: Abnormal Operating Procedures 5.1.1

B.17
Answer: b
REF: Administrative Procedures 1.12

B.18
Answer: c
REF: Abnormal Operating Procedures 5.4.6

B.19
Answer: b
REF: Abnormal Operating Procedures 5.5.11 Immediate Action

B.20
Answer: b
REF: Administrative Procedures 1.4.5

C.01
Answer: c
REF: TS 3.2.5 Applicability, pg. 3-24

C.02
Answer: d
REF: TS 3.2.7, Table 3.2.7-1, pg. 3-27

C.03
Answer: b
REF: TS 3.4, Specification 6 b), pg. 3-43

C.04
Answer: c
REF: TS 4.3, Specification 4, pg. 4-11

C.05
Answer: b
REF: TS 4.4, Specification 5, pg. 4-14

C.06
Answer: a
REF: TS 4.7.1, Specification 2. a), pg. 4-20

C.07
Answer: b
REF: TS 6.1, Specification 1, pg. 6-1

C.08
Answer: a
REF: Administrative Procedures 1.10.2.1

C.09
Answer: a
REF: Abnormal Operating Procedures 5.3.2

C.10
Answer: b
REF: Facility Description Manual, Section 1.1, pg. RSM 1-2, Section 1.4, pg. RSM 1-4

C.11
Answer: d
REF: SAR 6.1 b), pg. 6-2

C.12
Answer: a
REF: Facility Description Manual, Section 1.8.6, pg. RSM 1-10

C.13
Answer: b
REF: Facility Description Manual, Section 3.7.1, pg. RSM 3-18

C.14
Answer: c
REF: Facility Description Manual, Section 4.4, pg. RSM 4-5

~~**C.15**~~ (deleted per facility/NRC comment)
~~Answer: b~~
~~REF: Facility Description Manual, Section 6.7, pg. RSM 6-9~~

C.16
Answer: d
REF: Facility Description Manual, Section 5.2, pg. RSM 5-2
Facility Description Manual, Gas Detector Curve, Figure 5.9

C.17
Answer: b
REF: Facility Description Manual, Table 6.0, pg. RSM 6-11

C.18
Answer: d
REF: Facility Description Manual, Table 7.1, pg. RSM 7-5

C.19
Answer: c
REF: Facility Description Manual, Section 7.4.2, RSM 7-9
Facility Description Manual, Table 7.4, pg. RSM 7-10

C.20
Answer: a
REF: Facility Description Manual, Section 9.2, RSM 9-1