November 4, 2011

Dr. Samuel Frimpong, Chair
Mining and Nuclear Engineering
226 McNutt Hall
Missouri University of Science and Technology
Rolla, MO 65409-0450

SUBJECT: EXAMINATION REPORT NO. 50-123/OL-12-01,
MISSOURI UNIVERSITY OF SCIENCE AND TECHNOLOGY

Dear Dr. Frimpong:

During the week of October 17, 2011, the U.S. Nuclear Regulatory Commission (NRC) administered operator licensing examinations at your Missouri University of Science 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 at the conclusion of the examination with those members of your staff identified in the enclosed report.

In accordance with Title 10, Section 2.390 of the Code of Federal Regulations, 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 Public Electronic Reading Room). The NRC is forwarding the individual grades to you in a separate letter which will not be released publicly. If you have any questions concerning this examination, please contact Mr. John T. Nguyen at (301) 415-4007 or via internet e-mail John.Nguyen@nrc.gov.

Sincerely,

/RA/
Johnny H. Eads, Jr., Chief
Research and Test Reactors Oversight Branch
Division of Policy and Rulemaking
Office of Nuclear Reactor Regulation

Docket No. 50-123

Enclosures: 1. Examination Report No. 50-123/OL-12-01
2. Written examination with facility comments

cc: Bill Bonzer, Reactor Manager
cc: w/o enclosures: See next page

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DISTRIBUTION w/ encls.:
PUBLIC PROB r/f JEads Facility File CRevelle (O07-F8)
ADAMS ACCESSION #: ML113040172

OFFICE	PROB:CE		IOLB:LA		PROB:BC	
NAME	JNguyen		CRevelle		JEads	
DATE	10/31/2011		11/03/2011		11/042011	

OFFICIAL RECORD COPY

cc:

Homeland Security Coordinator
Missouri Office of Homeland Security
P.O. Box 749
Jefferson City, MO 65102

Planner, Dept of Health and Senior Services
Section for Environmental Public Health
930 Wildwood Drive, P.O. Box 570
Jefferson City, MO 65102-0570

Deputy Director for Policy
Department of Natural Resources
1101 Riverside Drive
Fourth Floor East
Jefferson City, MO 65101

A-95 Coordinator
Division of Planning
Office of Administration
P.O. Box 809
State Capitol Building
Jefferson City, MO 65101

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.: 50-123/OL-12-01

FACILITY DOCKET NO.: 50-123

FACILITY LICENSE NO.: R-79

FACILITY: Missouri University of Science and Technology

SUBMITTED BY: **/RA/** 10/31/2011
John T. Nguyen, Chief Examiner Date

SUMMARY:

During the week of October 17, 2011, the NRC administered operator licensing examinations to eight license candidates including four Reactor Operator (RO), two Senior Reactor Operator - Upgrade (SRO-U), and two Senior Reactor Operator – Instant (SRO-I) license candidates. All license candidates passed all applicable portions of their examinations.

REPORT DETAILS

1. Examiner: John T. Nguyen, Chief Examiner

2. Results:

	RO PASS/FAIL	SRO PASS/FAIL	TOTAL PASS/FAIL
Written	4/0	2/0	6/0
Operating Tests	4/0	4/0	8/0
Overall	4/0	4/0	8/0

3. Exit Meeting:

William Bonzer, MSTR, Reactor Manager
Craig Reisner, MSTR, Reactor Training Coordinator
John Nguyen, NRC, Chief Examiner
Patrick Isaac, NRC, Examiner

The NRC examiners thanked the facility for their support in the administration of the examinations. The NRC examiners noted that all the license candidates were well prepared for the examinations. The facility licensee had no comments on the written examination except the comments presented during the exit meeting, which have been incorporated into the examination included as Enclosure 2 to this report.

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

FACILITY:	Missouri University of Science and Technology (Rolla)
REACTOR TYPE:	MTR
DATE ADMINISTERED:	10/17/2011
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
16.00	33.3	_____	_____	A. REACTOR THEORY, THERMODYNAMICS AND FACILITY OPERATING CHARACTERISTICS
16.00	33.3	_____	_____	B. NORMAL AND EMERGENCY OPERATING PROCEDURES AND RADIOLOGICAL CONTROLS
16.00	33.3	_____	_____	C. FACILITY AND RADIATION MONITORING SYSTEMS
48.00		_____ FINAL GRADE	_____ %	TOTALS

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

_____
Candidate's Signature

ENCLOSURE 2

A. RX THEORY, THERMO & FAC OP CHARS

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 ___

(***** END OF CATEGORY A *****)

B. NORMAL/EMERG PROCEDURES & RAD CON

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 ___

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 ___

(***** END OF CATEGORY B *****)

C. PLANT AND RAD 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 ___

(***** END OF CATEGORY 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.

EQUATION SHEET

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

$\dot{Q} = \dot{m}\, \Delta h$

$\dot{Q} = UA\, \Delta T$

$$SUR = \frac{26.06\ (\lambda_{eff}\rho)}{(\beta - \rho)}$$

$SUR = 26.06/\tau$

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

$P = P_0\ e^{(t/\tau)}$

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

$\tau = (\ell^*/\rho) + [(\bar{\beta}-\rho)/\lambda_{eff}\rho]$

$\rho = (Keff-1)/Keff$

$\rho = \Delta Keff/Keff$

$\bar{\beta} = 0.007$

$DR_1D_1^2 = DR_2D_2^2$

$Cp\ (H20) = 0.146\ \frac{kw}{gpm \cdot {}^\circ F}$

$\lambda_{eff} = 0.1/sec$

$SCR = S/(1-Keff)$

$CR_1\ (1-Keff)_1 = CR_2\ (1-Keff)_2$

$$M = \frac{(1-Keff)_0}{(1-Keff)_1}$$

$M = 1/(1-Keff) = CR_1/CR_0$

$SDM = (1-Keff)/Keff$

$I = I_o\ e^{-ux}$

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

$\tau = \ell^*/(\rho-\bar{\beta})$

$R = 6\ C\ E\ n$

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

$DR = DR_o e^{-\lambda t}$

$P = S / (1 - Keff)$

---

1 Curie = 3.7×10^{10} dps

1 hp = 2.54×10^3 BTU/hr

1 BTU = 778 ft-lbf

931 Mev = 1 amu

1 kg = 2.21 lbm

1 Mw = 3.41×10^6 BTU/hr

$^\circ F = 9/5\,^\circ C + 32$

$^\circ C = 5/9\ (^\circ F - 32)$

QUESTION **A.01** [1.0 point]
Which ONE of the following will be the resulting stable reactor period when a 0.175 % Δk/k reactivity insertion is made into an exactly critical reactor core? Given β=0.007

a. 18 seconds

b. 30 seconds

c. 38 seconds

d. 50 seconds

QUESTION **A.02** [1.0 point]
Which ONE of the following isotopes has the highest thermal neutron cross section?

a. B-10

b. Sm-149

c. Xe-135

d. U-235

QUESTION **A.03** [1.0 point]
Which ONE of the following statements best describes on how moderator temperature affects the core operating characteristics?

a. Increase in moderator temperature will increase the neutron multiplication factor due to the resonance escape probability increase.

b. Increase in moderator temperature will increase the neutron multiplication factor due to the fast non leakage probability decrease.

c. Increase in moderator temperature will decrease the neutron multiplication factor due to the reproduction factor increase.

d. Increase in moderator temperature will decrease the neutron multiplication factor due to the resonance escape probability decrease.

Section A Rx Theory, Thermo & Fac. Operating Characteristics

QUESTION **A.04** [1.0 point]
The reactor is operating at 100 KW. The reactor operator withdraws the control rod allowing power to increase. The operator then inserts the same rod to its original position, decreasing power. In comparison to the rod withdrawal, the rod insertion will result in:

a. a slower period due to long lived delayed neutron precursors.

b. a faster period due to long lived delayed neutron precursors.

c. the same period due to equal amounts of reactivity being added.

d. the same period due to equal reactivity rates from the rod.

QUESTION **A.05** [1.0 point]
Given a source strength of 100 neutrons per second (N/sec) and a multiplication factor of 0.9, which ONE of the following is the expected stable neutron count rate?

a. 900 N/sec

b. 1000 N/sec

c. 2000 N/sec

d. 2500 N/sec

QUESTION **A.06** [1.0 point] Key answer changes from a to b. Corrected typographical error.

Given a reactor period of 32 seconds, approximately how long will it take for power to triple?

a. 22 seconds

b. 35 seconds

c. 46 seconds

d. 64 seconds

QUESTION **A.07** [1.0 point]
K_{eff} is K_{∞} times ...

a. the reproduction factor (η)

b. the resonance escape probability (p)

c. the fast fission factor (ε)

d. the total non-leakage probability ($\mathcal{L}_f \times \mathcal{L}_{th}$)

QUESTION **A.08** [1.0 point]
Xenon-135 (Xe^{135}) is produced in the reactor by two methods. One is directly from fission; the other is indirectly from the decay of :

a. Xe^{136}

b. Sm^{136}

c. Cs^{135}

d. I^{135}

QUESTION **A.09** [1.0 point]
Which one of the following is the principal source of heat in the reactor after a shutdown from extended operation at 100 KW?

a. Production of delayed neutrons

b. Subcritical reaction of photo-neutrons

c. Spontaneous fission of U^{238}

d. Decay of fission fragments

QUESTION **A.10** [1.0 point]
Which ONE of the following statements correctly describes thermal neutrons?

a. A neutron that experiences a linear decrease in energy as the temperature of the moderator increases.

b. A neutron at resonant epithermal energy levels that causes fissions to occur in U-238.

c. A neutron that experiences an increase in energy levels after collisions with larger atoms of the moderator.

d. A neutron that experiences no net change in energy after several collisions with atoms of the moderator.

QUESTION **A.11** [1.0 point]
A reactor with K_{eff} = 0.5 contributes 1000 neutrons in the first generation. Changing from the first generation to the SECOND generation, how many neutrons are there in the second generation?

a. 1250

b. 1500

c. 1750

d. 2000

QUESTION **A.12** [1.0 point]
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 core?

a. 0.054 delta-K/K

b. 0.104 delta-K/K

c. 0.125 delta-K/K

d. 0.161 delta-K/K

QUESTION **A.13** [1.0 point]
The reactor is shutdown with the count rate of 100 counts per second (cps) and K_{eff} of 0.952. The Shim rods are withdrawn until the count rate is a steady 2000 cps. What is the new value of K_{eff} ?

a. 0.952

b. 0.973

c. 0.998

d. 1.020

QUESTION **A.14** [1.0 point]
Delayed neutrons comprise approximately what percent of all neutrons produced in the reactor?

a. 0.65%

b. 1.3%

c. 6.5%

d. 20%

QUESTION **A.15** [1.0 point]
Which ONE of the following is accurate concerning control rod worth?

a. Doubling the poison content of a rod doubles its worth.

b. Rod worth increases as reactor coolant temperature decreases.

c. Rod worth increases as reactor coolant temperature increases.

d. A rod located in the edge of the core is worth more than one located near the center of the core.

QUESTION **A.16** [1.0 point]
The reactor is on a **CONSTANT** positive period. Which ONE of the following power changes will take the **longest time** to complete?

a. 5%, from 95% to 100%

b. 10%, from 80% to 90%

c. 15%, from 15% to 30%

d. 20%, from 60% to 80%

(***** END OF CATEGORY A *****)

Section B Normal/Emergency Procedures and Radiological Controls

QUESTION **B.01** [1.0 point]
Per SOP 101, the trainee may operate the reactor controls under the direct supervision of a Senior Reactor Operator when the excess reactivity is greater than _____ % Δ k/k and less than ____ % Δ k/k

a. 0.2, 0.7

b. 0.5, 0.7

c. 0.7, 1.5

d. 0.7, 2.0

QUESTION **B.02** [1.0 point]
A radiation survey of an area reveals a general radiation reading of 1 mrem/hr. However, there is a small section of pipe which reads 10 mrem/hr at one (1) meter. Assuming that the pipe is a point source, which ONE of the following defines the posting requirements for the area in accordance with 10CFR Part 20?

a. Restricted Area

b. Radiation Area

c. High Radiation Area

d. Grave Danger, Very High Radiation Area

QUESTION **B.03** [1.0 point, 0.25 each]
Common radioisotopes associated with research reactors are N^{16}, Ar^{4l}, H^3 and Na^{24}. The half-life for each is (seconds (sec), minutes (min) hours (hr) or years (yr)).

a. N^{16} is 7.0 _____.

b. Ar^{41} is 1.9 _____.

c. H^3 is 12.0 _____.

d. Na^{24} is 15.0 _____.

Section B Normal/Emergency Procedures and Radiological Controls

QUESTION **B.04** [1.0 point]
The drop-time of each of the three shim rods shall be measured:

a. monthly

b. quarterly

c. semi-annually

d. annually

QUESTION **B.05** [1.0 point]
Which ONE of the following definitions is the Total Effective Dose Equivalent (TEDE) as specified in 10 CFR Part 20?

a. The sum of thyroid dose and external dose.

b. The sum of the external deep dose and the organ dose.

c. The sum of the deep dose equivalent and the committed effective dose equivalent.

d. The dose that your whole body is received from the source, but excluded from the deep dose.

QUESTION **B.06** [1.0 point]
A small radioactive source is to be stored in the reactor building. The source is estimated to contain 4 curies and emit a 1.17 Mev gamma. Assuming no shielding was to be used, a Radiation Area barrier would have to be erected from the source at a distance of approximately:

a. 28 feet

b. 32 feet

c. 75 feet

d. 87 feet

Section C Facility and Radiation Monitoring Systems

QUESTION **B.07** [1.0 point]
What is the maximum allowable dose which the Emergency Director can authorize for a volunteer to receive to save the life of someone injured and trapped in the reactor compartment?

a. 125 Rem

b. 100 Rem

c. 75 Rem

d. 50 Rem

QUESTION **B.08** [1.0 point]
Reactor Operator works a standard forty (40) hour work week. His duties require him to work in a radiation area for (5) hours a day. The dose rate in the area is 50 mR/hour. Which ONE of the following is the MAXIMUM number of days Reactor Operator may perform his duties WITHOUT exceeding 10 CFR 20 limits?

a. 15 days

b. 20 days

c. 40 days

d. 50 days

QUESTION **B.09** [1.0 point]
Which ONE of the following materials shall NOT be irradiated at MSTR?

a. A corrosive material

b. 10 mg of explosive material

c. 0.2 %Δ k/k worth of unsecured experiment

d. Fueled experiment which would generate a power of 30 W

Section C Facility and Radiation Monitoring Systems

QUESTION **B.10** [1.0 point]
During a reactor startup, the reactor operator calculates that the maximum excess reactivity for reference core conditions is 1.6 %Δk/k. For this excess reactivity, which ONE of the following is the best action?

a. Continue to operate because the excess reactivity is within TS limit.

b. Increase power to 20 kW and verify the excess reactivity again.

c. Shutdown the reactor; immediately report the result to Reactor Manager due to excess being above TS limit.

d Continue operation, but immediately report the result to the Senior Reactor Operator since the excess reactivity is about exceeding TS limit.

QUESTION **B.11** [1.0 point]
A sheet of two-inch lead reduces the gamma exposure in a beam of radiation from 800 mR/hr to 400 mR/hr. If you add additional 2 sheets (total of six inches of lead) what will be the new radiation level? (Assume all reading is the same distance from the source.)

a. 50 mR/hr

b. 100 mR/hr

c. 175 mR/hr

d. 200 mR/hr

QUESTION **B.12** [1.0 point]
According to Technical Specification 3.3 “The minimum temperature of the reactor pool should be no less than _____ when the reactor is operated.”

a. 10.0 °C (50 °F)

b. 12.8 °C (55 °F)

c. 15.5 °C (60 °F)

d. 18.3 °C (65 °F)

Section C Facility and Radiation Monitoring Systems

QUESTION **B.13** [1.0 point]
During a normal reactor operation, a senior reactor operator (SRO) becomes ill and is taken to the hospital. Only a reactor operator (RO) and a knowledgeable student remain in the facility. Per Operation Procedure SOP101, reactor operation:

a. must be discontinued because reactor operation needs 2 licensed operators.

b. must be discontinued because reactor operation needs a licensed SRO.

c. may continue until a replacement SRO can arrive at the facility within 60 minutes.

d. may continue since the RO can monitor the console while the student can carry out prescribed written instructions.

QUESTION **B.14** [1.0 point]
Determine its **DECAY CONSTANT** (λ), when a radioactive material is **DECAYING** at a rate of 30% per hour.

a. 0.155

b. 0.236

c. 0.357

d. 1.202

QUESTION **B.15** [1.0 point]
Which ONE of the following is the large contributor to Ar-41 production?

a. Neutron interaction with the hydrogen in the reactor pool water

b. Gamma interaction with the oxygen in the reactor pool water

c. Beta interaction with the Nitrogen in the reactor pool water

d. Neutron interaction with dissolved air in the reactor pool water

Section C Facility and Radiation Monitoring Systems

QUESTION **B.16** [1.0 point]
Which ONE of the following conditions requires the reactor operator shutdown the reactor operation?

a. The inlet temperature reaches 65 °F.

b. The Safety Channel # 2 alarms due to an internal faulty relay.

c. Reactor power increases from 95% to 97% while pool is filling.

d. Reactor power decreases from 55% to 50% when a rabbit is removed.

(***** END OF CATEGORY B *****)

Section C Facility and Radiation Monitoring Systems

QUESTION **C.01** [1.0 point]
Which ONE of the following is the initial position of the SHIM rods that the reactor operator needs to withdraw during a startup to lower power?

a. 6 inches

b. 10 inches

c. 12 inches

d. 16 inches

QUESTION **C.02** [1.0 point]
To reduce radiological activity within the demineralizer tank, the reactor operator needs to:

a. encapsulate the corrosive material.

b. change the resin in the demineralizer tank by quarterly.

c. turn on the reactor pool's water pump after a high power run is performed.

d. turn off the reactor pool's water pump after a high power run is performed.

QUESTION **C.03** [1.0 point]
For a shim-safety rod, the "withdraw limit" light is ON, the "insert limit" light is OFF, and the "contact" light is ON. This means that:

a. The rod and drive are not in contact, the rod is full in and the drive is full out.

b. The rod and drive are not in contact, the rod and drive are both full in.

c. The rod and drive are in contact, the rod and drive are both full in.

d. The rod and drive are in contact, the drive and rod are full out.

Section C Facility and Radiation Monitoring Systems

QUESTION **C.04** [1.0 point]
A signal for the Period < 5 Sec Scram comes from the:

a. Startup channel

b. Log/Linear channel

c. Linear channel

d. Safety channel

QUESTION **C.05** [1.0 point]
Which ONE of the following events will cause the audio/visual (RED) alarms?

a. Log N =125 %

b. Recorder off

c. Significant Loss of coolant

d. Safety Channel # 2 = 130%

QUESTION **C.06** [1.0 point]
Which ONE of the following conditions does NOT allow the reactor operator changing the reactor operation from a steady-state mode to an AUTOMATIC mode?

a. Two of shim rods are fully up.

b. One of shim rods is fully down.

c. The regulating rod position indicates 12 inches of withdrawal.

d. The demand power sets at 150 kW, and the actual power indicates at 135 kW.

Section C Facility and Radiation Monitoring Systems

QUESTION **C.07** [1.0 point]
Which ONE of the following describes the status of reactor coolant systems when the reactor is filled with demineralized water?

a. Recirculation line valve: CLOSE. Pump discharge line valve:CLOSE. Pump suction line valve: OPEN

b. Recirculation line valve: CLOSE. Pump discharge line valve:OPEN. Pump suction line valve: CLOSE

c. Recirculation line valve: OPEN. Pump discharge line valve:CLOSE. Pump suction line valve: OPEN

d. Recirculation line valve: OPEN. Pump discharge line valve:CLOSE. Pump suction line valve: CLOSE

QUESTION **C.08** [1.0 point] Change from "Stack Particulate Monitor" to "Continuous Air Monitor (CAM)". The facility does not have the Stack Particulate Monitor

When a failure of a fuel experiment occurs, the ~~Stack Particulate Monitor~~ Continuous Air Monitor (CAM) will alarm due to the release of:

a. N-16

b. Ar-41

c. Na-24

d. Xe-135

QUESTION **C.09** [1 point] Change from "Stack Particulate Monitor" to "Continuous Air Monitor (CAM)". The facility does not have the Stack Particulate Monitor

WHICH ONE of the following is true statement regarding detector requirement to measure N^{16} release to the environment?

a. NONE, N^{16} has too short a half-life to require environmental monitoring.

b. ~~Stack Particulate Monitor~~ Continuous Air Monitor (CAM)

c. Stack Gas Monitor

d. Bridge Area Monitor

Section C Facility and Radiation Monitoring Systems

QUESTION **C.10** [1.0 point]
Which ONE of the following would indicate a clog in the demineralizer tank?

a. High radiation level at pool surface

b. High flow rate through demineralizer

c. High temperature in demineralizer

d. High pressure upstream of demineralizer

QUESTION **C.11** [1.0 point]
Which ONE of the following best describes on how the Uncompensated Ion Chamber (UIC) and Compensated Ion Chamber (CIC) operate?

a. The CIC has two chambers, both can sense gamma rays but only one is coated with boron-10 for (n,α) reaction; whereas the UIC has only one chamber coated with boron-10 for (n,α) reaction.

b. The CIC has two chambers, one is coated with U-235 for fission reaction and the other is coated with boron-10 for (n,α) reaction; whereas the UIC has only one chamber coated with U-235 for fission reaction.

c. The CIC has only one chamber coated with boron-10 for (n,α) reaction; whereas the UIC has two chambers, one is coated with U-235 for fission reaction and the other is coated with boron-10 for (n,α) reaction.

d. The CIC has only one chamber coated with U-235 for fission reaction, whereas the UIC has two chambers, both can sense gamma rays but only one is coated with boron-10 for (n,α) reaction.

QUESTION **C.12** [2.0 points, 0.5 each]
Match the input signals listed in column A with their respective responses listed in column B. (Items in column B is to be used more than once or not at all.)

	Column A		Column B
a.	Core inlet water temperature = 60 °C	1.	Alarm only
b.	Interlock by pass	2.	Alarm and rod prohibit
c.	Low CIC voltage	3.	Alarm and reactor scram
d.	Count rate= 2 cps	4.	Alarm and rod rundown

Section C Facility and Radiation Monitoring Systems

QUESTION **C.13** [1.0 point]
Which ONE of the following is the Safety Limit (LS) for the MSTR?

a. The cladding temperature must not exceed 510 °C.

b. The cladding temperature must not exceed 527 °C.

c. The thermal power shall not exceed 240 kW (120% of full power).

d. The thermal power shall not exceed 300 kW (150% of full power).

QUESTION **C.14** [1.0 point]
Which ONE of the following is the method used to get rid of radioactive liquid waste? Radioactive liquid waste is…

a. tested for 10CFR20 limits, then pumped to the storage tank.

b. put liquid waste through evaporators, collect them in solid form after passing through air filters.

c. diluted with chemical to meet 10CFR20 limits, then pumped to the sanitary sewer system.

d. held for decay of short lived isotopes then sampled for 10CFR20 limits and if satisfactory, pumped to the sanitary sewer system.

QUESTION **C.15** [1.0 point]
Which ONE of the following experimental facilities will have highest ratio between thermal neutron flux and fast neutron flux (flux in thermal/flux in fast) during full power operation?

a. Thermal Column in T mode

b. Sample Rotor Assembly

c. Core Access Element

d. Beam Tube

(***** END OF CATEGORY C *****)
(***** END OF EXAMINATION *****)

Section A Rx Theory, Thermo & Fac. Operating Characteristics

A.01
Answer: b
$T = (\beta-\rho)/\lambda\rho$ $T = (.0070 - .00175)/0.1 \times 0.00175 = 30$ seconds

A.02
Answer: c
Reference: Burn, R., *Introduction to Nuclear Reactor Operations,* © 1988, Table2.5, page 2-59.

A.03
Answer: d
Reference: Burn, R., *Introduction of Nuclear Reactor Operations*, © 1982, Sec 3.3.1

A.04
Answer: a
Reference: Burn, R., *Introduction of Nuclear Reactor Operations*, © 1982, Sec 3.2.2

A.05
Answer: b
Reference: $CR = S/(1-K) \rightarrow CR = 100/(1 - .9) = 1000$

A.06
Answer: ~~a~~ b Corrected typographical error.
Reference: $P=P_o e^{t/\tau}$ $3=1^* e^{t/32}$ $t = 32$ sec*ln(3) = 35.2 sec

A.07
Answer: d
Reference: DOE Handbook Vol 2, Rx Theory (Nuclear Parameters), E.O. 1.1 a&b, pg. 9

A.08
Answer: d
Reference: Burn, R., Introduction to Nuclear Reactor Operations, © 1988, §§ 8.1 —8.4, pp. 8-3 — 8-14.

A.09
Answer: d
Reference: DOE Fundamentals Handbook, Nuclear Physics and Reactor Theory Volume 1, Module 1, Enabling Objective 4.9, p. 61.

A.10
Answer: d
Reference: NRC Standard Question

A.11
Answer: b
Reference: Burn, R., Introduction to Nuclear Reactor Operations, © 1982, § 5.3, p. 5.6
2-nd generation=n + K*n=1000+500=1500 neutrons

A.12
Answer: b
Reference: Burn, R., *Introduction to Nuclear Reactor Operations,* © 1982, Sec 3.3.3, page 3-21.
At k=0.861; ρ = ΔKeff/Keff or ρ = Keff-1/Keff = -0.139/0.861 =-0.161. At k=0.946, ρ =-0.054/0.946 ρ = -0.0571. The difference between ρ is the answer ,i.e. -0.0571-(-0.161)=0.104

A.13
Answer: c
Reference: $Count_1*(1-K_{eff1}) = Count_{2*}(1-K_{eff2})$ $Count_1*(1-0.952) = Count_{2*}(1-K_{eff2})$
$100*(1-0.952) = 2000(1- K_{eff2})$; $K_{eff2} = 0.998$

A.14
Answer: a.
Reference: DOE Fundamentals Handbook, Nuclear Physics and Reactor Theory, Volume 2

A.15
Answer: c
Reference: Burn, R., *Introduction of Nuclear Reactor Operations*, © 1988, § 3.3.2, p. 3-18.

A.16
Answer: c
Reference: Time is related to ratio of final power to initial power. 2:1 is the largest ratio.

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Section B Normal/Emergency Procedures and Radiological Controls

B.01
Answer: c
Reference: SOP 101, Sec B.3.b.ii

B.02
Answer: c
Reference: 10 mrem/hr at 1 meter (100 cm.) = 111.1mrem/hr at 30 cm.

B.03
Answer: a. = sec, b. = hr; c. = yr; d. = hr;
Reference: NRC bank question

B.04
Answer: c
Reference: TS 4.2.1

B.05
Answer: c
Reference: 10 CFR 20.1003.

B.06
Answer: c
Reference: at 1 foot DR= 6CEN = 6*4*1.17*1, DR=28.1 Rem/hr at 1 foot.
Radiation Area barrier = 0.005 Rem/hr
Distance for a dose at 0.005 Rem/hr will be: $Dr_1D_1^2 = Dr_2D_2^2$ $28.1 = 0.005\ x^2$,
$x^2 = 5616$, $x = 74.9$ ft

B.07
Answer: c
Reference: MST Emergency Plan 7.4.6

B.08
Answer: b
Reference: 10CFR20.1201(a)(1) [5000 mr x $\frac{1\ hr}{50\ mr}$ x $\frac{day}{5\ hr}$ = 20 days

B.09
Answer: d
Reference: TS 3.7.1 & 3.7.2

B.10
Answer: c
Reference: TS 3.1

B.11
Answer: b
Reference: 2 inches equal a half-thickness. Adding 4 inches (in total of six inches) results in a total of three half-thicknesses. (800) × $(½)^3$ = 800*0.125 = 100 mR/hr

B.12
Answer: c
Reference: TS 3.3

Section B Normal/Emergency Procedures and Radiological Controls

B.13
Answer: d
Reference: SOP 101

B.14
Answer: c
Reference: $DR = DR_{\circ} * e^{-\lambda t}$
30% is decayed, so 70% is still there
$70\% = 100\% * e^{-\lambda(1hr)}$
$\ln(70/100) = -\lambda * 1 \quad \rightarrow \lambda = 0.357$

B.15
Answer: d
Reference: NRC Standard Question

B.16
Answer: b
Reference: TS 3.2.2

Section C Facility and Radiation Monitoring Systems

C.01
Answer: a
Reference: SOP 103

C.02
Answer: d
Reference: SOP 101, Sec B.5

C.03
Answer: d
Reference: SAR 7.2.2.6

C.04
Answer: b
Reference: SAR 7.2.2

C.05
Answer: c
Reference: SAR 7.2.2

C.06
Answer: d
Reference: SAR 7.2.2.6 page 7-8, the servo system interlock (>2% of set point)

C.07
Answer: a
Reference: SOP 301

C.08
Answer: d
Reference: SAR, Table 13.1

C.09
Answer: a
Reference: Standard NRC Question.

C.10
Answer: d
Reference: Standard NRC question

C.11
Answer: a
Reference: NRC Standard Question

C.12
Answer: a(2) b(1) c(4) d(2)
Reference: SAR 7.2

C.13
Answer: a
Reference: TS 2.1

Section C Facility and Radiation Monitoring Systems

C.14
Answer: d
Reference: SAR 11.1.1

C.15
Answer: a
Reference: SAR 10.2