February 23, 2107

Dr. Hyoung K. Lee, Reactor Facility Director
Missouri University of Science and
Technology Nuclear Engineering
222 Fulton Hall
Rolla, MO 65409-0170

SUBJECT: EXAMINATION REPORT NO. 50-123/OL-17-01, MISSOURI UNIVERSITY OF SCIENCE AND TECHNOLOGY

Dear Dr. Lee:

During the week of January 30, 2017, the U. S. Nuclear Regulatory Commission administered operator licensing examinations at your University Of Missouri – Columbia Reactor. The examinations were conducted according to NUREG-1478, "Operator Licensing Examiner Standards for Research and Test Reactors," Revision 2. Examination questions and preliminary findings were discussed with those members of your staff identified in the enclosed report at the conclusion of the examination.

In accordance with Title 10 of the *Code of Federal Regulations*, Section 2.390, a copy of this letter and the enclosures will be available electronically for public inspection in the NRC Public Document Room or from the Publicly Available Records (PARS) component of NRC's Agencywide Documents Access and Management System (ADAMS). ADAMS is accessible from the NRC Web site at http://www.nrc.gov/reading-rm/adams.html. The NRC is forwarding the individual grades to you in a separate letter, which will not be released publicly.

Should you have any questions concerning this examination, please contact Mr. Phillip T. Young at (301) 415-4094 or via e-mail at Phillip.Young@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. 50-123

Enclosure:
Examination Report No. 50-186/OL-17-01

cc: Bill Bonzer, Reactor Manager
Mr. Craig Reisner, Training Coordinator

cc w/o enclosures: See next page

EXAMINATION REPORT NO. 50-123/OL-17-01, MISSOURI UNIVERSITY OF SCIENCE AND TECHNOLOGY DATED February 23, 2017

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ADAMS ACCESSION #: ML17053A334 **TEMPLATE #: NRR-079**

Office	NRR/DPR/PROB:CE	NRR/DPR/PROB:OLA	NRR/DPR/PROB:BC
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Date	2/10/2017	2/22/2017	2/23/2017

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U. S. NUCLEAR REGULATORY COMMISSION

OPERATOR LICENSING INITIAL EXAMINATION REPORT

REPORT NO.: 50-186/OL-17-01

FACILITY DOCKET NO.: 50-123

FACILITY LICENSE NO.: R-79

FACILITY: MISSOURI UNIVERSITY OF SCIENCE AND TECHNOLOGY

EXAMINATION DATES: January 31 and February 1, 2017

SUBMITTED BY: /RA/ 2/10/17

Phillip T. Young, Chief Examiner Date

SUMMARY:

During the week of January 30, 2017 the NRC administered licensing examinations to three Reactor Operator (RO) applicants. The applicants passed all portions of the examination.

REPORT DETAILS

1. Examiner: Phillip T. Young, Chief Examiner, NRC

2. Results:

	RO PASS/FAIL	SRO PASS/FAIL	TOTAL PASS/FAIL
Written	3/0	0/0	3/0
Operating Tests	3/0	0/0	3/0
Overall	3/0	0/0	3/0

3. Exit Meeting:
   Phillip T. Young
   Bill Bonzer, Reactor Manager
   Mr. Craig Reisner, Training Coordinator

   The examiner thanked the facility for their assistance ensuring the exam administration went smoothly and for their feedback on the written examination.

ENCLOSURE 1

U. S. NUCLEAR REGULATORY COMMISSION

NON-POWER REACTOR INITIAL LICENSE EXAMINATION

FACILITY: Missouri University of Science and Technology Reactor

REACTOR TYPE: MTR

DATE ADMINISTERED: 1/31/2017

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 parentheses for each question. A 70% overall 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
18.00	33.3	_____	_____	A. REACTOR THEORY, THERMODYNAMICS, AND FACILITY OPERATING CHARACTISTICS
18.00	33.3	_____	_____	B. NORMAL AND EMERGENCY OPERATING PROCEDURES AND RADIOLOGICAL CONTROLS
1800	33.3	_____	_____	C. FACILITY AND RADIATION MONITORING SYSTEMS
56.00		_____ **FINAL GRADE**		TOTALS

ALL THE WORK DONE ON THIS EXAMINATION IS MY OWN. I HAVE NEITHER GIVEN NOR RECEIVED AID.

_____
CANDIDATE'S SIGNATURE

ENCLOSURE 2

NRC RULES AND GUIDELINES
FOR LICENSE EXAMINATIONS

During the administration of this examination the following rules apply:

1. Cheating on the examination means an automatic denial of your application and could result in more severe penalties.

2. After the examination has been completed, you must sign the statement on the cover sheet indicating that the work is your own and you have not received or 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.

6. Fill in the date on the cover sheet of the examination (if necessary).

7. Print your name in the upper right-hand corner of the first page of each section of your answer sheets.

8. The point value for each question is indicated in parentheses after the question.

9. Partial credit will NOT be given.

10. If the intent of a question is unclear, ask questions of the examiner only.

11. When you are done and have turned in your examination, leave the examination area as defined by the examiner.

EQUATION SHEET

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

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

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

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

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

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

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

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

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

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

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

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

$$M = \frac{1 - K_{eff_1}}{1 - K_{eff_2}}$$

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

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

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

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

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

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

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

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

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

$$I = I_{oe^{-\mu x}}$$

$$\mu_m = \frac{\mu}{\rho}$$

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

1 Curie = 3.7 x 10^{10} dis/sec
1 Horsepower = 2.54 x 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 x 10^6 BTU/hr
°F = 9/5 °C + 32
°C = 5/9 (°F - 32)
c_p = 1 cal/sec/gm/°C

Question A.01 [1.0 point] (1.0)
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.

Answer: A.01 c.
Reference: Burn, R., Introduction of Nuclear Reactor Operations, © 1988, p. 3-18.

Question A.02 [1.0 point] (2.0)
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%

Answer: A.02 c.
Reference: Time is related to ratio of final power to initial power. 2:1 is the largest ratio.

Question A.03 [1.0 point] (3.0)
After a week of full power operation, Xenon will reach its peak following a shutdown in approximately:
a. 6 hours
b. 12 hours
c. 24 hours
d. 48 hours

Answer: A.03 b.
Reference: Burn, R., Introduction to Nuclear Reactor Operations, © 1988, §

Question A.04 [1.0 point] (4.0)
A thermal neutron is a neutron which:
a. is produced as a result of thermal fission.
b. possesses thermal rather than kinetic energy.
c. has been produced several seconds after its initiating fission occurred.
d. experiences no net change in its energy after several collisions with atoms of the diffusing medium.

Answer: A.04 d.
Reference: Burn, Introduction to Nuclear Reactor Operations, Pages 2-36, 2-45.

Question A.05 [1.0 point] (5.0)

Control Rod withdrawal predominantly changes Keff by changing the …

a. fast fission factor (ε).
b. thermal utilization factor (f).
c. neutron reproduction factor (η).
d. resonance escape probability (p).

Answer: A.05 b.
Reference: Burn, R., Introduction to Nuclear Reactor Operations, © 1988, §

Question A.06 [1.0 point] (6.0)

Suppose the temperature coefficient of a core is -2.5 × 10-4 ΔK/K/C and the average control rod worth of the regulating control rod is 5.895 × 10-3 ΔK/K/inch. If the temperature INCREASES by 50C what will the automatic control command the regulating rod to do? Select the answer that is closest to the calculated value.

a. 5.6 inches in
b. 2.1 inches out
c. 0.5 inches in
d. 4.3 inches out

Answer: A.06 b.
Reference: The temperature increase will result in a change in reactivity of:
-2.5 × 10-4 ΔK/K/C × 50C = -1.25 × 10-2 ΔK/K.
Since the temperature rise results in a negative reactivity insertion, the control rod will need to drive out to add positive reactivity.
D = (1.25 × 10-2 ΔK/K) ÷ (5.895 × 10-3 ΔK/K/inch) = 2.12 inches

Question A.07 [1.0 point] (7.0)

Which one of the following describes how delayed neutrons affect control of the reactor?

a. More delayed neutrons are produced than prompt neutrons resulting in a longer time to reach a stable subcritical countrate.

b. Delayed neutrons are born at higher energies than prompt neutrons resulting in a shorter reactor period from increased leakage.

c. Delayed neutrons take longer to thermalize than prompt neutrons resulting in a longer reactor period.

d. Delayed neutrons increase the average neutron lifetime resulting in a longer reactor period.

Answer: A.07 d.
Reference: Glasstone, S. and Sesonske, A, Nuclear Reactor Engineering, Kreiger Publishing, Malabar, Florida, 1991, § 5.20, p. 236.

Question A.08 [1.0 point] (8.0)
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 subcritical.
c. The reactor is supercritical.
d. The neutron source has been removed from the core.

Answer: A.08 c.
Reference: Burn, R., Introduction of Nuclear Reactor Operations, © 1988, §

Question A.09 [1.0 point, 0.25 each] (9.0)
The reactor is operating at full power. A malfunction of equipment in the secondary cooling system causes primary temperature to increase by 10°C. Fill out the blank with **INC**REASE or **DEC**REASE due to temperature effects.
a. Slowing down length _____
b. Thermal non-leakage probability _____
c. Fast non-leakage _____
d. Shut down margin _____

Answer: A.09 a. = Increase b. = Decrease c. = Decrease d. = Increase
Reference: Burn, R., Introduction of Nuclear Reactor Operations, © 1988, Sec 3.3.2

Question A.10 [1.0 point] (10.0)
Which ONE of the following describes the difference between a moderator and a reflector?
a. A reflector will increase the fast non-leakage factor whereas a moderator increases the thermal utilization factor.

b. A reflector will increase the reproduction factor whereas a moderator increases the fast fission factor.

c. A reflector will decrease the thermal utilization factor whereas a moderator increases the fast fission factor.

d. A reflector will decrease the neutron production factor whereas a moderator decreases the fast non-leakage factor.

Answer: A.10 a.
Reference: DOE Fundamentals Handbook, Nuclear Physics and Reactor Theory, Volume 2, Module 4, Reactor Theory (Reactor Operations), pp. 25-26

Question A.11 [1.0 point] (11.0)
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

Answer: A.11 b.
Reference: P=Poet/τ x =10 kW* e180/-80 x = 10 kW *0.105 = 1.05 kW

Question A.12 [1.0 point] (12.0)
Given the following Core Reactivity Data during startup (not at MSTR):
NOTE: During the examination, the applicants were told to treat the values in column 2 as $ values instead of %Δk/k.

Control Rod	Total Rod Worth (%Δk/k)	Rod Worth removed at 5watts critical ($)	Rod excess at 5 watts critical ($)
Rod 1	1.50	1.50	0.00
Rod 2	1.80	1.50	0.30
Rod 3	2.20	2.20	1.00
Rod 4	3.50	2.50	1.50
Total Worth	9.0	7.50	1.50

Assume all rods are scrammable. The SHUTDOWN MARGIN in accordance with the definition of Technical Specifications for this core is:
a. $1.5
b. $4.0
c. $5.5
d. $6.0

Answer: A.12 b.
Reference: Tech Spec SDM = 3 rod worth removed at critical – most reactivity control rod worth= $7.5 -$3.5 = $4.0 or
Tech Spec SDM = total rod worth – (3(rod excesses) + most reactivity control rod worth) = $9.0 – ($1.5+$3.5) = $4.0

Question A.13 [1.0 point] (13.0)
Which ONE of the following will be the resulting stable reactor period when a 0.175 % $\Delta k/k$ 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

Answer: A.13 b.
Reference: $T = (\beta-\rho)/\lambda\rho$ T = (.0070 - .00175)/0.1 x 0.00175 = 30 seconds

Question A.14 [1.0 point] (14.0)
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

Answer: A.14 c.
Reference: Burn, R., Introduction to Nuclear Reactor Operations, © 1988, page 2-59.

Question A.15 [1.0 point] (15.0)
Which ONE of the following is the MOST affected factor in the six factor formula due to fuel burnup?
a. Fast fission factor.
b. Reproduction factor.
c. Thermal utilization factor.
d. Resonance escape probability.

Answer: A.15 c.
Reference: Burn, R., Introduction to Nuclear Reactor Operations, © 1982, page 3-18.

Question A.16 [1.0 point] (16.0)
The injection of a sample results in a 50 millisecond period. If the scram setpoint is 300 KILOWATTS and the scram delay time is 0.1 seconds, which ONE of the following is the peak power of the reactor at shutdown?
a. 250 kW
b. 600 kW
c. 900 kW
d. 2200 kW

Answer: A.16 d.
Reference: Burn, R., Introduction to Nuclear Reactor Operations, © 1982,
$P = P0\ et/\tau$, P = 300 kilowatts × e0.1/0.05 = 300 × e2 = 2216.7 kW

Question A.17 [1.0 point] (17.0)
Delayed neutrons comprise approximately what percent of all neutrons produced in the reactor?
a. 0.65%
b. 1.3%
c. 6.5%
d. 20%

Answer: A.17 a.
Reference: DOE Fundamentals Handbook, Nuclear Physics and Reactor Theory, Volume 2

Question A.18 [1.0 point] (18.0)
Which ONE of the following conditions describes a critical reactor?
a. Keff = 1; $\Delta k/k$ (ρ) = 1
b. Keff = 1; $\Delta k/k$ (ρ) = 0
c. Keff = 0; $\Delta k/k$ (ρ) = 1
d. Keff = 0; $\Delta k/k$ (ρ) = 0

Answer: A.18 b.
Reference: Burn, R., Introduction to Nuclear Reactor Operations, © 1988,

Question B.01 [1.0 point] (1.0)
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

Answer: B.01 d.
Reference: NRC Standard QUESTION

Question B.02 [1.0 point] (2.0)
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.

Answer: B.02 b.
Reference: TS 3.2.2

Question B.03 [1.0 point] (3.0)
MS&T reactor facility _____ requires each operator to be cognizant of all facility design, procedures and license changes.
a. Emergency Plan
b. Security Plan
c. Operator Requalification Program
d. Technical Specifications

Answer: B.03 c.
Reference: Operator Requalification Program, Section 2.0.b.(2), pg. 2

Question B.04 [1.0 point] (4.0)
The MAIN purpose to encapsulate a corrosive material irradiated in the reactor core is to prevent:
a. contamination in the pool water.
b. pressure build up in the sample holder.
c. release of corrosive gas to the reactor bay.
d. contamination to a reactor operator while handling it.

Answer: B.04 a.
Reference: Technical Specifications, Section 3.7.2 Basis 1

Question B.05 [1.0 point] (5.0)
For the purpose of a reactor startup to low power, the reactor is considered “hot” if …
a. within the past 52 hours it has been operated above 200 kW.
b. after a shutdown the Startup channel count rate is still decreasing.
c. within the past 52 hours power levels have not exceeded 20 kW-hr.
d. the reactor is not considered “clean”.

Answer: B.05 b.
Reference: SOP 103 Startup to Low Power, § B.4

Question B.06 [1.0 point] (6.0)
SOP 501 Emergency Procedures for Reactor Building Evacuation lists the actions for you (the RO) and the SRO on duty to take during this type of an emergency. The lowest level that may rescind the evacuation is …
a. Licensed Operator
b. SRO on Duty
c. Reactor Manager Reactor Director
d. Reactor Director

Answer: B.06 a
Reference: SOP 501 Emergency Procedures for Reactor Building Evacuation B.3

Question B.07 [1.0 point] (7.0)
The Safety Limit specification specifically applies to:
a. fuel element cladding temperature.
b. fuel element temperature.
c. primary coolant flow rate.
d. reactor power level.

Answer: B.07 a.
Reference: Technical Specifications, Section 2.1.

Question B.08 [1.0 point] (8.0)
A radiation survey of an area reveals a general radiation reading of 1 mrem/hr. There is, however, a small section of pipe (point source) which reads 10 mrem/hr at one (1) meter. Which ONE of the following defines the posting requirements for the area in accordance with 10CFR20?
a. "CAUTION RADIATION AREA."
b. "CAUTION RADIOACTIVE MATERIAL."
c. "CAUTION HIGH RADIATION AREA."
d. "GRAVE DANGER, VERY HIGH RADIATION AREA."

Answer: B.08 c.
Reference: 10 CFR 20.1003
DR1/D12 = DR2/D22 10 mR/hr at 1 meter = 111 mR/hr at 30 cm.

Question B.09 [1.0 point] (9.0)
_____ are considered to be appropriate to initiate protective actions for members of the general public onsite.
a. Emergency Procedures
b. Emergency Action Levels
c. Emergency Planning Zones
d. Protective Action Guides

Answer: B.09 b.
Reference: EP section 5.0, pg. 12

Question B.10 [1.0 point] (10.0)
Per Technical Specifications, what is the basis for keeping the reactor pool temperature at a minimum of 60°F or greater when the reactor is operated?
a. To avoid damaging the regenerative mixed bed of ion exchanged resin in the demineralizer.

b. To not risk reaching a fuel temperature greater than the Safety Limit.

c. To ensure that the excess reactivity will not significantly increase and that the shutdown margin will not decrease.

d. To avoid damaging the heat exchanger plates.

Answer: B.10 c.
Reference: TS 3.3 bases

Question B.11 [1.0 point] (11.0)
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

Answer: B.11 c.
Reference: SOP 101, Sec B.3.b.ii

Question B.12 [1.0 point, 0.25 each] (12.0)
Common radioisotopes associated with research reactors are N16, Ar4l, H3 and Na24. The halflife for each is (seconds (sec), minutes (min) hours (hr) or years (yr)).
a. N16 is 7.0 _____.
b. Ar41 is 1.9 _____.
c. H3 is 12.0 _____.
d. Na24 is 15.0 _____.

Answer: B.12 a. = sec; b. = hr; c. = yr; d. = hr;
Reference: NRC bank QUESTION

Question B.13 [1.0 point, 0.25 each] (13.0)
Match the Control Channel in column A with its respective rundown setpoint in column B.

Control Channel	Setpoint
a. Linear power (%)	1. 15
b. Reactor period (seconds)	2. 20
c. Low CIC voltage (%)	3. 80
d. Radiation Monitors (mR/hr)	4. 120

Answer: B.13 a = 4; b = 1; c = 3; d = 2
Reference: Technical Specification Table 3.1

Question B.14 [1.0 point] (14.0)
Which one of the following is the definition of Emergency Action Level?

a. condition that calls for immediate action, beyond the scope of normal operating procedures, to avoid an accident or to mitigate the consequences of one.

b. shall be in accordance with the values for effluent monitors or other plant parameters for which the dose rates and radiological effluent releases at the site boundary could be projected.

c. classes of accidents grouped by severity level for which predetermined emergency measures should be taken or considered.

d. a document that provides the basis for actions to cope with an emergency. It outlines the objectives to be met by the emergency procedures and defines the authority and responsibilities to achieve such objectives.

Answer: B.14 b.
Reference: Emergency Plan, 5.0 EMERGENCY ACTION LEVELS

Question B.15 [1.0 point] (15.0)
You (a licensed Reactor Operator) and a Senior Reactor Operator (SRO) are operating the reactor on the weekend. No one else is available. In order to meet Technical Specifications requirements if you are on the console the SRO must be …
a. within the Reactor Building.
b. within the reactor control room.
c. within the confines of the Campus.
d. within 15 minutes' walk of the Reactor Facility.

Answer: B.15 a.
Reference: SOP 101, General Operating Procedures, § B.2 &
TS 6.1.3, 1) b)

Question B.16 [1.0 point] (16.0)
Which, one of the following, is the definition of 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.

Answer: B.16 c.
Reference: 10 CFR 20.1003.

Question B.17 [1.0 point] (17.0)
The statement "Unless the reactor is secured, the truck door is to be closed and the ventilation intake and exhaust duct louvers operable or secured in a closed position" corresponds to Technical Specification on:
a. Reactor Control and Safety Systems
b. Confinement
c. Ventilation System
d. Experiments

Answer: B.17 b.
Reference: TS 3.4, pg. 12

Question B.18 [1.0 point] (18.0)
The dose rate 10 feet from a point gamma source is 25 mR/hr. A person working for 1.5 hours at 3 feet from the source will receive a dose of:
a. 417 mR
b. 278 mR
c. 125 mR
d. 83 mR

Answer: B.18 a.
Reference: DR1d12 = DR2d22;
DR1 = 25 mR/hr, d1 = 10 ft, d2 = 3 ft DR2 = (25)(10)2/(3)2 DR2 =
278 mR/hr x 1.5 hr = 417 mR

Question C.01 [1.0 point] (1.0)
The Ventilation system consists of three fans mounted on the Reactor Building roof. On a Building Evacuation Alarm from the Reactor Bridge Radiation Area Monitor,

a. Verify all three fans will secure automatically.
b. All three fans must be secured by the Reactor Operator.
c. The two normal exhaust fans will secure automatically, the emergency exhaust fan will start automatically.

d. The Reactor Operator must secure the two normal exhaust fans and start the emergency exhaust fan.

Answer: C.01 a.
Reference: SOP-501

Question C.02 [1.0 point] (1.0)
Which ONE of the following is the method used to minimize mechanical shock to the Shim/Safety control rods on a scram?

a. A small spring located at the bottom of the rod.
b. An electrical-mechanical brake energizes when the rod down limit switch is energized.
c. A piston (part of the connecting rod) drives air out of a dashpot as the rod nears the bottom of travel.

d. A piston attached to the upper end of the rod enters a special damping cylinder as the rod approaches the full insert position.

Answer: C.02 d.
Reference: SAR § 4.2.2

Question C.03 [1.0 point] (3.0)
Which ONE of the following correctly describes how indicated power will compare to actual power for a loss of compensating voltage to the Linear Channel detector? Power level is at 150 watts, when the compensating voltage is lost.

a. Indicated power will peg high.
b. Indicated power is slightly higher than actual power.
c. Indicated power is slightly lower than actual power.
d. Indication will read zero.

Answer: C.03 b.
Reference: Standard NRC Question

Question C.04 [1.0 point] (4.0)
Input to the servo system is provided by the:
a. Log and Linear Power Channel.
b. Linear Power Channel.
c. Safety Channel #1.
d. Safety Channel #2.

Answer: C.04 b.
Reference: SAR § 3.5.2 and 7.2.2.2

Question C.05 [1.0 point] (5.0)
The MAIN reason to have a hole in the top tube end plug of the regulating rod is to:
a. reduce the amount of Ar-41 release
b. minimize trapping air in the regulating rod
c. bolt the regulating rod to the drive mechanism
d. allow water to flow through in order to cool the regulating rod

Answer: C.05 b.
Reference: SAR 4.2.2

Question C.06 [1.0 point] (6.0)
Which ONE of the following equipment can initiate a rod withdraw prohibit, a rundown, and a reactor scram?
a. CAM
b. RAM
c. Linear Recorder
d. Log & Linear Drawer

Answer: C.06 d.
Reference: SAR Table 7.2. (Due to reactor period of Log & Linear Channel)

Question C.07 [1.0 point] (7.0)
During a full power, which ONE of the following is the correct method that helps to mitigate the buildup of Ar41 in the reactor bay?
a. Turn Purification system ON to absorb more Ar41 from the pool
b. Turn Diffuser pumps ON to reduce the release of Ar41 from the pool
c. Operation of the ventilation system, which releases the Ar41 through the stack
d. None required due to the relatively short half-life of Ar41 (seven seconds)

Answer: C.07 c.
Reference: Information during site visit

Question C.08 [1.0 point] (8.0)
For a shim-safety rod, the "withdraw limit" light is OFF, the "insert limit" light is ON, and the "contact" light is OFF. Assume that no light bulb failure. This means that:
a. Normal condition, rod insertion permissible
b. Normal condition, rod withdrawal permissible
c. Abnormal condition, misadjusted rod down limit switch
d. Abnormal condition, rod has stuck above lower limit

Answer: C.08 c.
Reference: SAR 7.2.2.6

Question C.09 [1.0 point] (9.0)
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

Answer: C.09 a.
Reference: SOP 103 - REACTOR STARTUP TO LOW POWER, C.1

Question C.10 [1.0 point] (10.0)
A signal for the Period < 5 Sec Scram comes from the:
a. Startup channel
b. Log/Linear channel
c. Linear channel
d. Safety channel

Answer: C.10 b.
Reference: SAR 7.2.2 Table 7.1

Question C.11 [1.0 point] (11.0)
Per MSTR Technical Specifications, the minimum resistivity of the MSTR pool water shall be greater than _____ megohm-cm when the fuel elements are in the reactor pool.
a. 0.2
b. 0.5
c. 2.0
d. 5.0

Answer: C.11 a.
Reference: TS 3.3

Question C.12 [1.0 point] (12.0)
Exposing a check source to the particulate detector to verify whether it is operable is considered to be:
a. a channel test.
b. a channel check.
c. a channel calibration.
d. a channel verification.

Answer: C.12 b.
Reference: TS, Definition

Question C.13 [1.0 point] (13.0)
Each shim/safety rods consists of a grooved,
a. hafnium rod.
b. boron-carbide rod.
c. boral (boron and aluminum alloy) rod.
d. boron stainless steel rod.

Answer: C.13 d.
Reference: SAR § 4.2.2

Question C.14 [1.0 point] (14.0)
Which one of the following conditions would activate an interlock preventing Shim-Safety Rod withdrawal?
a. Radiation Area Monitor = 25 mr/hour.
b. Reactor period = 15 seconds.
c. Log and Linear power recorder is not turned on.
d. Period amplifier not operable.

Answer: C.14 c.
Reference: SAR, § 7.2.2.3

Question C.15 [1.0 point] (15.0)
Reactor is in Automatic Mode at 100 kW. You insert an experiment causing the reactor power to increase to 105 kW. Which ONE of the following correctly describes the reactor conditions due to this insertion?
a. Normal operation, reactor is still in Automatic Mode.
b. Rod Run Down, Visual and Audible alarms.
c. Revert to Manual; Visual and Audible alarms.
d. Reactor scram; Visual and Audible alarms.

Answer: C.15 c.
Reference: SAR 7.2.2.6 (revert to manual because power level deviates outside of the ± 2 % limit in the Automatic Mode)

Question C.16 [1.0 point] (16.0)
Which ONE of the following experimental facilities will provide the high thermal neutron flux with low gamma flux during full power operation?
a. Pneumatic Sample Transfer System
b. Thermal Column in T mode
c. Sample Rotor Assembly
d. Beam Tube

Answer: C.16 b.
Reference: SAR 4.2.3 and10.2.1

Question C.17 [1.0 point] (17.0)
Normal evaporation of the MSTR pool is approximately between:
a. 0.09 – 0.11 inch per day
b. 0.30 – 0.50 inch per day
c. 0.60 – 0.80 inch per day
d. 0.90 – 1.10 inch per day

Answer: C.17 a.
Reference: SOP 309, Sec B

Question C.18 [1.0 point] (18.0)
This question is deleted from the examination. The CAM is set up to detect particulate isotopes, therefore there is not a plausible answer to the question.
~~When a failure of a fuel experiment occurs, the Continuous Air Monitor (CAM) will alarm due to the release of:~~
~~a. N-16~~
~~b. Ar-41~~
~~c. Na-24~~
~~d. Xe-135~~
~~Answer: C.18 d.~~
~~Reference: SAR, Table 13.1~~