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

REPORT NO.: 50-186/OL-95-01

FACILITY DOCKET NO.: 50-186

FACILITY LICENSE NO.: R-103

FACILITY: University of Missouri — Columbia

EXAMINATION DATES: September 25 — 26, 1995

EXAMINER: Paul Doyle, Chief Examiner

SUBMITTED BY: Paul Doyle, Chief Examiner — 10/10/95 Date

APPROVED BY: Anthony J. Mendiola, Deputy Chief — 10/11/95 Date
Operator Licensing Branch
Division of Reactor Controls
and Human Factors
Office of Nuclear Reactor Regulation

SUMMARY:

The NRC administered an operator licensing examination to one Reactor Operator candidate. The candidate passed both the written and operating test portions of the examination.

ENCLOSURE 1

REPORT DETAILS

1. Examiners:

Paul Doyle, Chief Examiner

2. Results:

	RO (Pass/Fail)	SRO (Pass/Fail)	Total (Pass/Fail)
NRC Grading:	1/0	0/0	1/0

3. Exit Meeting:

Paul Doyle, NRC
Tony Schoone, Univ. of Missouri — Columbia

During the exit meeting, Mr. Doyle thanked Mr. Schoone for the facility's help in arranging support for the examination, and discussed corrections made during administration of the written examination. The examiner uncovered no concerns as a result of the administration of the examination.

Per telephone conversation with Walter Meyer, on October 4, 1995, the facility has no comments on the written beyond those made during examination administration, which have been incorporated into the examination attached as enclosure 2 to this report.

Operator Licensing Examination

Enclosure 2

NRC RULES AND GUIDELINES FOR LICENSE EXAMINATIONS

During the administration of this examination the following rules apply:

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

2. After the examination has been completed, you must sign the statement on the cover sheet indicating that the work is your own and you have neither received nor given assistance in completing the examination. This must be done after you complete the examination.

3. Restroom trips are to be limited and only one candidate at a time may leave. You must avoid all contacts with anyone outside the examination room to avoid even the appearance or possibility of cheating.

4. Use black ink or dark pencil only to facilitate legible reproductions.

5. Print your name in the blank provided in the upper right-hand corner of the examination cover sheet and each answer sheet.

6. Mark your answers on the answer sheet provided. USE ONLY THE PAPER PROVIDED AND DO NOT WRITE ON THE BACK SIDE OF THE PAGE.

7. The point value for each question is indicated in [brckets] after the question.

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

9. When turning in your examination, assemble the completed examination with examination questions, examination aids and answer sheets. In addition turn in all scrap paper.

10. Ensure all information you wish to have evaluated as part of your answer is on your answer sheet. Scrap paper will be disposed of immediately following the examination.

11. To pass the examination you must achieve a grade of 70 percent or greater in each category.

12. There is a time limit of three (3) hours for completion of the examination.

13. When you have completed and turned in you examination, leave the examination area. If you are observed in this area while the examination is still in progress, your license may be denied or revoked.

EQUATION SHEET

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

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

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

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

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

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

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

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

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

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

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

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

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

$$CR_1(1-K_{eff_1}) = CR_2(1-K_{eff_2})$$
$$CR_1(-\rho_1) = CR_2(-\rho_2)$$

$$M = \frac{1-K_{eff_0}}{1-K_{eff_1}}$$

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

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

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

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

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

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

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

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

1 Curie = 3.7×10^{10} dis/sec

1 Horsepower = 2.54×10^3 BTU/hr

1 BTU = 778 ft-lbf

1 gal (H_2O) ≈ 8 lbm

c_p = 1.0 BTU/hr/lbm/°F

1 kg = 2.21 lbm

1 Mw = 3.41×10^6 BTU/hr

°F = 9/5 °C + 32

°C = 5/9 (°F - 32)

c_p = 1 cal/sec/gm/°C

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

FACILITY: Univ. of Missouri-Columbia

REACTOR TYPE: MURR

DATE ADMINISTERED: 1995/09/26

REGION: 3

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
20.00	33.3	_____	_____	A.	REACTOR THEORY, THERMODYNAMICS AND FACILITY OPERATING CHARACTERISTICS
20.00	33.3	_____	_____	B.	NORMAL AND EMERGENCY OPERATING PROCEDURES AND RADIOLOGICAL CONTROLS
20.00	33.3	_____	_____	C.	PLANT AND RADIATION MONITORING SYSTEMS
60.00		_____ FINAL GRADE	_____%		TOTALS

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

_____
Candidate's Signature

QUESTION (A.1) [1.0]
During startup, the count rate is 40 cps and K_{eff} = 0.95, what will the count rate be when K_{eff} = 0.98?

a. 41

b. 50

c. 100

d. 120

QUESTION (A.2) [2.0, 0.4 each]
Matching - Indicate for each item in Column A the item in Column B that is associated with it.

	Column A		Column B
a.	Highest σ_f for fast neutrons	1.	U^{236}
b.	Highest σ_f for thermal neutrons	2.	U^{238}
c.	Highest σ_a for thermal neutrons	3.	B^{10}
d.	Lowest σ_a for thermal neutrons	4.	Water
e.	Highest σ_c for all neutrons	5.	Graphite

QUESTION (A.3) [1.0]
Following a scram, you noted that within one minute reactor power decreased to 10^{-5} amps on the intermediate range. Over the next three minutes reactor power decreased to 10^{-6} amps, and then over the next 3 minutes, 10^{-7} amps. What is the reason for this constant decrease?

a. mean average decay rate of ALL neutron sources.

b. decay rate of the SHORTEST-lived delayed neutron precursor.

c. decay rate of the LONGEST-lived delayed neutron precursor.

d. decay rate of the MOST PROBABLE delayed neutron precursor.

QUESTION (A.4) [1.0]
Which ONE of the following describes "CORE EXCESS"?

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

b. A measure of the resultant reactivity if all of the control rods and other poisons were removed.

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

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

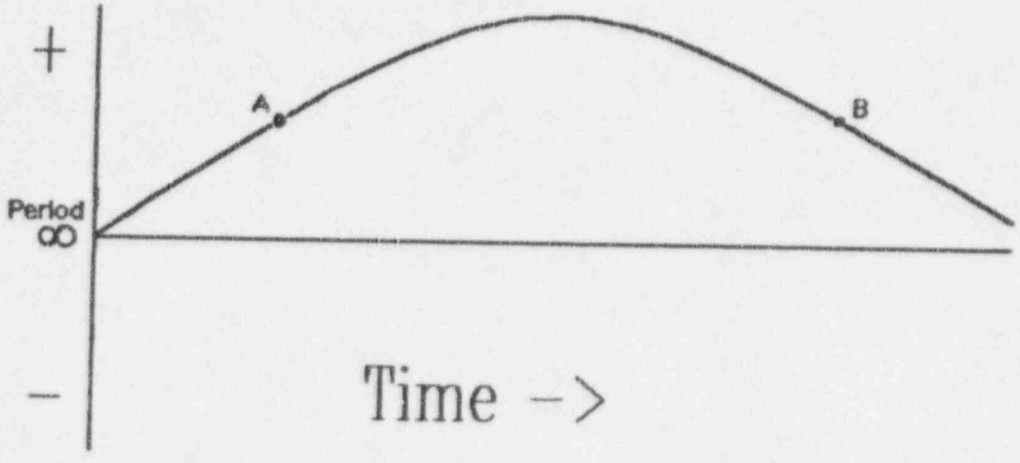
QUESTION (A.5) [1.0]
Shown below is a trace of reactor period as a function of time. Between points A and B reactor power is:

a. continually increasing.

b. continually decreasing.

c. increasing, then decreasing.

d. constant.



QUESTION (A.6) [1.0]
Which ONE of the following describes the time period in which the maximum amount of Xe^{135} will be present in the core?

a. 4 to 6 hours after a power decrease from 100% to 50%.

b. 4 to 6 hours after a power increase from 50% to 100%.

c. 6 to 11 hours after a startup to 100% power.

d. 6 to 11 hours after shutdown from 8 hours of 100% power operation.

QUESTION (A.7) [1.0]
In a subcritical reactor, K_{eff} is increased from 0.861 to 0.946. Which ONE of the following is the amount of reactivity that was added to the reactor core?

a. 0.085 Δk/k

b. 0.104 Δk/k

c. 0.161 Δk/k

d. 0.218 Δk/k

QUESTION (A.8) [1.0]
During a reactor startup, criticality occurred before the value calculated. Which ONE of the following reasons could be the cause?

a. Experiment adding positive reactivity.

b. Xe^{135} peaked.

c. Moderator temperature increased.

d. Power defect (Reactor power increasing).

QUESTION (A.9) [1.0]
Which ONE of the following describe the difference between a moderator and reflector?

a. A reflector increases the fast non-leakage factor and a moderator increases the thermal utilization factor.

b. A reflector increases the neutron production factor and a moderator increases the fast fission factor.

c. A reflector decreases the thermal utilization factor and a moderator increases the fast fission factor.

d. A reflector decreases the neutron production factor and a moderator decreases the fast non-leakage factor.

QUESTION (A.10) [1.0]
When a reactor is critical on prompt neutrons alone, it is said to be prompt critical. If K_{eff} equals 1.0, how much reactivity must be added to make the reactor prompt critical? The amount of reactivity added equals:

a. the β_{eff} fraction.

b. the amount to make K_{eff} equal to 1.1.

c. the amount to make the reactor period infinite.

d. the amount needed to increase the mean neutron lifetime to 0.080 seconds.

QUESTION (A.11) [1.0]
The following facility parameters are given:

- Primary coolant flow rate 1000 GPM
- Secondary system flow rate 1400 GPM
- ΔT across the primary side of the heat exchanger 13°F
- inlet temperature on the secondary side heat exchanger 73°F

Which one of the following is approximate secondary side heat exchanger outlet temperature.

a. 82°F

b. 85°F

c. 89°F

d. 92°F

QUESTION (A.12) [1.0]
With the reactor on a constant period, which transient requires the LONGEST time to occur? A reactor power change of:

a. 5% of rated power - going from 1% to 6% of rated power

b. 10% of rated power - going from 10% to 20% of rated power

c. 15% of rated power - going from 20% to 35% of rated power

d. 20% of rated power - going from 40% to 60% of rated power

QUESTION (A.13) [1.0]
Which one of the following is the description of a thermal neutron?

a. A neutron possessing thermal rather than kinetic energy.

b. The primary source of thermal energy increase in the reactor coolant during reactor operation.

c. A neutron that has been produced in a significant time (on the order of seconds) after its initiating fission took place.

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

QUESTION (A.14) [1.0]
Which ONE of the following conditions would cause the regulating rod to insert into the core to maintain power?

a. Formation of N^{16} in the coolant.

b. Removal of an experiment with negative reactivity from the reactor.

c. Buildup of Xe^{135}.

d. A fault in the automatic system causes S-1 to go more open.

QUESTION (A.15) [1.0]
Given the following:
- Moderator temperature coefficient: -1.0×10^{-4} $\Delta K/K/°F$
- Control rod worth: 0.003 $\Delta K/K/inch$

A reactor is operating in automatic at 5 MW. The moderator temperature decreases slowly by 18°F. Which one of the following is the direction and distance that the control rod will move to compensate for the change in temperature?

a. The control rod moves in 0.3 inches.

b. The control rod moves out 0.3 inches.

c. The control rod moves in 0.6 inches.

d. The control rod moves out 0.6 inches.

QUESTION (A.16) [1.0]
Which ONE of the following factors is the most significant in determining the differential worth of a control rod?

a. The rod speed.

b. Reactor power.

c. The flux shape.

d. The amount of fuel in the core.

QUESTION (A.17) [1.0]
The term "prompt jump" refers to:

a. the instantaneous change in power due to raising a control rod.

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

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

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

QUESTION (A.18) [1.0]
Which ONE of the following statements correctly describes the influence of delayed neutrons on the neutron life cycle?

a. Delayed neutrons decrease the average period of a reactivity addition because they thermalize more quickly than prompt neutrons.

b. Delayed neutrons take longer to thermalize because they are born at higher energies than prompt neutrons.

c. Delayed neutrons cause the length of the average neutron generation time to increase.

d. Delayed neutrons are born later than prompt neutrons and make up a larger fraction of the fission neutrons.

QUESTION (A.19) [1.0]
A small, self-contained neutron source has been made using an alpha producing isotope and a suitable target material. The equation for this interaction is:

$$_{Z}\alpha^{4} + (X) = C + {}_{0}n^{1} + (\text{energy})$$

Which of the following is the most common and efficient target material, (X) in the above equation, for this source?

a. Plutonium

b. Americium

c. Radium

d. Beryllium

(*** End of Section A ***)

QUESTION (B.1) [1.0]
Which ONE of the following is the rod position at which you must stop pulling the shim-safety blades in gang during a normal reactor startup? When rods are within...

a. 5 inches of ECP position.

b. 2 inches of ECP position.

c. 1½ inches of ECP position, if ECP is 12 inches.

d. 1½ inches of ECP position, if ECP is 18 inches.

QUESTION (B.2) [1.0]
Who must authorize resumption of reactor operations after exceeding a safety limit, as defined by Technical Specifications?

a. Reactor Safety Subcommittee

b. Reactor Advisory Committee

c. Reactor Manager

d. Nuclear Regulatory Commission

QUESTION (B.3) [1.0]
Which ONE of the following is NOT the responsibility of the Duty Operator following a reactor isolation?

a. Verify that the containment building has sealed by the ventilation door and exhaust valve indication lights.

b. Ensure all personnel have evacuated all levels of the containment building.

c. Position himself at the outer airlock allowing only authorized personnel entry.

d. Investigate the cause of the alarm and magnitude of the incident.

QUESTION (B.4) [1.0]
You are required to perform work a foot from a component which reads 1 rem/hr at 1 foot. Installing a 2 inch thick lead sheet reduces the radiation level to 100 mrem/hr. How many MORE 2 inch lead sheets are required to reduce the radiation level to 10 mrem/hr at 1 foot?

a. 1

b. 2

c. 3

d. 4

QUESTION (B.5) [1.0]
A survey instrument with a window probe was used to measure an irradiated experiment. The results were 100 mrem/hr window open and 40 mrem/hr window closed. What was the gamma dose?

a. 140 mrem/hr

b. 100 mrem/hr

c. 60 mrem/hr

d. 40 mrem/hr

QUESTION (B.6) [1.0]
A room contains a source which, when exposed, results in a general area dose rate of 175 millirem per hour. This source is scheduled to be exposed continuously for 35 days. Select an acceptable method for controlling radiation exposure from the source within this room.

a. Post the area with the words "Danger-Radiation Area".

b. Equip the room with a device to visually display the current dose rate within the room.

c. Equip the room with a local visual alarm that will inform the individual that he/she is entering a high dose field.

d. Lock the room to prevent inadvertent entry into the room.

QUESTION (B.7) [1.0]
The emergency plan gives the Emergency Director the authority to ask for volunteers to receive emergency radiation doses. What is the limit allowed for preventing exposures to the general public in excess of the Protective Action Guides (PAGs)?

a. 5 R per incident. Not to exceed 25 R lifetime.

b. 25 R.

c. 50 R.

d. 75 R.

QUESTION (B.8) [1.0]
Which ONE of the following Reactor Emergencies would require you to insert a manual rod run-in as an immediate action?

a. Failure of experimental apparatus

b. High radiation levels

c. Nuclear instrumentation failure

d. Control rod drive failure/stuck rod

QUESTION (B.9) [1.0]
Which ONE of the following isotopes is primarily generated by neutron interaction with air?

a. N^{16}

b. Ar^{41}

c. H^{3}

d. Na^{24}

QUESTION (B.10) [1.0]
Which ONE of the following control rod manipulations is NOT allowed.

a. Gang operation of the control rods after criticality to reduce power.

b. Gang operation of the control rods as part of automatic shimming.

c. Simultaneous withdrawal of one control blade and the regulating blade.

d. Gang operation of the controls rods during hot startup.

QUESTION (B.11) [1.0]
The reactor had been operating for 5 days, when it was shutdown 2 hours ago. Which ONE of the following conditions would require a Full Power Startup checksheet to be performed?

a. The Intermediate Range Monitoring system was deenergized.

b. An experiment in the reflector was replaced with a new experiment.

c. Work was performed on the Wide Range Monitoring System.

d. During a routine reactor patrol, the operator notes North Isolation Door Seal pressure at 15 psig.

QUESTION (B.12) [1.0]
The drop time for the four shim blades was last performed October 31, 1995. Which ONE of the following is the last date, by technical specifications, to perform this surveillance again?

a. November 10, 1995.

b. December 12, 1995.

c. February 28, 1996.

d. June 30, 1996

QUESTION (B.13) [1.0]
The sample taken of one of the liquid waste tanks exceeds the limits of 10 CFR 20. Which ONE of the following methods is the PREFERRED method of reducing activity prior to disposal of the liquid waste?

a. Transfer the water to a distillation unit for evaporation of the liquid. The solid distillate is to be disposed of as solid waste.

b. Chemically treat the waste so that the radionuclides will form a precipitate. Then pump the water through filters to lower the activity.

c. Maintain the liquid in the tank(s) until the radioactivity has decayed low enough to allow normal pumping.

d. Add domestic cold water (DCW) to the tank to reduce the concentration low enough to allow pumping.

QUESTION (B.14) [1.0]
Which ONE of the following persons (by job title) may authorize temporary removal of a tag? (To allow for testing of component.)

a. Reactor Manager

b. Shift Supervisor

c. Senior Reactor Operator

d. No one. (Not allowed per MURR procedures.)

QUESTION (B.15) [1.0]
Which ONE of the following statements correctly describes the relationship between a Safety Limit (SL) and a Limiting Safety System Setting (LSSS)?

a. The SL is a maximum operationally limiting value that prevents exceeding the LSSS during normal operations.

b. The SL is a parameter that assures the integrity of the fuel cladding. The LSSS initiates protective action to preclude reaching the SL.

c. The LSSS is a parameter that assures the integrity of the fuel cladding. The SL initiates protective action to preclude reaching the LSSS.

d. The SL is a maximum setpoint for instrumentation response. The LSSS is the minimum number of channels required to operate in various modes.

QUESTION (B.16) [1.0]
Which ONE of the following statements correctly defines the term "Instrument Channel Test?"

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

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

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

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

QUESTION (B.17) [1.0]
How long before a Radiation Work Permit expires (no extension)?

a. 8 hours

b. 24 hours

c. 48 hours

d. one week

QUESTION (B.18) [1.0]
If the reactor is not critical when the upper ECP limit is reached, you must:

a. stop and recalculate the ECP prior to further rod withdrawal.

b. shut down the reactor.

c. verify the ECP with a 1/M plot.

d. check the control rod position transmitters.

QUESTION (B.19) [1.0]
A pneumatic tube sample is stuck somewhere. What is(are) your (Reactor Operator) immediate action(s)?

a. Scram the reactor

b. Reduce power by manual Rod Run-in

c. Notify the Reactor Manager

d. Notify the Shift Supervisor or Manager of Health Physics.

QUESTION (B.20) [1.0]
Which ONE of the following corresponds to the maximum allowable reactivity worth of a single secured removable experiment?

a. 0.1% $\Delta K/K$

b. 0.25% $\Delta K/K$

c. 0.6% $\Delta K/K$

d. 2.0% $\Delta K/K$

(*** End of Section B ***)

QUESTION (C.1) [1.0]
Which ONE of the following alarms on the control panel is NOT associated with the startup interlock?

a. Channel 1 Low Count rate

b. Nuclear Instrument Anomaly

c. Thermal Column Door Open

d. Jumper Board in Use

QUESTION (C.2) [1.0]
Which ONE of the following conditions will result in a reactor scram while operating in MODE III?

a. Reactor period — 11 seconds

b. Reactor power — 115%

c. Reactor Outlet temperature — 180°F

d. Primary Coolant loop flow — 1800 gpm

QUESTION (C.3) [1.0]
Which ONE of the following is the reason that the pool DI system water returns to the pool about 2 feet below the pool surface? In order to...

a. aid in the mixing of the water, which results in a more even temperature distribution.

b. create a blanket of warmer water at the top of the pool to reduce mixing, and therefore reduce the dose rate at the surface of the pool.

c. reduce pool surface temperature, since DI water is cooler than pool water.

d. reduce interference between the pool cooling system and the pool skimmer, which takes its suction at the pool surface.

QUESTION (C.4) [1.0]
A facility evacuation may be initiated from...

a. the control room and the front lobby.

b. the control room and the electronics shop.

c. the reactor bridge and the front lobby.

d. the reactor bridge and the electronics shop.

QUESTION (C.5) [1.0]
Which ONE of the following correctly lists the "Tangential" beam ports?

a. C & D

b. B & E

c. A, B, E & F

d. A, C, D & F

QUESTION (C.6) [2.0, 0.5 each]
Match the channel in column A with the correct detector in column B.

	Column A		Column B
a.	Fission Product Monitor	1.	Geiger Müeller
b.	Secondary Coolant Monitor	2.	Scintillation Detector
c.	Stack Gas Monitor	3.	GeLi Detector
d.	Stack Particulate Monitor	4.	BF_3 Ion Chamber Detector
e.	Stack Iodine Monitor		
f.	Bridge ARMS		
g.	Exhaust Plenum 1		
h.	Room 114 ARMS		

QUESTION (C.7) [1.0]
Just prior to withrdrawing control rods with all process control systems on line, the Master Control Switch (1S1) is taken from the ON position to the OFF position. Which ONE of the following conditions will result?

a. All systems will shut down.

b. All systems will remain running, but without automatic operation.

c. The system is mechanically interlocked and you cannot move 1S1 to the off position with all systems running.

d. All systems will remain running with all automatic functions operable.

QUESTION (C.8) [1.0]
At what values of regulating rod height is the "Auto Shim Circuit" engaged and disengaged?

	Engaged	Disengaged
a.	60%	10%
b.	20%	60%
c.	10%	60%
d.	5%	15%

QUESTION (C.9) [1.0]
Energizing a three way solenoid valve in the valve operating system causes the ...

a. control valve operator to remain in its present condition.

b. solenoid to position to its "vent" position closing off the vent port and providing a direct path for valve operator air to the control valve operator.

c. solenoid to position to its "operate" position, opening the vent port to the valve operator and closing of the air path from valve operator air.

d. applicable isolation valve to close.

QUESTION (C.10) [1.0]
Which ONE of the following conditions will result in an automatic rod run-in?

a. Low Pressurizer Level

b. Rod Not in contact with magnet

c. Anti-Siphon System Pressure High

d. Thermal Column Door Open

QUESTION (C.11) [1.0]
Which ONE of the following conditions will preclude placing the regulating rod in automatic?

a. The period as indicated by both IRM-2 and IRM-3 is 30 seconds.

b. The WRM selector switch in the 5 Kilowatt red scale position.

c. The power trace pointer (black) on the WRM recorder is reading greater than the auto control setpoint (red).

d. The regulating rod position is greater than 60% withdrawn (alarm is energized).

QUESTION (C.12) [2.0, 0.5 each]
Match the annunciator light condition in column A with the correct condition in column B.

	Column A		Column B
a.	Illuminated Dim	1.	Alarm acknowledged, not yet clear.
b.	Flashing	2.	Alarm not acknowledged, not yet clear.
c.	Illuminated Bright	3.	Alarm acknowledged, clear, but not yet reset.
d.	OFF	4.	Alarm acknowledged, clear and reset.

QUESTION (C.13) [1.0]
Which ONE of the following components can be supplied by the Emergency Backup Air Compressor?

a. Pool Loop Isolation valve 509

b. Reactor Loop Isolation Valve 507A

c. Emergency Generator

d. Freight Door 101 gasket

QUESTION (C.14) [1.0]
How long and why must you wait to start a second secondary cooling pump.

a. 5 minutes, to allow for makeup to the sump basin.

b. 5 minutes, to prevent electrical overload trip

c. 10 minutes, to allow for makeup to the sump basin.

d. 10 minutes, to prevent electrical overload trip

QUESTION (C.15) [2.0, 0.4 each]
Indicate whether each of the following reactivity coefficients are positive or negative for the indicated locations.

a. Void Coeff. of the Flux Trap

b. Void Coeff. of the Core

c. Temperature Coeff. of the Core

d. Temperature Coeff. of the Pool

e. Temperature Coeff. of the Flux Trap

QUESTION (C.16) [1.0]
How is gamma radiation compensated for in the Startup channel (Channel #1)?

a. A current equal and opposite to the signal due to gammas is generated by the detector.

b. After calibration, the detector is positioned toward or away from the core to compensate for gammas.

c. The output of the detector is fed through a discriminator circuit which passes only pulses due to neutron interactions.

d. Lead shielding is placed around the detector to reduce the signal due to gammas to the 'noise' level.

QUESTION (C.17) [1.0]
Which ONE of the following is NOT a feature of the pneumatic tube system designed to limit the radiation hazard?

a. The speed at which the sample container is transported through the system.

b. Both blowers start simultaneously.

c. Facility exhaust fan operation in the vicinity of the rabbit system.

d. Double encapsulation of samples.

(*** End of Section C ***)

ANSWER (A.1)
c
REFERENCE (A.1)
Given: $C_1 = 40$, $k_1 = 0.95$, $k_2 = 0.98$

$$\frac{C_1}{C_2} = \frac{(1-K_2)}{(1-K_1)} \qquad C_2 = C_1\frac{(1-K_1)}{(1-K_2)}$$

$$C_2 = 40\frac{1-0.95}{1-0.98} = 100$$

Burn, R., *Intro. to Nuclear Reactor Ops.*, © 1988, § 5 Problem 5.7.4, p. 5-28.

ANSWER (A.2)
a. 2; b. 1; c. 3; d. 5; e. 4
REFERENCE (A.2)
Burn, R., *Intro. to Nuclear Reactor Ops.*, © 1988, Tbls 2.3/2.4, pp. 2-58–2-59.

ANSWER (A.3)
c
REFERENCE (A.3)
Burn, R., *Intro. to Nuclear Reactor Operations*, © 1988, § 4.6, p. 4-16.

ANSWER (A.4)
b
REFERENCE (A.4)
Burn, R., *Intro. to Nuclear Reactor Operations*, © 1988, § 6.2.2, p. 6-4.

ANSWER (A.5)
a
REFERENCE (A.5)
Non-Power Generic Fundamentals Bank

ANSWER (A.6)
d
REFERENCE (A.6)
Burn, R., *Intro. to Nuclear Reactor Operations*, © 1988, §§ 8.1 –8.4, pp. 8-3 – 8-14.

ANSWER (A.7)
b
REFERENCE (A.7)
Burn, R., *Intro. to Nuclear Reactor Operations*, © 1988, § 3.3.4, pp. 3-20 – 3-22. (equation 3.8) (0.946 - 0.861)/(0.946 x 0.861) = 0.10435 ΔK/K

ANSWER (A.8)
a
REFERENCE (A.8)
Burn, R., *Introduction to Nuclear Reactor Operations*, © 1988, §

ANSWER (A.9)
a
REFERENCE (A.9)
Burn, R., *Intro. to Nuclear Reactor Operations*, © 1988, § 2.5.3, p. 2-45.

ANSWER (A.10)
a
REFERENCE (A.10)
Burn, R., *Intro. to Nuclear Reactor Operations*, © 1988, § 4.2, p. 4-1.

ANSWER (A.11)
a
REFERENCE (A.11)
General Electric, Heat Transfer and Fluid Flow Chapter 7

$$\dot{m}_1 c_{P_1} \Delta T_1 = \dot{m}_2 c_{P_2} \Delta T_2$$
$$1000(1.0)13 = 1400(1.0)\Delta T_2$$

$$\Delta T_2 = \frac{1000}{1400} \times 13°F = 9.28°F$$
$$T_{Outlet} = T_{Inlet} + \Delta T = 73 + 9.28 = 82.3°F$$

ANSWER (A.12)
a
REFERENCE: (A.12)
Burn, R., *Intro. to Nuclear Reactor Operations*, © 1988, § 4.3, p. 4-4.
$P_f = P_0 e^{t/\tau} \rightarrow t = \ln (P_f/P_0) \cdot \tau$
$\ln(6/1) > \ln(20/10) > \ln(35/20) > \ln(60/40)$

ANSWER (A.13)
d.
REFERENCE (A.13)
Burn, R., *Intro. to Nuclear Reactor Operations*, © 1988, § 2.5, pp. 2-36.

ANSWER (A.14)
b
REFERENCE (A.14)
Burn, R., *Intro. to Nuclear Reactor Operations*, © 1988, §

ANSWER (A.15)
c
REFERENCE (A.15)
Burn, R., *Intro. to Nuclear Reactor Operations*, © 1988, § 6.4, pp. 6-4 — 6.6.
(Moderator Temperature Coefficient)*(Change in Temperature)/(Control Rod Worth per Inch) = (Control Rod Movement) a positive sign would be rod insertion and negative sign would be rod withdrawal.
$(-1 \times 10^{-5}) * (-18)/(.003) = +0.6$ inches

ANSWER (A.16)
c
REFERENCE (A.16)
Burn, R., *Intro. to Nuclear Reactor Operations*, © 1988, § 7.2 & 7.3, pp. 7-1 — 7-9.

ANSWER (A.17)
a
REFERENCE (A.17)
Burn, R., *Intro. to Nuclear Reactor Operations*, © 1988, § 4.7, p. 4-21.

ANSWER (A.18)
c
REFERENCE (A.18)
Burn, R., *Intro. to Nuclear Reactor Operations*, © 1988, §§ 3.2.2—3.2.3, pp. 3-7—3-12.

ANSWER (A.19)
d
REFERENCE (A.19)
Burn, R., *Introduction to Nuclear Reactor Operations*, © 1988, § 5.2, p. 5-2.

(*** End of Section A ***)

ANSWER (B.1)
b
REFERENCE (B.1)
SOP II.1.1.H, pg. II-1.

ANSWER (B.2)
d
REFERENCE (B.2)
REP 0.2

ANSWER (B.3)
d
REFERENCE (B.3)
FEP-2

ANSWER (B.4)
a
REFERENCE (B.4)
One two inch sheet represents one tenth thickness worth of shielding. You are already at 100 mrem, and need only one more tenth thickness to get to 10 mrem/hr.

ANSWER (B.5)
d
REFERENCE (B.5)
Window closed shield β. 40 mrem/hr must be gamma

ANSWER (B.6)
d
REFERENCE (B.6)
10CFR20.203(c)(2)(i)

ANSWER (B.7)
b
REFERENCE (B.7)
10 CFR 20.2106
MURR EMERGENCY PLAN § 5.0.1 Protective Actions for All Classes p. 12

ANSWER (B.8)
a
REFERENCE (B.8)
REP-10; REP-4; REP-5; REP-8

ANSWER (B.9)
b
REFERENCE (B.9)
MURR HSR, § 6.6 *Coolant System Shielding*, p. 6-9. HSR, § 8.5 *Pneumatic Tubes*, p. 8-22. Burn, R., *Nuclear Power Plant Health Physics & Rad. Prot.* § 5.4

ANSWER (B.10)
c
REFERENCE (B.10)
SOP-I.4.3.D *Control Blade Operation*, p. SOP/I-5

ANSWER (B.11)
d
REFERENCE (B.11)
SOP I.4.3.F.a & b, p. SOP/I-6 also, SOP/A-8a, Routine Reactor Patrol

ANSWER (B.12)
c
REFERENCE (B.12)
MURR TS § 5.3 p. 1 of 1, TS § 1.2 Definition: Calibration or Testing Interval, pp. 1 & 2.

ANSWER (B.13)
c
REFERENCE (B.13)
SOP § VII.8.3.B p. SOP/VII-23

ANSWER (B.14)
b
REFERENCE (B.14)
SOP I.4.11.3 p. SOP/I-18

ANSWER (B.15)
b
REFERENCE (B.15)
MURR TS, § 1.0 Definitions pp. 3, 4 & 8 of 9.

ANSWER (B.16)
a
REFERENCE (B.16)
MURR TS, § 1.8

ANSWER (B.17)
b
REFERENCE (B.17)
SOP/A-10a

ANSWER (B.18)
b
REFERENCE (B.18)
SOP I.4.3.G.5 p. SOP/I-7

ANSWER (B.19)
d
REFERENCE (B.19)
MURR HSR, § 8.5, p. 8-24

ANSWER (B.20)
c
REFERENCE (B.20)
MURR TS, § 3.1.g

(*** End of Section B ***)

ANSWER (C.1)
d
REFERENCE (C.1)
Drawing # 79, HSR § 9.5 *Startup Interlocks*, Training Manual for ROs § II.14.A Rod Control System/Shim-Safety Rod Control, p. II.14.2

ANSWER (C.2)
c
REFERENCE (C.2)
SOP I, Table IV p.I-20 — I-22

ANSWER (C.3)
b
REFERENCE (C.3)
MURR HSR, § 7.1.10 p. 7-20.

ANSWER (C.4)
a
REFERENCE (C.4)
Training Manual for Reactor Operators § II.10, p. II.10.1. Also 02/92 NRC examination.

ANSWER (C.5)
a
REFERENCE (C.5)
MURR Facility prepared Requalification Examination administered 11/93.

ANSWER (C.6)
a, 2; b, 2; c, 1; d, 2; e, 2; f, 1; g, 1; h, 1
REFERENCE (C.6)
MURR Facility prepared Requalification Examination administered 11/93.

ANSWER (C.7)
d
REFERENCE (C.7)
MURR Facility prepared Requalification Examination administered 11/93.

ANSWER (C.8)
b
REFERENCE (C.8)
MURR Facility prepared Requalification Examination administered 11/93.

ANSWER (C.9)
b
REFERENCE (C.9)
Training Manual for Reactor Operators, § I.5, p. I.5.1. Also 02/92 NRC examination.

ANSWER (C.10)
b
REFERENCE (C.10)
NRC Examination bank, also MURR SOP I, TABLE IV p. SOP/I 20 - 24, and Training Manual for Reactor Operators, § II.11.L, p. I.11.4

ANSWER (C.11)
a
REFERENCE (C.11)
NRC Examination bank, Training Manual for Reactor Operators, § II.14.b, p. II.14.3.

ANSWER (C.12)
a, 3; b, 2; c, 1; d, 4
REFERENCE (C.12)
NRC Examination bank. Training manual for Reactor Operators § II.12, p. II.12.1.

ANSWER (C.13)
d
REFERENCE (C.13)
NRC Examination bank, also Training Manual for Reactor Operators, § IV.2, p. IV.2.1.

ANSWER (C.14)
c
REFERENCE (C.14)
NRC examination bank, SOP § VI.1.H

ANSWER (C.15)
a. positive b. negative c. negative d. positive e. positive
REFERENCE (C.15)
MURR Hazards Summary Report, p. 4-14.,SOP/VIII-7 Critical Parameters List

ANSWER (C.16)
c
REFERENCE (C.16)
Training Manual for Reactor Operators § II.1, Nuclear Detectors and Ranges, p. II.1.6

ANSWER (C.17)
b
REFERENCE (C.17)
HSR § 8.5 pp. 8-20 — 8-25.

(*** End of Section C ***)

A.1 c

A.2 a. 2
b. 1
c. 3
d. 5
e. 4

A.3 c

A.4 b

A.5 a

A.6 d

A.7 b

A.8 a

A.9 a

A.10 a

A.11 a

A.12 a

A.13 d.

A.14 b

A.15 c

A.16 c

A.17 a

.18 c

A.19 d

(*** End of Section A ***)

B.1 b

B.2 d

B.3 d

B.4 a

B.5 d

B.6 d

B.7 b

B.8 a

B.9 b

B.10 c

B.11 d

B.12 c

B.13 c

B.14 b

B.15 b

B.16 a

B.17 b

B.18 b

B.19 d

B.20 c

(*** End of Section B ***)

C.1 d

C.2 c

C.3 b

C.4 a

C.5 a

C.6 a, 2
b, 2
c, 1
d, 2
e, 2
f, 1
g, 1
h, 1

C.7 d

C.8 b

C.9 b

C.10 b

C.11 a

C.12 a, 3;
b, 2
c, 1
d, 4

C.13 d

C.14 c

C.15 a. positive
b. negative
c. negative
d. positive
e. positive

C.16 c

C.17 b

(*** End of Section C ***)