ENCLOSURE 1

EXAMINATION REPORT - 50-297/OL-86-01

Facility Licensee: North Carolina State University
Raleigh, NC 27695-7909

Facility Name: North Carolina State University

Facility Docket No.: 50-297

Written and oral examinations were administered at the North Carolina State University, PULSTAR Reactor near Raleigh, North Carolina.

Chief Examiner: for W. G. Douglas — 5/19/86 Date Signed

Approved by: for John F. Munro, Acting Section Chief — 5/19/86 Date Signed

Summary:

Examinations on April 23-24, 1986

Oral and written examinations were administered to five candidates, all of whom passed.

REPORT DETAILS

1. Facility Employees Contacted:

*T. C. Bray, Reactor Operations Manager
*S. M. Grady, Chief Reactor Operator

*Attended Exit Meeting

2. Examiners:

*W. G. Douglas, Region II
K. E. Brockman, Region II

*Chief Examiner

3. Examination Review Meeting

At the conclusion of the written examinations, the examiners provided S. M. Grady, Chief Reactor Operator, with a copy of the written examination and answer key for review. The comments made by the facility reviewers and the NRC Resolutions to these comments are listed below.

a. SRO Exam

(1) Question J.07

Facility Comment: These are normal criteria always used with procedure and not appropriate for memorization. Recommend deletion.

NRC Resolution: Agreed. Question deleted.

b. RO Exam

(1) Question A.02

Facility Comment: The NCSU Operations Manual does not specify conditions for calling the reactor critical; it only says log approximately critical. Recommend accepting either response a or b.

NRC Resolution: Accepted. Difference in specificity does conform to facility standards.

(2) Question C.03

Facility Comment: The term "average coolant temperature" is confusing as used in the question. Recommend question be deleted.

NRC Resolution: Examinees could have asked examiner for interpretation if they were confused. Comment not accepted.

(3) Question C.05

Facility Comment: Four hours is not the normal run time at PULSTAR and the operators have not memorized the four hours Xenon curve. Allow a greater tolerance to answer.

NRC Resolution: Answer key modified to accept 125-200 pcm as correct response.

(4) Question C.06

Facility Comment: Same as SRO Question J.07.

(5) Question D.08

Facility Comment: Since question asks for only two responses, change answer key to reflect two answers at 0.75 each.

NRC Resolution: Accepted. Answer key modified.

4. Exit Meeting

At the conclusion of the site visit the examiners met with representatives of the plant staff to discuss the results of the examination. Those individuals who clearly passed the oral examination were identified. There were no generic weaknesses noted during the oral examination.

The cooperation given to the examiners and the effort to ensure an atmosphere in the control room conducive to oral examinations was also noted and appreciated.

The licensee did not identify as proprietary any of the material provided to or reviewed by the examiners.

ENCLOSURE 3

(1 of 2)

U. S. NUCLEAR REGULATORY COMMISSION
REACTOR OPERATOR LICENSE EXAMINATION

FACILITY: NORTH CAROLINA STATE UNIV.

REACTOR TYPE: TEST

DATE ADMINISTERED: 86/04/24

EXAMINER: JERRY DOUGLAS

APPLICANT: _____

INSTRUCTIONS TO APPLICANT:

Use separate paper for the answers. Write answers on one side only. Staple question sheet on top of the answer sheets. Points for each question are indicated in parentheses after the question. The passing grade requires at least 70% in each category and a final grade of at least 80%. Examination papers will be picked up six (6) hours after the examination starts.

CATEGORY VALUE	% OF TOTAL	APPLICANT'S SCORE	% OF CATEGORY VALUE	CATEGORY
13.50	13.50			A. PRINCIPLES OF REACTOR OPERATION
14.00	14.00			B. FEATURES OF FACILITY DESIGGN
14.00	14.00			C. GENERAL OPERATING CHARACTERISTICS
14.50	14.50			D. INSTRUMENTS AND CONTROLS
15.00	15.00			E. SAFETY AND EMERGENCY SYSTEMS
14.00	14.00			F. STANDARD AND EMERGENCY OPERATING PROCEDURES
15.00	15.00			G. RADIATION CONTROL AND SAFETY
100.00	100.00			TOTALS

FINAL GRADE _____%

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

_____
APPLICANT'S SIGNATURE

QUESTION A.01 (1.00)

Which of the following statements concerning delayed neutrons is correct?

a. The magnitude of the EFFECTIVE delayed neutron fraction is greater at EOL than at BOL.

b. When calculating reactor period (SUR), the delayed neutron term may be considered to be insignificant if the reactivity added is less than the EFFECTIVE delayed neutron fraction.

c. The delayed neutron fraction is the ratio of the number of delayed neutrons produced to the total number of neutrons produced.

d. The presence of delayed neutrons cause the average neutron generation time to decrease.

QUESTION A.02 (1.00)

Given: You are in the course of a reactor startup. Which of the following conditions are most appropriate for announcing that the reactor is critical?

a. No control rod motion, stable zero SUR, stable source range count rate.

b. No control rod motion, stable positive SUR, increasing source range count rate.

c. No control rod motion, stable zero SUR, increasing source range count rate.

d. Control rod motion, stable positive SUR, increasing source range count rate.

(***** CATEGORY A CONTINUED ON NEXT PAGE *****)

QUESTION A.03 (1.00)

During a power escalation on the Log N channel, it takes 30 seconds to double reactor power level. Which of the following is the stable reactor period that would cause this rate of change?

a. 21 seconds

b. 30 seconds

c. 39 seconds

d. 43 seconds

QUESTION A.04 (1.00)

Which of the following is the correct definition of microscopic cross section?

a. The actual target area of the nucleus.

b. The effective target area of the nucleus.

c. The total actual target area of all nuclei within the core.

d. The total effective target area of all nuclei within the core.

QUESTION A.05 (1.00)

Which of the following is defined as "the fractional change in neutron population per generation"?

a. keff

b. Delta k

c. Reactivity

d. Delta reactivity

(***** CATEGORY A CONTINUED ON NEXT PAGE *****)

QUESTION A.06 (1.00)

Which of the following terms is defined as 'the energy equivalent of the mass defect'?

a. Excitation energy

b. Binding energy

c. Fission energy

d. Critical energy

QUESTION A.07 (1.00)

Which of the following express the relationship between differential rod worth (DRW) and integral rod worth (IRW)?

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

b. DRW is the area under the IRW curve at that location.

c. DRW is the square root of the IRW at that location.

d. There is no relationship between DRW and IRW.

QUESTION A.08 (1.00)

Which of the following terms of the six-factor formula has the highest value?

a. Fast Fission Factor

b. Reproduction Factor

c. Thermal Utilization Factor

d. Thermal Non-leakage Probability

(***** CATEGORY A CONTINUED ON NEXT PAGE *****)

QUESTION A.09 (1.00)

In a subcritical reactor, Keff is increased from .88 to .965. Which of the following is the amount of reactivity that was added to the core?

a. .085 (8500 pcm)

b. .10 (10000 pcm)

c. .125 (12500 pcm)

d. .220 (22000 pcm)

QUESTION A.10 (1.00)

Movement of the rods has the most effect on which of the following factors?

a. Reproduction Factor

b. Fast Fission Factor

c. Thermal Utilization Factor

d. Resonance Escape Factor

QUESTION A.11 (1.50)

During a reactor startup, equal increments of reactivity are added and the count rate is allowed to reach equilibrium each time. Choose the bracketed ([]) word(s) that describe what is observed on the Source Range recorder and/or SUR meter.

a. The change in equilibrium count rate is [larger] [the same] [smaller] each time. (0.5)

b. The time required to reach equilibrium is [longer] [the same] [shorter] each time. (0.5)

c. The point of supercriticality can be identified by a(n) [increasing] [constant] [decreasing] positive SUR several seconds after the reactivity addition is terminated. (0.5)

(***** CATEGORY A CONTINUED ON NEXT PAGE *****)

QUESTION A.12 (1.00)

Xenon has two production and two removal mechanisms.

a. List the most significant production mechanism. (0.5)

b. List the most significant removal mechanism while at low (less than 10%) power levels. (0.5)

QUESTION A.13 (1.00)

a. What is a delayed neutron? (0.5)

b. Why are delayed neutrons important? (0.5)

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

QUESTION B.01 (1.00)

Which of the following is the purpose of the 10 graphite reflectors in grid positions 1A - 6A and 6B - 6E?

a. Reduce the neutron irradiation of the beam tubes.

b. Add excess reactivity to the core.

c. Provide a high prompt negative temperature coefficient.

d. Serve as an irradiation facility.

QUESTION B.02 (1.00)

The flow rate of the primary system is varied by which of the following methods?

a. Adjusting the speed of the primary pump.

b. Adjusting the orifice downstream of the flow straightening tubes.

c. Adjusting the control signal from the flow transmitter.

d. Adjusting the position of the primary pump discharge valve.

QUESTION B.03 (1.00)

Which of the following correctly describes the flow path through the primary coolant system?

a. Pool, Delay Tank, Heat Exchanger, Primary Pump, Core

b. Pool, Delay Tank, Primary Pump, Heat Exchanger, Core

c. Core, Delay Tank, Primary Pump, Heat Exchanger, Pool

d. Core, Delay Tank, Heat Exchanger, Primary Pump, Pool

(***** CATEGORY B CONTINUED ON NEXT PAGE *****)

QUESTION B.04 (1.00)

Which of the following describes how secondary system inventory is maintained?

a. The Chief of Reactor Maintenance (CRM) manually adds makeup on a predetermined schedule.

b. Makeup is automatically initiated by cooling tower basin level.

c. Makeup is manually initiated on a low cooling tower basin level.

d. Makeup is automatically initiated by secondary pump suction temperature.

QUESTION B.05 (1.50)

Should a tube leak develop in the primary to secondary heat exchanger, which way will the leakage flow (PRIMARY-TO-SECONDARY or SECONDARY-TO-PRIMARY) for the following plant conditions?

a. Reactor a 1.0 MW, primary and secondary pump running. (0.5)

b. Reactor secured, primary pump running and secondary pump secured. (0.5)

c. Reactor at 50 kW in natural circulation with secondary pump secured. (0.5)

QUESTION B.06 (1.50)

Answer TRUE or FALSE to the following.

a. The primary backup for the reactor air compressor is the BEL air compressor.

b. The purification system uses a H-OH mixed resin bed to control primary system pH.

c. The service water system is used to directly supply water for beam tube annulus recirculation.

(***** CATEGORY B CONTINUED ON NEXT PAGE *****)

QUESTION B.07 (1.00)

Fill in the blanks with the proper material.

The basic fuel module is a pin made up of _____ pellets contained in a _____ tube.

QUESTION B.08 (1.50)

List THREE uses of reactor air.

QUESTION B.09 (1.50)

List the THREE loads that can be supplied by the auxiliary distribution panel.

QUESTION B.10 (1.00)

List FOUR components on which the Main Exhaust Fan takes a suction.

QUESTION B.11 (1.00)

Describe how the three-way mixing valve responds to an increase in the secondary pump suction temperature. Include in your description the motive force for operating the valve.

QUESTION B.12 (1.00)

What is the purpose of the Pneumatic Nitrogen Purge System?

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

QUESTION C.01 (1.00)

Which of the following rods has the highest worth?

a. Safety #1

b. Safety #2

c. Regulating

d. Pulse

QUESTION C.02 (1.00)

During a reactor startup (after shutdown for two weeks) with the startup source installed, the rod withdrawal is stopped at the -200 pcm position and power level stablizes. Which of the following statements concerning how power level will respond in the next hour, if no other actions are taken, is correct?

a. Reactor power will remain essentially constant.

b. Reactor power will slowly decrease due to being subcritical.

c. Reactor power will rapidly decrease to initial prestartup level.

d. Reactor power will slowly increase due to long-lived delayed neutrons.

QUESTION C.03 (1.50)

Answer TRUE or FALSE to the following.

a. By maintaining a constant pool temperature, T-2, the average coolant temperature increases as power level increases. (0.5)

b. At 105 degrees F, xenon-free, the reactor can be taken critical with the lowest worth rod completely inserted. (0.5)

c. The normal purification flow rate is approximately 50 gpm. (0.5)

(***** CATEGORY C CONTINUED ON NEXT PAGE *****)

QUESTION C.04 (2.00)

Indicate whether the ACP would be HIGHER THAN, THE SAME AS, or LOWER THAN the ECP for the following conditions. Consider each separately.

a. Beam Tube 2 is inadvertently filled after the ECP is calculated. (0.5)

b. The reactor is started up 10 hours after S/D from 4 hours at 1.0 MW instead of 2 hours after shutdown. (0.5)

c. The ACP is taken at 100 W instead of 10 W with other parameters as calculated on ECP. (0.5)

d. The primary pump is secured just prior to startup. Note: the reactor has been shutdown all weekend. (0.5)

QUESTION C.05 (.50)

List the approximate xenon reactivity value for a startup at peak xenon following operations for 4 hours at 1.0 MW.

~~QUESTION C.06 (2.50)~~ deleted

~~In order to use the SDM 'Benchmark' for verifying SDM on a reactor S/U, eight conditions are assumed. List FIVE of these eight conditions.~~

QUESTION C.07 (1.00)

Is the Gang rod worth LESS THAN, EQUAL TO, or MORE THAN the sum of the individual rod worths? EXPLAIN.

QUESTION C.08 (1.00)

Indicate HOW and WHY power level will initially respond to starting the primary pump while at 100 kW.

(***** CATEGORY C CONTINUED ON NEXT PAGE *****)

QUESTION C.09 (2.50)

Calculate the reactivity associated with the following changes. Indicate whether this change is positive or negative. Consider each separately.

a. Pool temperature increases by 5.0 degrees F. (0.5)

b. Power level is decreased from 1.0 MW to 700 kW. (0.5)

c. Startup source is removed from holder (placed on pool floor). (0.5)

d. Pneumatic sample container is inserted (rabbit in reactor). (0.5)

e. Neutron Radiography Facility is installed. (0.5)

QUESTION C.10 (1.00)

Given the following indications, what is the reactor power level? Consider each separately.

a. Delta T across core = 13.9 degrees F with a constant temperature. (0.5)

b. N-16 Channel reads a stable 0.395 x 10 E-8 amperes. (0.5)

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

QUESTION D.01 (1.00)

The process of determining an instrument's accuracy by visually comparing the indication to other independent instrument channels measuring the same parameter is defined in Technical Specifications as a:

a. Channel Calibration

b. Channel Check

c. Channel Functional Test

d. Channel Verification

QUESTION D.02 (1.00)

Which of the following reactions is used for neutron detection in the startup channel detector?

a. Neutron + Uranium-235 ---> 2 Fission Fragment Ions

b. Neutron + Nitrogen-16 ---> Nitrogen-17 + Gamma

c. Neutron + Boron-10 ---> Lithium-7 Ion + Helium-4 Ion

d. Neutron + Fluorine-19 ---> Nitrogen-15 Ion + Helium-4 Ion

QUESTION D.03 (1.00)

Which of the following statements describes the signal path from the Startup Channel detector to the level (cps) meter on the console?

a. Detector, Pre Amp, Discriminator, Log Integrator, Meter

b. Detector, Log Integrator, Pulse Shaper, Pulse Counter, Meter

c. Detector, Pre Amp, Log Integrator, Discriminator, Meter

d. Detector, Log Amp, Meter

(***** CATEGORY D CONTINUED ON NEXT PAGE *****)

QUESTION D.04 (1.00)

Which of the following methods is used to remove the gamma signal from the neutron signal in the Log N Channel?

a. The outer chamber prevents gammas from ionizing the inner chamber.

b. Inner chamber current cancels out gamma current in the outer chamber.

c. A pulse height discriminator does not allow the gamma signals to be counted.

d. Squaring the combined signal makes the gamma contribution insignificant.

QUESTION D.05 (1.00)

Indicate whether the following statements concerning a resistance temperature detector (RTD) are TRUE or FALSE.

a. An RTD is connected across one leg of a bridge circuit. As temperature that is sensed by the RTD changes, a proportional change in the output voltage (current) across the bridge occurs. (0.5)

b. When an RTD fails open, it will indicate a downscale (low) reading on its meter. (0.5)

QUESTION D.06 (1.50)

What THREE conditions will generate a reverse drive of the control rods?

QUESTION D.07 (2.00)

What FOUR conditions must be met to operate the regulating rod in automatic control?

(***** CATEGORY D CONTINUED ON NEXT PAGE *****)

QUESTION D.08 (1.50)

List TWO functions of the Log N Operative (4 W) relay.

QUESTION D.09 (1.00)

What is the purpose of the 9 x 10 E 4 cps rod drive inhibit?

QUESTION D.10 (.50)

Many of the reactor protection and control setpoints are sensed by P-E switches. Explain how a P-E switch works.

QUESTION D.11 (1.00)

Why isn't the Safety Power Channel downscaled prior to a reactor S/U?

QUESTION D.12 (2.00)

During the performance of a long form startup checklist, how is the Over-the-Pool VAMP checked for proper operation? Include all checks and/or readings required.

(***** END OF CATEGORY D *****)

QUESTION E.01 (1.50)

a. What TWO scram inputs can be automatically bypassed? (1.0)

b. When are they bypassed? (0.5)

QUESTION E.02 (2.00)

List the EIGHT signals, either automatic or manual, that will cause an Evacuation signal. No setpoints are required.

QUESTION E.03 (2.50)

Excluding the Low Flow reactor scram, list the other FIVE scrams and their setpoints.

QUESTION E.04 (2.00)

Describe how the reactor instrumentation and protection channels would respond to BOTH a high and a low failure of the regulator supplying the flow measuring channel. Include any applicable setpoints.

QUESTION E.05 (1.00)

How is the auxiliary generator started on a loss of commerical power?

QUESTION E.06 (1.50)

List all the actions that occur upon the receipt of a Confinement signal.

QUESTION E.07 (2.00)

Basically, explain how redunancy is achieved in the scram logic unit.

(***** CATEGORY E CONTINUED ON NEXT PAGE *****)

QUESTION E.08 (1.50)

Explain how core heat is removed in the event of a loss of commerical power.

QUESTION E.09 (1.00)

In the event of a failure of the pool level measuring channel, what TWO methods are available to monitor pool water level?

(***** END OF CATEGORY E *****)

QUESTION F.01 (1.50)

What are the THREE requirements that must be met in order to do a Key-On Startup?

QUESTION F.02 (2.00)

The Operations Manual gives four ranges of action depending upon the SDM. List these FOUR ranges and the actions (requirements) of each.

QUESTION F.03 (1.00)

What are the TWO conditions that require the performance of a Long Form Startup Checklist?

QUESTION F.04 (2.00)

List FOUR differences in steps that are performed between the Long Form and Short Form Startup Checklists, i.e., the Over-the-Pool VAMP check is more thorough on the Long Form.

QUESTION F.05 (1.50)

a. What criteria determines what category of high residual startup can be performed? (0.5)

b. What is the major difference in how the two categories of high residual startups are performed? (1.0)

QUESTION F.06 (2.00)

List ALL Immediate Actions for a reactor scram.

QUESTION F.07 (1.50)

What actions are required if the reactor operator suspects a Primary Coolant leak while operating at 1 MW?

(***** CATEGORY F CONTINUED ON NEXT PAGE *****)

QUESTION F.08 (.50)

What is the Immediate Operator Action for a loss of commerical power?

QUESTION F.09 (2.00)

Assuming the reactor is at 1.0 MW, list the Immediate Actions for a Reactor Building Evacuation?

(***** END OF CATEGORY F *****)

QUESTION G.01 (1.00)

Which of the following is a 10 CFR 20 exposure limit?

a. 5 rem/year - whole body.

b. 1 rem/quarter - whole body.

c. 18.75 rem/quarter - hands.

d. 7 rem/quarter - skin of whole body.

QUESTION G.02 (1.00)

Which of the following radiation exposures would inflict the greatest biological damage to man?

a. 1 Rem of GAMMA.

b. 1 Rem of ALPHA.

c. 1 Rem of NEUTRON.

d. NONE of the above; they are all equivalent.

QUESTION G.03 (1.00)

What would be the activity of 28 grams of Al-28? (Al-28 has a half-life of 2.24 minutes).

a. 1.95 E24 dps

b. 1.86 E23 dps

c. 3.25 E22 dps

d. 3.10 E21 dps

(***** CATEGORY G CONTINUED ON NEXT PAGE *****)

QUESTION G.04 (1.00)

If a point source of gamma radiation gives an exposure rate of 10 mR/hr at 1 meter, what would be the exposure rate a 5 meters?

a. 2.0 mR/nr

b. 1.0 mR/hr

c. 0.4 mR/hr

d. 0.2 mR/hr

QUESTION G.05 (1.00)

When frisking with the RM-3, at what level (reading) are you considered contaminated?

a. 200 cpm (absolute)

b. 100 cpm (absolute)

c. 100 cpm (above background)

d. 50 cpm (above background)

QUESTION G.06 (1.00)

How much radiation exposure is a minor (under 18) visitor allowed to receive?

a. 10% of the 10CFR20 limit

b. 20% of the 10CFR20 limit

c. 25% of the 10CFR20 limit

d. 50% of the 10CFR20 limit

(***** CATEGORY G CONTINUED ON NEXT PAGE *****)

QUESTION G.07 (2.00)

For the following radiation detector types, indicate whether the output intensity (current or pulse height) is proportional to the incident radiation energy; i.e., if the incident energy increases, will the output intensity increase? (Answer YES or NO to each part.)

a. Ion Chamber (0.5)

b. GM (0.5)

c. Proportional Counter (0.5)

d. Scintillation (0.5)

QUESTION G.08 (1.50)

Match the isotopes in Column A with the principal type of radiation exposure hazard in Column B. Column B choices may be used more than once each.

COLUMN A	COLUMN B
a. Ar-41	1. Alpha
	2. Beta
b. Tritium	3. Neutron
	4. Gamma
c. N-16	5. Proton

QUESTION G.09 (1.50)

Match the radiation detector in Column A to the detector type in Column B.

COLUMN A	COLUMN B
a. Control Room	1. Ion Chamber
	2. Proportional Counter
b. Stack Gaseous	3. GM
	4. Scintillation
c. Stack Particulate	

QUESTION G.10 (1.50)

List THREE ways in which personnel exposure may be monitored at NCSU.

(***** CATEGORY G CONTINUED ON NEXT PAGE *****)

QUESTION G.11 (1.00)

As a reactor operator, what are the TWO conditions that must be met for YOU to authorize the release of irradiated samples?

QUESTION G.12 (1.50)

What THREE individuals must sign a RWP before commencing work in an area controlled by the Radiation Work Permit (RWP)?

(***** END OF CATEGORY G *****)
(********** END OF EXAMINATION **********)

ANSWERS -- NORTH CAROLINA STATE UNIV.-86/04/24-JERRY DOUGLAS

ANSWER A.01 (1.00)

c

REFERENCE
Basic Reactor Theory

ANSWER A.02 (1.00)

b

REFERENCE
Basic Reactor Theory

ANSWER A.03 (1.00)

d (period = 1.443 x doubling time)

REFERENCE
NCSU, Reactor Operator Training, Exp. 3, p. 3

ANSWER A.04 (1.00)

b

REFERENCE
CP&L, Nuclear Reactor Theory, p. 5-2

ANSWER A.05 (1.00)

c

REFERENCE
NUS, Reactor Theory

ANSWER A.06 (1.00)

b

ANSWERS -- NORTH CAROLINA STATE UNIV.-86/04/24-JERRY DOUGLAS

REFERENCE
CP&L, Nuclear Reactor Theory, p. 2-15

ANSWER A.07 (1.00)

a

REFERENCE
DPC, Fundamentals of Nuclear Reactor Engineering, p. 138
WNTO, pp. I-5.36 - 43

001/000-K5.02 (2.9/3.4)

ANSWER A.08 (1.00)

b

REFERENCE
NUS, Reactor Theory

ANSWER A.09 (1.00)

b

REFERENCE
NUS, Vol 3, pp 6.1-3

ANSWER A.10 (1.00)

c

REFERENCE
Reactor Theory Manual - Six Factor Formula

ANSWERS -- NORTH CAROLINA STATE UNIV.-86/04/24-JERRY DOUGLAS

ANSWER A.11 (1.50)

a. LARGER (0.5)
b. LONGER (0.5)
c. CONSTANT (0.5)

REFERENCE
Westinghouse Reactor Physics, Section I-4
DPC, Fundamentals of Nuclear Reactor Engineering, Sect. IV

004/000-K5.08 (2.6/3.2)

ANSWER A.12 (1.00)

a. Decay of Iodine (Tellurium) (0.5)
b. Decay of Xenon (0.5)

REFERENCE
Westinghouse Nuclear Training Operations, pp. I-5.64 & 65

001/000-K5.33 (3.2/3.5)

ANSWER A.13 (1.00)

a. A neutron born at some time (>1E-14 seconds) after fission (0.25 pts.) from the decay of fission fragments (0.25 pts.) (0.5)
b. They allow control of the reactor (0.25 pts.) by increasing the average neutron lifetime (0.25 pts.) (0.5)
c. Decreases (0.25 pts.) due to buildup of Plutonium (0.25 pts.) (0.5)

REFERENCE
Westinghouse Nuclear Training Operations, pp. I-3.4 & I-3.10 - 12

001/000-K5.47 (2.9/3.4)

ANSWERS -- NORTH CAROLINA STATE UNIV.-86/04/24-JERRY DOUGLAS

ANSWER B.01 (1.00)

b

REFERENCE
NCSU, Ops Manual, p. 1-3

ANSWER B.02 (1.00)

d

REFERENCE
NCSU, Ops Manual, Figure 5.1

ANSWER B.03 (1.00)

c

REFERENCE
NCSU, Ops Manual, Figure 5.1

ANSWER B.04 (1.00)

b

REFERENCE
NCSU, Ops Manual, p. 5-14

ANSWER B.05 (1.50)

a. SECONDARY-TO-PRIMARY (0.5)
b. PRIMARY-TO-SECONDARY (0.5)
c. SECONDARY-TO-PRIMARY (0.5)

REFERENCE
NCSU, Ops Manual, pp. 5-8 and 5-17

ANSWERS -- NORTH CAROLINA STATE UNIV.-86/04/24-JERRY DOUGLAS

ANSWER B.06 (1.50)

a. FALSE (0.5)
b. TRUE (0.5)
c. FALSE (0.5)

REFERENCE
NCSU, Ops Manual, pp. 5-34, 5-21, and 5-7

ANSWER B.07 (1.00)

1. Uranium Dioxide (0.5)
2. Ziracoly (0.5)

REFERENCE
NCSU, Ops Manual, p. 1-3

ANSWER B.08 (1.50)

Any THREE at 0.5 points each
1. Pulsing
2. Pool Level (Bubbler)
3. Flow Transmitter (Primary)
4. Experimental Air Supply

REFERENCE
NCSU, Ops Manual, p. 5-32

ANSWER B.09 (1.50)

1. Confinement Fan #1 (0.5)
2. Confinement Fan #2 (0.5)
3. Control Room Distribution Panel (0.5)

REFERENCE
NCSU, Ops Manual, Figure 8.1

ANSWERS -- NORTH CAROLINA STATE UNIV.-86/04/24-JERRY DOUGLAS

ANSWER B.10 (1.00)

1. BP&TC Exhaust Fan (0.25)
2. Rx Bridge Glove Box (0.25)
3. Pneumatic System Exhaust (0.25)
4. Rx Bay Hood (0.25)

REFERENCE
NCSU, Ops Manual, Figure 8.1

ANSWER B.11 (1.00)

A pneumatic signal (proportional to temperature) (0.5) positions the three-way mixing valve to direct more flow to the cooling tower (less directly to suction of pump) (0.5) (1.0)

REFERENCE
NCSU, Ops Manual, p. 5-16

ANSWER B.12 (1.00)

Reduce Ar-41 released from pneumatic system (0.7) when the pneumatic system is not being used (0.3). (1.0)

REFERENCE
NCSU, Ops Manual, p. 9-5

ANSWERS -- NORTH CAROLINA STATE UNIV.-86/04/24-JERRY DOUGLAS

ANSWER C.01 (1.00)

c

REFERENCE
NCSU, PDS, Vol. II, p. 4

ANSWER C.02 (1.00)

a

REFERENCE
Basic Reactor Theory, Subcritical Multiplication

ANSWER C.03 (1.50)

a. TRUE (0.5)
b. FALSE (0.5)
c. FALSE (0.5)

REFERENCE
NCSU, PDS, Vol. II, pp. 4 & 13 and Ops Manual, Sections 3 & 5

ANSWER C.04 (2.00)

a. THE SAME AS (0.5)
b. HIGHER THAN (0.5)
c. THE SAME AS (0.5)
d. THE SAME AS (0.5)

REFERENCE
NCSU, PDS, Vol. II, p. 11

ANSWER C.05 (.50)

150 pcm (+/- 15 pcm) (0.5)

ANSWERS -- NORTH CAROLINA STATE UNIV.-86/04/24-JERRY DOUGLAS

REFERENCE
NCSU, PDS, Vol. II, p. 11

~~ANSWER C.06 (2.50)~~ deleted

Any FIVE at 0.5 points each
1. 5x5 Reflected Core #3
2. Control rods banked, pulse rod at 24.0 inches
3. NRF installed
4. BT plugged and filled
5. Pool temperature < 110 degrees F
6. Latest rod gang worth
7. PCU installed
8. Less xenon than peak after 8 hours at 1.0 Mw

REFERENCE
~~NCSU, PDS, Vol. II, p. 19~~

ANSWER C.07 (1.00)

LESS THAN (0.5) due to rod shadowing (0.5) (1.0)

REFERENCE
NSCU, PDS, Vol. II, p. 4

ANSWER C.08 (1.00)

Power level will increase (0.7) due to primary pump circulating cooler (than water in core) pool water through core (0.3). (1.0)

REFERENCE
CAF

ANSWERS -- NORTH CAROLINA STATE UNIV.-86/04/24-JERRY DOUGLAS

ANSWER C.09 (2.50)

(0.25 points for value, 0.25 points for sign)

a. -19.5 pcm (+/- 2 pcm) (-3.9 x 5) (0.5)
b. +99 pcm (+/- 5 pcm) (-330 x -.3) (0.5)
c. -16 pcm (+/- 2 pcm) (0.5)
d. +9 pcm (+/- 1 pcm) (0.5)
e. -35 pcm (+/- 3 pcm) (0.5)

REFERENCE
NCSU, PDS, Vol. II, pp. 15 and 16

ANSWER C.10 (1.00)

a. 1.007 MW (13.9/13.8) (0.5)
b. 0.975 MW (.395/.405) (0.5)

REFERENCE
NCSU, PDS, Vol. II, pp. 25 and 28

ANSWERS -- NORTH CAROLINA STATE UNIV.-86/04/24-JERRY DOUGLAS

ANSWER D.01 (1.00)

b

REFERENCE
McG, TS, p. 1-1
Surry, TS 1.0-3
CAT, TS, p. 1-1
WBN, TS, p. 1-1
VCS, TS, p. 1-1
HBR, TS, p. 1-3
NCSU, TS, p. 2

ANSWER D.02 (1.00)

a

REFERENCE
NCSU, Ops Manual, Section 4

ANSWER D.03 (1.00)

a

REFERENCE
FNP, Excore Nuclear Instrumentation System, Fig. 7
Surry, Instrumentation Manual, Excore Instrumentation System, p. IV-1.29
VEGP, Training Text, Volume 5, Fig. 3a-2
CAT, Figure CN-IC-ENB-4
NCSU, Ops Manual, pp. 4-2 & 3

015/000-K6.03 (2.6/3.0)

ANSWER D.04 (1.00)

b

REFERENCE
Nuclear Power Reactor Instrumentation Systems Handbook, Vol. 1, Ch. 2
NCSU, Ops Manual, Section 4

015/000-K5.02 (2.7/2.9)

ANSWERS -- NORTH CAROLINA STATE UNIV.-86/04/24-JERRY DOUGLAS

ANSWER D.05 (1.00)

a. TRUE (0.5)
b. FALSE (0.5)

REFERENCE
Nuclear Power Reactor Instrumentation Systems Handbook, Vol. 1, Ch. 4

ANSWER D.06 (1.50)

1. Linear power at 73.5 % (1.1 MW) of scale (0.5)
2. Operation of the "Ganged Insert" switch (0.5)
3. Reactor scram (if keyswitch is on) (0.5)

REFERENCE
NCSU, Ops Manual, pp. 4-22 & 23

ANSWER D.07 (2.00)

1. Mode Selector Switch in "Steady State" (0.5)
2. No manual operation of ganged drive switch (0.5)
3. Servo error (deviation) < 0.5 % (0.5)
4. Regulating rod withdrawn beyond 13.5 inches (0.5)

REFERENCE
NCSU, Ops Manual, pp. 4-20 & 21

ANSWER D.08 (1.50)

1. Bypass S/U Channel inhibits (0.5)
2. Switch LCRM/Log N recorder (0.5)
3. Pulse interlock (0.5)

REFERENCE
NCSU, Ops Manual, pp. 4-21 & 22

ANSWERS -- NORTH CAROLINA STATE UNIV.-86/04/24-JERRY DOUGLAS

ANSWER D.09 (1.00)

Prevent operation of the S/U Channel in flux levels where saturation of the detector may occur. (1.0)

REFERENCE
NCSU, Ops Manual, p. 4-22

ANSWER D.10 (.50)

A device that at the set pneumatic pressure generates an electrical output signal (on or off). (0.5)

REFERENCE
NCSU, Ops Manual, p. 4-12

ANSWER D.11 (1.00)

Because it uses an uncompensated ion chamber (0.7) and would only read the gamma level if downscaled (0.3). (1.0)

REFERENCE
NCSU, Ops Manual, p. 4-8

ANSWER D.12 (2.00)

1. White light illuminated (0.5)
2. Record reading (0.5)
3. Record alarm setpoint (0.5)
4. Verify battery operation (0.5)

REFERENCE
NCSU, Ops Manual, p. 3-3

ANSWERS -- NORTH CAROLINA STATE UNIV.-86/04/24-JERRY DOUGLAS

ANSWER E.01 (1.50)

a. 1. Safety Power Channel (0.5)
   2. Linear Power Channel (0.5)
b. During pulsing (0.5)

REFERENCE
NCSU, Ops Manual, p. 4-18

ANSWER E.02 (2.00)

1. Manual switch on RAP (0.25)
2. Remote manual switch in basement corridor (0.25)
3. West Wall monitor (0.25)
4. Over-the-Pool monitor (0.25)
5. Control Room monitor (0.25)
6. Particulate monitor (0.25)
7. Stack Gas monitor (0.25)
8. Auxiliary GM monitor (0.25)

REFERENCE
NCSU, Ops Manual, p. 8-11

ANSWER E.03 (2.50)

1. Manual (0.3) - pushbutton (0.2) (0.5)
2. Linear Overpower (0.3) - 80% of scale (1.2 MW) (0.2) (0.5)
3. Safety Overpower (0.3) - 80% of scale (1.2 MW) (0.2) (0.5)
4. Flapper Open (0.3) - open > 150 kW (0.2) (0.5)
5. Low Water Level (0.3) - -36 inches (0.2) (0.5)

REFERENCE
NCSU, Ops Manual, p. 4-28

ANSWERS -- NORTH CAROLINA STATE UNIV.-86/04/24-JERRY DOUGLAS

ANSWER E.04 (2.00)

1. HIGH - High flow indication (0.25), Low Flow reactor scram (0.25) at 23 psi regulator output (0.25) if > 150 kW (0.25) (1.0)
2. LOW - Low flow indication (0.25), Low Flow reactor scram (0.25) at 475 gpm (0.25) if > 150 kW (0.25) (1.0)

REFERENCE
NCSU, Ops Manual, pp. 4-12 & 19

ANSWER E.05 (1.00)

Manually (0.5) by switch on reactor console (0.5). (1.0)

REFERENCE
NCSU, Ops Manual, p. 6-7

ANSWER E.06 (1.50)

1. Main H&V system off (supply & exhaust fans and dampers) (0.3)
2. CR HVAC off (0.3)
3. BP&TC exhaust fan off (and damper) (0.3)
4. Confinement Fan #1 starts (and damper opens) (0.3)
5. If after set time delay, confinement fan #1 is not started, confinement fan #2 will start (and damper opens) (0.3)

REFERENCE
NCSU, Ops Manual, p. 8-12

ANSWER E.07 (2.00)

1. NAND gate turns off solid state switch in magnet current loop and energizes "scram relay" to open contact which removes magnet power. (1.0)
2. AND gate causes relay to drop out and interrupt magnet power. (1.0)

REFERENCE
NCSU, Ops Manual, p. 4-18

ANSWERS -- NORTH CAROLINA STATE UNIV.-86/04/24-JERRY DOUGLAS

ANSWER E.08 (1.50)

When the primary pump is lost, flapper falls open (0.5) establishing a path for natural circulation (0.5). The core heat is transferred to the pool water and dissipated to the bay atmosphere at the pool surface (0.5). (1.5)

REFERENCE
NCSU, Ops Manual, p. 1-6

ANSWER E.09 (1.00)

1. Two radiation monitors on the pool bridge. (0.5)
2. Yardstick attached to overflow weir. (0.5)

REFERENCE
NCSU, Ops Manual, pp. 3-4 & 4-13

ANSWERS -- NORTH CAROLINA STATE UNIV.-86/04/24-JERRY DOUGLAS

ANSWER F.01 (1.50)

1. Keyswitch off for < 6 hours (0.5)
2. No RSS maintenance performed (0.5)
3. Long or Short Form completed within 24 hours (0.5)

REFERENCE
NCSU, Ops Manual, p. 3-29

ANSWER F.02 (2.00)

1. > 800 pcm (0.2) - can use benchmark (0.3) (0.5)
2. < 800 pcm & > 500 pcm (0.2) - must calculate (0.3) (0.5)
3. < 500 pcm & > 400 pcm (0.2) - DSRO permission to operate (0.3) (0.5)
4. < 400 pcm (0.2) - scram and notify DSRO (0.3) (0.5)

REFERENCE
NCSU, Ops Manual, pp. 3-36 & 37

ANSWER F.03 (1.00)

1. Last successful operation more than 48 hours ago. (0.5)
2. Greater than 7 days since last Long Form has been completed. (0.5)

REFERENCE
NCSU, Ops Manual, p. 3-3

ANSWER F.04 (2.00)

(Any FOUR at 0.5 points each)
1. Nitrogen purge pressure
2. Pulse safety disconnect removed
3. Inspection of reactor bay area
4. Inspection of MER
5. Manual Evacuation
6. Confinement system delta P
7. S/U Channel period test
8. Reverses
(Evaluate other responses against procedure)

ANSWERS -- NORTH CAROLINA STATE UNIV.-86/04/24-JERRY DOUGLAS

REFERENCE
NCSU, Ops Manual, pp. 3-64 - 75

ANSWER F.05 (1.50)

a. Whether less than or greater than 10 watts. (0.5)
b. 1. If greater than 10 W, Log N compensation is set to 6.0 volts. (0.5)
   2. If less than 10 W, Log N compensation is set using checklist procedure once less than 10 E 3 cps (with fission chamber fully inserted). (0.5)

REFERENCE
NCSU, Ops Manual, pp. 3-37 & 38

ANSWER F.06 (2.00)

1. Verify rods "seated" (0.2) and "off magnet" (0.2). If not, initiate manual scram or turn off keyswitch (0.2). (0.6)
2. Insure prompt power drop and power level decreasing (0.4) (0.4)
3. Insure follow-on reverse (0.4). If not, turn ganged insert switch to on (0.2). (0.6)
4. Inform DSRO (0.2)
5. Make log entries (0.2)

REFERENCE
NCSU, Ops Manual, p. 3-51

ANSWER F.07 (1.50)

1. Secure the reactor (0.4)
2. Stop the primary pump (0.4)
3. Inform DSRO (0.2)
4. Attempt to isolate leak(0.4) while maintaining water over the core by any means (0.1) (0.5)

REFERENCE
NCSU, Ops Manual, p. 3-52

ANSWERS -- NORTH CAROLINA STATE UNIV.-86/04/24-JERRY DOUGLAS

ANSWER F.08 (.50)

Turn off Reactor Keyswitch (0.5)

REFERENCE
NCSU, Ops Manual, p. 3-57

ANSWER F.09 (2.00)

1. Check status of Confinement (0.3) - manually initiate if necessary (0.2) (0.5)
2. Evacuate BEL if (0.1)
   a. CR Rad alarm (0.1)
   b. 2 of 3 pool status alarms (0.1)
   c. Any 2 (of 6) radiation alarms (0.1)
   d. Your judgement (0.1) (0.5)
3. Inform Emergency Squad members (0.3) using "All Call" (0.2) (0.5)
4. Verify personnel clear of bay (0.5)

REFERENCE
NCSU, Ops Manual, p. 3-60

ANSWERS -- NORTH CAROLINA STATE UNIV.-86/04/24-JERRY DOUGLAS

ANSWER G.01 (1.00)

c

REFERENCE
10 CFR 20.101

000/060-K1.02 (2.5/3.1)

ANSWER G.02 (1.00)

d

REFERENCE
10CFR20

068/000-K5.04 (3.2/3.5)

ANSWER G.03 (1.00)

d

REFERENCE
NUS,NET, Volume 2

ANSWER G.04 (1.00)

c

REFERENCE
Rad Health Handbook, USDHEW, p. 56

ANSWER G.05 (1.00)

CAF

REFERENCE
CAF

ANSWERS -- NORTH CAROLINA STATE UNIV.-86/04/24-JERRY DOUGLAS

ANSWER G.06 (1.00)

a

REFERENCE
NCSU, Ops Manual, p. 2-21

ANSWER G.07 (2.00)

a. YES (0.5)
b. NO (0.5)
c. YES (0.5)
d. YES (0.5)

REFERENCE
FNP, Health Physics and Radiation Protection Lesson Plans, pp. 41-46
William J. Price, Nuclear Radiation Detection, pp. 43 - 46, 77, 138, and 196
VEGP, Training Text, Volume 9, pp. 23-39 - 42

072/00-K5.01 (2.7/3.0)

ANSWER G.08 (1.50)

a. 4 (0.5)
b. 2 (0.5)
c. 4 (0.5)

REFERENCE
Chart of the Nuclides

ANSWER G.09 (1.50)

a. 1 (0.5)
b. 3 (0.5)
c. 4 (0.5)

REFERENCE
NCSU, Ops Manual, Table 7-1

ANSWERS -- NORTH CAROLINA STATE UNIV.-86/04/24-JERRY DOUGLAS

ANSWER G.10 (1.50)

1. Film Badge (0.5)
2. TLD (0.5)
3. Pocket Dosimeter (0.5)

REFERENCE
NCSU, Ops Manual, p. 2-21

ANSWER G.11 (1.00)

1. Person receiving sample is known (on user list) (0.5)
2. Release limited to BEL (0.5)

REFERENCE
NCSU, Ops Manual, p. 2-24

ANSWER G.12 (1.50)

1. Person in charge (0.5)
2. Reactor Manager (Tom Bray) (0.5)
3. Health Physics (0.5)

REFERENCE
NCSU, Ops Manual, p. 2-22

QUESTION	VALUE	REFERENCE
A.01	1.00	WGD0000189
A.02	1.00	WGD0000190
A.03	1.00	WGD0000514
A.04	1.00	WGD0000515
A.05	1.00	WGD0000516
A.06	1.00	WGD0000519
A.07	1.00	WGD0000520
A.08	1.00	WGD0000521
A.09	1.00	WGD0000561
A.10	1.00	WGD0000888
A.11	1.50	WGD0000890
A.12	1.00	WGD0000669
A.13	1.00	WGD0000886
	13.50	
B.01	1.00	WGD0000955
B.02	1.00	WGD0000957
B.03	1.00	WGD0000958
B.04	1.00	WGD0000961
B.05	1.50	WGD0000959
B.06	1.50	WGD0000963
B.07	1.00	WGD0000956
B.08	1.50	WGD0000962
B.09	1.50	WGD0000964
B.10	1.00	WGD0000965
B.11	1.00	WGD0000960
B.12	1.00	WGD0000966
	14.00	
C.01	1.00	WGD0000968
C.02	1.00	WGD0000976
C.03	1.50	WGD0000977
C.04	2.00	WGD0000974
C.05	.50	WGD0000970
C.06	2.50	WGD0000971
C.07	1.00	WGD0000969
C.08	1.00	WGD0000975
C.09	2.50	WGD0000972
C.10	1.00	WGD0000973
	14.00	
D.01	1.00	WGD0000262
D.02	1.00	WGD0000979
D.03	1.00	WGD0000980
D.04	1.00	WGD0000988
D.05	1.00	WGD0000981
D.06	1.50	WGD0000984

QUESTION	VALUE	REFERENCE
D.07	2.00	WGD0000986
D.08	1.50	WGD0000991
D.09	1.00	WGD0000983
D.10	.50	WGD0000985
D.11	1.00	WGD0000989
D.12	2.00	WGD0000990
	14.50	
E.01	1.50	WGD0000987
E.02	2.00	WGD0000993
E.03	2.50	WGD0000995
E.04	2.00	WGD0000982
E.05	1.00	WGD0000992
E.06	1.50	WGD0000994
E.07	2.00	WGD0000996
E.08	1.50	WGD0000997
E.09	1.00	WGD0000998
	15.00	
F.01	1.50	WGD0001001
F.02	2.00	WGD0001002
F.03	1.00	WGD0000999
F.04	2.00	WGD0001000
F.05	1.50	WGD0001003
F.06	2.00	WGD0001004
F.07	1.50	WGD0001005
F.08	.50	WGD0001006
F.09	2.00	WGD0001007
	14.00	
G.01	1.00	WGD0000647
G.02	1.00	WGD0000648
G.03	1.00	WGD0000892
G.04	1.00	WGD0000893
G.05	1.00	WGD0000895
G.06	1.00	WGD0000896
G.07	2.00	WGD0000891
G.08	1.50	WGD0000894
G.09	1.50	WGD0000897
G.10	1.50	WGD0000898
G.11	1.00	WGD0000899
G.12	1.50	WGD0000900
	15.00	
	100.00	

ENCLOSURE 3

(2 of 2)

U. S. NUCLEAR REGULATORY COMMISSION
SENIOR REACTOR OPERATOR LICENSE EXAMINATION

FACILITY: NORTH CAROLINA STATE UNIV.

REACTOR TYPE: TEST

DATE ADMINISTERED: 86/04/24

EXAMINER: JERRY DOUGLAS

APPLICANT: _____

INSTRUCTIONS TO APPLICANT:

Use separate paper for the answers. Write answers on one side only. Staple question sheet on top of the answer sheets. Points for each question are indicated in parentheses after the question. The passing grade requires at least 70% in each category and a final grade of at least 80%. Examination papers will be picked up six (6) hours after the examination starts.

CATEGORY VALUE	% OF TOTAL	APPLICANT'S SCORE	% OF CATEGORY VALUE	CATEGORY
20.00	20.00			H. REACTOR THEORY
20.00	20.00			I. RADIOACTIVE MATERIALS HANDLING DISPOSAL AND HAZARDS
20.00	20.00			J. SPECIFIC OPERATING CHARACTERISTICS
20.00	20.00			K. FUEL HANDLING AND CORE PARAMETERS
20.00	20.00			L. ADMINISTRATIVE PROCEDURES, CONDITIONS AND LIMITATIONS
100.00	100.00			TOTALS

FINAL GRADE _____%

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

_____
APPLICANT'S SIGNATURE

QUESTION H.01 (1.00)

Which of the following is the units of heat flux?

a. Watts / cubic centimeter

b. BTU / (hr square ft)

c. Calories / gram

d. kW / ft

QUESTION H.02 (1.00)

Which of the following is the correct definition of microscopic cross section?

a. The actual target area of the nucleus.

b. The effective target area of the nucleus.

c. The total actual target area of all nuclei within the core.

d. The total effective target area of all nuclei within the core.

QUESTION H.03 (1.00)

Which of the following can be defined as "the number of neutrons causing fission that were originally born delayed divided by the total number of neutrons causing fission"?

a. Lambda effective

b. Rho

c. Beta effective

d. Tau

(***** CATEGORY H CONTINUED ON NEXT PAGE *****)

QUESTION H.04 (1.00)

Which of the following terms is defined as "the energy equivalent of the mass defect"?

a. Excitation energy

b. Binding energy

c. Fission energy

d. Critical energy

QUESTION H.05 (1.00)

Which of the following express the relationship between differential rod worth (DRW) and integral rod worth (IRW)?

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

b. DRW is the area under the IRW curve at that location.

c. DRW is the square root of the IRW at that location.

d. There is no relationship between DRW and IRW.

QUESTION H.06 (1.00)

In a subcritical reactor, Keff is increased from .88 to .965. Which of the following is the amount of reactivity that was added to the core?

a. .085 (8500 pcm)

b. .10 (10000 pcm)

c. .125 (12500 pcm)

d. .220 (22000 pcm)

(***** CATEGORY H CONTINUED ON NEXT PAGE *****)

QUESTION H.07 (1.00)

Which of the following statements best characterizes Natural Circulation?

a. It needs a pump to get started.

b. The elevation of the heat source must be above that of the heat sink.

c. The driving force is a difference in density.

d. Heat transfer is more efficient if steam is mixed with water.

QUESTION H.08 (1.00)

One of the characteristics of water is that it will hold gases dissolved in solution. Which of the following will INCREASE the concentration of dissolved gases in a quantity of water?

a. INCREASING the pressure and LOWERING the temperature.

b. DECREASING the pressure and LOWERING the temperature.

c. INCREASING the pressure and RAISING the temperature.

d. DECREASING the pressure and RAISING the temperature.

QUESTION H.09 (1.00)

Which of the following statements concerning the reactivity values of equilibrium (at power) xenon and peak (after shutdown) xenon is correct? Assume shutdown occurs from equilibrium conditions.

a. Equilibrium xenon is INDEPENDENT of power level; peak xenon is INDEPENDENT of power level.

b. Equilibrium xenon is INDEPENDENT of power level; peak xenon is DEPENDENT on power level.

c. Equilibrium xenon is DEPENDENT on power level; peak xenon is INDEPENDENT of power level.

d. Equilibrium xenon is DEPENDENT on power level; peak xenon is DEPENDENT on power level.

(***** CATEGORY H CONTINUED ON NEXT PAGE *****)

QUESTION H.10 (1.00)

The reactor is operating at 700 kW with a 10.0 degree delta T, which of the following is the mass flow rate?

a. 518 gpm

b. 500 gpm

c. 495 gpm

d. 483 gpm

QUESTION H.11 (1.00)

During a reactor startup (after shutdown for two weeks) with the startup source installed, the rod withdrawal is stopped at the -200 pcm position and power level stablizes. Which of the following statements concerning how power level will respond in the next hour, if no other actions are taken, is correct?

a. Reactor power will remain essentially constant.

b. Reactor power will slowly decrease due to being subcritical.

c. Reactor power will rapidly decrease to initial prestartup level.

d. Reactor power will slowly increase due to long-lived delayed neutrons.

QUESTION H.12 (1.00)

The -1/3 DPM SUR following a reactor trip is caused by which of the following?

a. The decay constant of the longest-lived group of delayed neutrons.

b. The ability of U-235 to fission with source neutrons.

c. The amount of negative reactivity added on a trip being greater than the Shutdown Margin.

d. The doppler effect adding positive reactivity due to the temperature decrease following a trip.

(***** CATEGORY H CONTINUED ON NEXT PAGE *****)

QUESTION H.13 (1.00)

Which of the following statements concerning the use of water as the moderator is correct?

a. Water has a HIGH scattering cross-section, a LOW absorption cross-section, and a LARGE energy decrement per collision.

b. Water has a LOW scattering cross-section, a HIGH absorption cross-section, and a LARGE energy decrement per collision.

c. Water has a HIGH scattering cross-section, a LOW absorption cross-section, and a SMALL energy decrement per collision.

d. Water has a LOW scattering cross-section, a HIGH absorption cross section, and a SMALL energy decrement per collision.

QUESTION H.14 (1.00)

With the reactor initially at a keff of 0.99, a certain reactivity change causes the count rate to double. If this same amount of reactivity is again added to the reactor, which of the following will be the status of the reactor?

a. Subcritical

b. Critical

c. Supercritical

d. Prompt Critical

(***** CATEGORY H CONTINUED ON NEXT PAGE *****)

QUESTION H.15 (1.00)

During a reactor startup, the first reactivity addition caused count rate to increase from 10 cps to 16 cps. The second reactivity addition caused count rate to increase from 16 cps to 32 cps. Assuming the reactor is subcritical after the second reactivity addition, which of the following statements describing the relationship between the first and second reactivity additions is correct?

a. The first reactivity addition was larger.

b. The second reactivity addition was larger.

c. The first and second reactivity additions were equal.

d. There is not enough data given to determine relationship between reactivity values.

QUESTION H.16 (1.50)

Indicate whether the following statements are TRUE or FALSE.

a. A positive 100 pcm reactivity addition and a negative 100 pcm addition produce the same value of startup rates; only the signs are different. (0.5)

b. A delayed neutron has a higher probability of causing fission than does a prompt neutron. (0.5)

c. If a reactor is supercritical, the fraction of delayed neutrons shifts to the shorter lived precursors and the value of the average decay constant (lambda) decreases. (0.5)

QUESTION H.17 (2.00)

Indicate how (INCREASE, DECREASE, or REMAIN THE SAME) an increase in moderator temperature will affect the following parameters.

a. Resonance Escape Probability (0.5)

b. Thermal Utilization Factor (0.5)

c. Fast Non-Leakage Probability (0.5)

d. Fast Fission Factor (0.5)

(***** CATEGORY H CONTINUED ON NEXT PAGE *****)

QUESTION H.18 (1.50)

For the following definitions, give the term that is defined.

a. The amount of reactivity that is needed to go from hot zero power to hot full power. (0.5)

b. The fractional change in neutron population per generation. (0.5)

c. The decay of a neutron into a proton with the simultaneous ejection of an electron (and antineutrino) from the nucleus. (0.5)

(***** END OF CATEGORY H *****)

QUESTION I.01 (1.00)

Which of the following is a 10 CFR 20 exposure limit?

a. 5 rem/year - whole body.

b. 1 rem/quarter - whole body.

c. 18.75 rem/quarter - hands.

d. 7 rem/quarter - skin of whole body.

QUESTION I.02 (1.00)

Which of the following radiation exposures would inflict the greatest biological damage to man?

a. 1 Rem of GAMMA.

b. 1 Rem of ALPHA.

c. 1 Rem of NEUTRON.

d. NONE of the above; they are all equivalent.

QUESTION I.03 (1.00)

What would be the activity of 28 grams of Al-28? (Al-28 has a half-life of 2.24 minutes).

a. 1.95 E24 dps

b. 1.86 E23 dps

c. 3.25 E22 dps

d. 3.10 E21 dps

(***** CATEGORY I CONTINUED ON NEXT PAGE *****)

QUESTION I.04 (1.00)

If a point source of gamma radiation gives an exposure rate of 10 mR/hr at 1 meter, what would be the exposure rate a 5 meters?

a. 2.0 mR/hr

b. 1.0 mR/hr

c. 0.4 mR/hr

d. 0.2 mR/hr

QUESTION I.05 (1.00)

When frisking with the RM-3, at what level (reading) are you considered contaminated?

a. 200 cpm (absolute)

b. 100 cpm (absolute)

c. 100 cpm (above background)

d. 50 cpm (above background)

QUESTION I.06 (1.00)

How much radiation exposure is a minor (under 18) visitor allowed to receive?

a. 10% of the 10CFR20 limit

b. 20% of the 10CFR20 limit

c. 25% of the 10CFR20 limit

d. 50% of the 10CFR20 limit

(***** CATEGORY I CONTINUED ON NEXT PAGE *****)

QUESTION I.07 (1.00)

If a contaminated person requires prompt medical attention, he should be sent to which of the following facilities?

a. The NCSU Infirmary

b. Rex Hospital

c. Wake Memorial Hospital

d. Raleigh Community Hospital

QUESTION I.08 (2.00)

For the following radiation detector types, indicate whether the output intensity (current or pulse height) is proportional to the incident radiation energy; i.e., if the incident energy increases, will the output intensity increase? (Answer YES or NO to each part.)

a. Ion Chamber (0.5)

b. GM (0.5)

c. Proportional Counter (0.5)

d. Scintillation (0.5)

QUESTION I.09 (1.50)

Match the isotopes in Column A with the principal type of radiation exposure hazard in Column B. Column B choices may be used more than once each.

COLUMN A	COLUMN B
a. Ar-41	1. Alpha
	2. Beta
b. Tritium	3. Neutron
	4. Gamma
c. N-16	5. Proton

(***** CATEGORY I CONTINUED ON NEXT PAGE *****)

QUESTION I.10 (1.50)

Match the radiation detector in Column A to the detector type in Column B.

COLUMN A	COLUMN B
a. Control Room	1. Ion Chamber
	2. Proportional Counter
b. Stack Gaseous	3. GM
	4. Scintillation
c. Stack Particulate	

QUESTION I.11 (1.50)

What THREE individuals must sign a RWP before commencing work in an area controlled by the Radiation Work Permit (RWP)?

QUESTION I.12 (.50)

As the designated senior reactor operator, to what locations are you approved to release irradiated material?

QUESTION I.13 (2.00)

List, in order of severity (from lowest to highest), the FOUR Emergency Action Levels (EAL's) specified in the Emergency Plan.

QUESTION I.14 (.50)

What is the most limiting site boundary for gaseous radioactive releases from the PULSTAR stack?

QUESTION I.15 (1.00)

For the following surveys, give the frequency they are conducted AND who conducts them.

a. Routine Radiation Survey (0.5)

b. Routine Contamination Survey (0.5)

(***** CATEGORY I CONTINUED ON NEXT PAGE *****)

QUESTION I.16 (1.50)

Answer the following questions concerning the Liquid Waste Control Panel.

a. Where is this panel located? (0.5)

b. What indications are on this panel? (0.5)

c. What controls are on this panel? (0.5)

QUESTION I.17 (1.00)

According to the Technical Specifications, under what TWO conditions and for how long can the Over-the-Pool monitor be bypassed?

(***** END OF CATEGORY I *****)

QUESTION J.01 (1.00)

The flow rate of the primary system is varied by which of the following methods?

a. Adjusting the speed of the primary pump.

b. Adjusting the orifice downstream of the flow straightening tubes.

c. Adjusting the control signal from the flow transmitter.

d. Adjusting the position of the primary pump discharge valve.

QUESTION J.02 (1.50)

Should a tube leak develop in the primary to secondary heat exchanger, which way will the leakage flow (PRIMARY-TO-SECONDARY or SECONDARY-TO-PRIMARY) for the following plant conditions?

a. Reactor a 1.0 MW, primary and secondary pump running. (0.5)

b. Reactor secured, primary pump running and secondary pump secured. (0.5)

c. Reactor at 50 kW in natural circulation with secondary pump secured. (0.5)

QUESTION J.03 (1.50)

Answer TRUE or FALSE to the following.

a. By maintaining a constant pool temperature, T-2, the average coolant temperature increases as power level increases. (0.5)

b. At 105 degrees F, xenon-free, the reactor can be taken critical with the lowest worth rod completely inserted. (0.5)

c. The normal purification flow rate is approximately 50 gpm. (0.5)

(***** CATEGORY J CONTINUED ON NEXT PAGE *****)

QUESTION J.04 (.50)

TRUE or FALSE?

The longer the reactor is run at full power, the longer it will take for xenon to peak following reactor shutdown.

QUESTION J.05 (2.00)

Indicate whether the ACP would be HIGHER THAN, THE SAME AS, or LOWER THAN the ECP for the following conditions. Consider each separately.

a. Beam Tube 2 is inadvertently filled after the ECP is calculated. (0.5)

b. The reactor is started up 10 hours after S/D from 4 hours at 1.0 MW instead of 2 hours after shutdown. (0.5)

c. The ACP is taken at 100 W instead of 10 W with other parameters as calculated on ECP. (0.5)

d. The primary pump is secured just prior to startup. Note: the reactor has been shutdown all weekend. (0.5)

QUESTION J.06 (.50)

List the approximate xenon reactivity value for a startup at peak xenon following operations for 4 hours at 1.0 MW.

~~QUESTION J.07 (2.50)~~ deleted

In order to use the SDM "Benchmark" for verifying SDM on a reactor S/U, ~~eight~~ conditions are assumed. List FIVE of these ~~eight conditions.~~

QUESTION J.08 (1.50)

a. What TWO scram inputs can be automatically bypassed? (1.0)

b. When are they bypassed? (0.5)

(***** CATEGORY J CONTINUED ON NEXT PAGE *****)

QUESTION J.09 (1.00)

Describe how the three-way mixing valve responds to an increase in the secondary pump suction temperature. Include in your description the motive force for operating the valve.

QUESTION J.10 (1.00)

Is the Gang rod worth LESS THAN, EQUAL TO, or MORE THAN the sum of the individual rod worths? EXPLAIN.

QUESTION J.11 (1.00)

Indicate HOW and WHY power level will initially respond to starting the primary pump while at 100 kW.

QUESTION J.12 (2.00)

Describe how the reactor instrumentation and protection channels would respond to BOTH a high and a low failure of the regulator supplying the flow measuring channel. Include any applicable setpoints.

QUESTION J.13 (1.50)

Explain how core heat is removed in the event of a loss of commerical power.

(***** CATEGORY J CONTINUED ON NEXT PAGE *****)

QUESTION J.14 (2.50)

Calculate the reactivity associated with the following changes. Indicate whether this change is positive or negative. Consider each separately.

a. Pool temperature increases by 5.0 degrees F. (0.5)

b. Power level is decreased from 1.0 MW to 700 kW. (0.5)

c. Startup source is removed from holder (placed on pool floor). (0.5)

d. Pneumatic sample container is inserted (rabbit in reactor). (0.5)

e. Neutron Radiography Facility is installed. (0.5)

(***** END OF CATEGORY J *****)

QUESTION K.01 (1.00)

Which of the following is NOT a reason for pressurizing the fuel rods with helium?

a. Minimize clad creeping inwards toward fuel pellets.

b. Increase gap (pellet to clad) thermal conductivity.

c. Allow detection of clad failure by helium analysis of the coolant.

d. Maintain lower fuel centerline temperature.

QUESTION K.02 (1.00)

Following a reactivity insertion of +50 pcm to a subcritical reactor, the count rate will take longest to reach equilibrium if :

a. The new keff is .997 and source strength is 50 N/sec.

b. The new keff is .999 and source strength is 50 N/sec.

c. The new keff is .997 and source strength is 100 N/sec.

d. The new keff is .998 and source strength is 100 N/sec.

QUESTION K.03 (1.00)

A 1/M curve that predicts criticality early is referred to as which of the following?

a. Useless

b. Conservative

c. Non-conservative

d. Ideal

(***** CATEGORY K CONTINUED ON NEXT PAGE *****)

QUESTION K.04 (1.00)

Which of the following conditions would cause a 1/M curve to predict criticality earlier than it will actually occur?

a. Source located too near detector.

b. Fuel assemblies loaded too far from detector.

c. Highest worth fuel assemblies loaded first.

d. Control rod located between fuel assemblies loaded and detector.

QUESTION K.05 (1.00)

The integral rod worth of Safety #2 is which of the following?

a. 3580 pcm

b. 2780 pcm

c. 2640 pcm

d. 2260 pcm

QUESTION K.06 (1.00)

The Shutdown Margin is correctly calculated by which of the following?

a. Total Rod Worth - Highest Rod Worth + Cold, Clean Excess

b. Highest Rod Worth - Cold, Clean Excess + Total Rod Worth

c. Cold, Clean Excess - Highest Rod Worth - Total Rod Worth

d. Total Rod Worth - Highest Rod Worth - Cold, Clean Excess

(***** CATEGORY K CONTINUED ON NEXT PAGE *****)

QUESTION K.07 (1.00)

Which of the following is the bases of the maximum total energy release during Pulsing?

a. Energy density less than 470 W-sec/gram

b. Cladding temperature less than 273 degrees F

c. No bulk boiling

d. Departure from Nucleate Boiling Ration less than 2.0

QUESTION K.08 (1.00)

The following are the boiling phases associated with nucleate boiling and departure from nucleate boiling.

1) Transition Boiling
2) Bulk Boiling
3) Film Boiling
4) Sub-cooled (Local) Boiling

Which of the following is the order in which they would occur in a channel with normal flow and high heat flux?

a. 2, 4, 3, 1

b. 2, 4, 1, 3

c. 4, 2, 3, 1

d. 4, 2, 1, 3

QUESTION K.09 (1.00)

During fuel loading, which of the following will have NO effect on the shape of a 1/M plot?

a. Location of the neutron source in the core.

b. Strength of the neutron source in the core.

c. Location of the neutron detectors around the core.

d. Order of placement of fuel assemblies in the core.

(***** CATEGORY K CONTINUED ON NEXT PAGE *****)

QUESTION K.10 (2.00)

Indicate whether the following statements concerning fuel handling are TRUE or FALSE.

a. A fuel handler must be a licensed operator or a trainee under the direct supervision of a licensed operator. (0.5)

b. Unless specifically exempted by the RHP, a Radiation Work Permit is required for fuel handling evolutions. (0.5)

c. Loading fuel into a water hole or 'U' is NOT permitted. (0.5)

d. Having the Designated Senior Reactor Operator as the fuel handler and a Reactor Operator Assistant as the numbering and orientation observer meets the minimum required two person fuel handling crew. (0.5)

QUESTION K.11 (1.50)

Indicate whether the following parameters INCREASE, DECREASE, or REMAIN THE SAME over core life. Assume 5 x 5 Reflected Core #3 installed.

a. Maximum Axial Peak to Average Ratio (0.5)

b. Total Core Peak to Average Ratio (0.5)

c. Power Imbalance (Absolute Value) (0.5)

QUESTION K.12 (1.00)

Fill in the blanks with the proper material.

The basic fuel module is a pin made up of _____ pellets contained in a _____ tube.

QUESTION K.13 (1.00)

During fuel movement the control rods are 'cocked'. What TWO conditions must be met for the rods to be considered 'cocked'?

(***** CATEGORY K CONTINUED ON NEXT PAGE *****)

QUESTION K.14 (1.50)

In the event of an Evacuation signal during fuel movement, what THREE actions are taken by the fuel handling crew?

QUESTION K.15 (1.00)

What are the TWO Technical Specification design limits for fuel storage locations?

QUESTION K.16 (1.00)

What are the minimum radiation monitoring detectors that must be in operation during fuel handling evolutions?

QUESTION K.17 (2.00)

Given the Fuel Temperature Coefficient is -1.6 pcm/degree F, calcualte the average fuel temperature increase when going from 10kW to 1.0 MW. Assume pool temperature remains constant at 105 degrees F.

(***** END OF CATEGORY K *****)

QUESTION L.01 (1.00)

During repair of the ventilation system, the Technical Specifications allow operation without the required negative differential pressure. Which of the following is the limit for this operation?

a. Power limited to 500 kW for less than 24 hours

b. Power limited to 100 kW for less than 24 hours

c. Power limited to 500 kW for less than 72 hours

d. Power limited to 100 kW for less than 72 hours

QUESTION L.02 (1.00)

Answer TRUE or FALSE to the following.

a. The licensee (you) shall notify the NRC within 15 days after the occurrence of a disability. (0,5)

b. If a licensee (you) have not been actively performing the functions of a senior operator for a period of five months, you can NOT resume licensed activities without NRC concurrence. (0.5)

QUESTION L.03 (1.50)

Match the evolution in Column A to the responsible person in Column B.

COLUMN A	COLUMN B
1. Insure Reactor Building secured each evening	a. REACTOR SUPERVISOR
2. Approve bypass of interlocks	b. DESIGNATED SRO
3. Approve operations with pulse rod in core	c. RHP
4. Approve bypass of radiation monitors	d. CRM
5. Allow operation with SDM of 600 pcm	e. REACTOR OPERATOR
6. Approve access to MER with reactor operating	

(***** CATEGORY L CONTINUED ON NEXT PAGE *****)

QUESTION L.04 (2.00)

What is the minimum required operating crew with the reactor at 1.0 MW, steady state conditions? Indicate whether each individual must be at the facility or may be on call.

QUESTION L.05 (1.00)

The operator is authorized to leave the area in front of the console to obtain replacement recorder paper. What conditions must be met in order for he/she to leave the area?

QUESTION L.06 (2.00)

The following questions concern the PULSTAR Tag System.

a. Who may initiate red tag-outs? (0.5)

b. Who may close red tag-outs? (0.5)

c. Who may close yellow tag-outs? (0.5)

d. What type tag-out is placed on a channel of the Reactor Safety System that is out of specification? (0.5)

QUESTION L.07 (1.00)

Assuming approval has been granted, what FIVE conditions are necessary to work on an energized circuit?

QUESTION L.08 (1.50)

List the Safety Limits for full flow forced convection while in the Steady State mode of operations.

(***** CATEGORY L CONTINUED ON NEXT PAGE *****)

QUESTION L.09 (1.50)

List the following Limiting Conditions for Operations.

a. In pulse mode, maximum pulse rod travel in terms of reactivity. (0.5)

b. Maximum pneumatic rabbit reactivity insertion. (0.5)

c. Maximum rate of reactivity insertion. (0.5)

QUESTION L.10 (.50)

Other than the Radiation Protection Council, what campus group is responsible for independent appraisals of reactor operations?

QUESTION L.11 (1.50)

What THREE conditions constitute an abnormal reactivity change? Give categories, not examples of specific events.

QUESTION L.12 (1.00)

What FOUR conditions must be met for the reactor to be considered secured?

QUESTION L.13 (2.00)

Describe the requirements to make a Temporary Change to the Operations Manual. Include any time requirements and approvals/reviews before or after implementation.

QUESTION L.14 (1.00)

What is the basis for the Limiting Safety System Setting for power while operating with natural convection flow?

QUESTION L.15 (1.50)

Give THREE examples of a Reportable Event as defined in the Technical Specifications.

(***** END OF CATEGORY L *****)

(********** END OF EXAMINATION **********)

ANSWERS -- NORTH CAROLINA STATE UNIV.-86/04/24-JERRY DOUGLAS

ANSWER H.01 (1.00)

b

REFERENCE
General Physics, HT & FF, p. 229

002/000-K5.01 (3.1/3.4)

ANSWER H.02 (1.00)

b

REFERENCE
CP&L, Nuclear Reactor Theory, p. 5-2

ANSWER H.03 (1.00)

c

REFERENCE
NUS, Reactor Theory

ANSWER H.04 (1.00)

b

REFERENCE
CP&L, Nuclear Reactor Theory, p. 2-15

ANSWER H.05 (1.00)

a

REFERENCE
DPC, Fundamentals of Nuclear Reactor Engineering, p. 138
WNTO, pp. I-5.36 - 43

001/000-K5.02 (2.9/3.4)

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ANSWER H.06 (1.00)

b

REFERENCE
NUS, Vol 3, pp 6.1-3

ANSWER H.07 (1.00)

c

REFERENCE
General Physics, HT&FF, pp. 355 - 358

ANSWER H.08 (1.00)

a

REFERENCE
General Physics, HT & FF, Chapter 1

ANSWER H.09 (1.00)

d

REFERENCE
Westinghouse Nuclear Training Operations, pp. I-5.66 - 70

001/000-K5.26 (3.5/3.7)

ANSWER H.10 (1.00)

d

REFERENCE
NCSU, PULSTAR Data Summary and Second Law of Thermodynamics

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ANSWER H.11 (1.00)

a

REFERENCE
Basic Reactor Theory, Subcritical Multiplication

ANSWER H.12 (1.00)

a

REFERENCE
VEGP, Training Text, Vol. 9, p. 21-47
Westinghouse Reactor Physics, pp. I-3.17 & 19
DPC, Fundamentals of Nuclear Reactor Engineering, p. 106

001/000-K5.49 (2.9/3.4)

ANSWER H.13 (1.00)

a

REFERENCE
Westinghouse Reactor Physics, pp. I-2.19 - 21
HBR, Reactor Theory, Session 14, p. 3
DPC, Fundamentals of Nuclear Reactor Engineering, p. 53

001/000-K5.57 (3.0/3.2)

ANSWER H.14 (1.00)

c

REFERENCE
HBR Reactor Theory, Session 42, pp. 3 & 4
DPC, Fundamentals of Nuclear Reactor Engineering

004/000-K5.08 (2.6/3.2)

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ANSWER H.15 (1.00)

a

REFERENCE
HBR, Reactor Theory, Sessions 41 and 42
DPC, Fundamentals of Nuclear Reactor Engineering, pp. 121 and 122

004/000-K5.08 (2.6/3.2)

ANSWER H.16 (1.50)

a. FALSE (0.5)
b. FALSE (Power Reactor); TRUE (Research Reactor) (0.5)
c. FALSE (0.5)

REFERENCE
Westinghouse Nuclear Training Operations, pp. I-3.9 - 15

ANSWER H.17 (2.00)

a. DECREASE (0.5)
b. INCREASE (0.5)
c. DECREASE (0.5)
d. INCREASE (0.5)

REFERENCE
Westinghouse Nuclear Training Operations, pp. I-2.31 - 36

ANSWER H.18 (1.50)

a. Power Defect (-0.25 for power coefficient) (0.5)
b. Reactivity (0.5)
c. Beta (minus) Decay (0.5)

REFERENCE
Westinghouse Reactor Physics, pp. I-5.26, I-3.2, and I-1.18
HBR, Reactor Theory, Session 32, p. 3 and Session 21, p. 2 and
Session 4, p. 2

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ANSWER I.01 (1.00)

c

REFERENCE
10 CFR 20.101

000/060-K1.02 (2.5/3.1)

ANSWER I.02 (1.00)

d

REFERENCE
10CFR20

068/000-K5.04 (3.2/3.5)

ANSWER I.03 (1.00)

d

REFERENCE
NUS,NET, Volume 2

ANSWER I.04 (1.00)

c

REFERENCE
Rad Health Handbook, USDHEW, p. 56

ANSWER I.05 (1.00)

CAF

REFERENCE
CAF

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ANSWER I.06 (1.00)

a

REFERENCE
NCSU, Ops Manual, p. 2-21

ANSWER I.07 (1.00)

b

REFERENCE
NCSU, Emergency Procedure 1.0, p. 4

ANSWER I.08 (2.00)

a. YES (0.5)
b. NO (0.5)
c. YES (0.5)
d. YES (0.5)

REFERENCE
FNP, Health Physics and Radiation Protection Lesson Plans, pp. 41-46
William J. Price, Nuclear Radiation Detection, pp. 43 - 46, 77, 138, and 196
VEGP, Training Text, Volume 9, pp. 23-39 - 42

072/00-K5.01 (2.7/3.0)

ANSWER I.09 (1.50)

a. 4 (0.5)
b. 2 (0.5)
c. 4 (0.5)

REFERENCE
Chart of the Nuclides

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ANSWER I.10 (1.50)

a. 1 (0.5)
b. 3 (0.5)
c. 4 (0.5)

REFERENCE
NCSU, Ops Manual, Table 7-1

ANSWER I.11 (1.50)

1. Person in charge (0.5)
2. Reactor Manager (Tom Bray) (0.5)
3. Health Physics (0.5)

REFERENCE
NCSU, Ops Manual, p. 2-22

ANSWER I.12 (.50)

Release limited to BEL (0.5)

REFERENCE
NCSU, Ops Manual, p. 2-24

ANSWER I.13 (2.00)

(0.3 for EAL, 0.2 for order)
1. Unusual Event (0.5)
2. Alert (0.5)
3. Site Emergency (0.5)
4. General Emergency (0.5)

REFERENCE
NCSU, Emergency Procedure 4.0, p. 1

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ANSWER I.14 (.50)

D.H. Hill Library (0.3), 8th floor (0.2) (0.5)

REFERENCE
NCSU, Emergency Procedure 4.0, p. 2

ANSWER I.15 (1.00)

a. Monthly (+/- 7 days) (0.25) - conducted by any qualified person (normally RHP) (0.25) (0.5)
b. Twice weekly (0.25) - conducted by RPO (0.25) (0.5)

REFERENCE
NCSU, Standing Order #44

ANSWER I.16 (1.50)

a. Health Physics Laboratory (Room B103) (0.5)
b. Tank levels (3) (0.5)
c. 1. Inlet valve control switches (3) (0.2) (0.5)
   2. Outlet valve control switches (3) (0.2)
   3. Level alarm setpoints (3) (0.1)

REFERENCE
NCSU, Ops Manual, p. 7-5

ANSWER I.17 (1.00)

1. During return of rabbit capsule (0.3) for less than 1 minute (0.2)(0.5)
2. During removal of experiments from pool (0.3) for less than 3 minutes (0.2) (0.5)

REFERENCE
NCSU, TS, p. 22

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ANSWER J.01 (1.00)

d

REFERENCE
NCSU, Ops Manual, Figure 5.1

ANSWER J.02 (1.50)

a. SECONDARY-TO-PRIMARY (0.5)
b. PRIMARY-TO-SECONDARY (0.5)
c. SECONDARY-TO-PRIMARY (0.5)

REFERENCE
NCSU, Ops Manual, pp. 5-8 and 5-17

ANSWER J.03 (1.50)

a. TRUE (0.5)
b. FALSE (0.5)
c. FALSE (0.5)

REFERENCE
NCSU, PDS, Vol. II, pp. 4 & 13 and Ops Manual, Sections 3 & 5

ANSWER J.04 (.50)

FALSE (0.5)

REFERENCE
NCSU, PDS, Vol. II, p. 11

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ANSWER J.05 (2.00)

a. THE SAME AS (0.5)
b. HIGHER THAN (0.5)
c. THE SAME AS (0.5)
d. THE SAME AS (0.5)

REFERENCE
NCSU, PDS, Vol. II, p. 11

ANSWER J.06 (.50)

150 pcm (+/- 15 pcm) (0.5)

REFERENCE
NCSU, PDS, Vol. II, p. 11

~~ANSWER J.07 (2.50)~~ deleted

Any FIVE at 0.5 points each
1. 5x5 Reflected Core #3
2. Control rods banked, pulse rod at 24.0 inches
3. NRF installed
4. BT plugged and filled
5. Pool temperature < 110 degrees F
6. Latest rod gang worth
7. PGU installed
8. Less xenon than peak after 8 hours at 1.0 Mw

REFERENCE
~~NCSU, PDS, Vol. II, p. 13~~

ANSWER J.08 (1.50)

a. 1. Safety Power Channel (0.5)
   2. Linear Power Channel (0.5)
b. During pulsing (0.5)

ANSWERS -- NORTH CAROLINA STATE UNIV.-86/04/24-JERRY DOUGLAS

REFERENCE
NCSU, Ops Manual, p. 4-18

ANSWER J.09 (1.00)

A pneumatic signal (proportional to temperature) (0.5) positions the three-way mixing valve to direct more flow to the cooling tower (less directly to suction of pump) (0.5) (1.0)

REFERENCE
NCSU, Ops Manual, p. 5-16

ANSWER J.10 (1.00)

LESS THAN (0.5) due to rod shadowing (0.5) (1.0)

REFERENCE
NSCU, FOS, Vol. II, p. 4

ANSWER J.11 (1.00)

Power level will increase (0.7) due to primary pump circulating cooler (than water in core) pool water through core (0.3). (1.0)

REFERENCE
CAF

ANSWER J.12 (2.00)

1. HIGH - High flow indication (0.25), Low Flow reactor scram (0.25) at 23 psi regulator output (0.25) if > 150 kW (0.25) (1.0)
2. LOW - Low flow indication (0.25), Low Flow reactor scram (0.25) at 475 gpm (0.25) if > 150 kW (0.25) (1.0)

REFERENCE
NCSU, Ops Manual, pp. 4-12 & 19

ANSWERS -- NORTH CAROLINA STATE UNIV.-86/04/24-JERRY DOUGLAS

ANSWER J.13 (1.50)

When the primary pump is lost, flapper falls open (0.5) establishing a path for natural circulation (0.5). The core heat is transferred to the pool water and dissipated to the bay atmosphere at the pool surface (0.5). (1.5)

REFERENCE
NCSU, Ops Manual, p. 1-6

ANSWER J.14 (2.50)

(0.25 points for value, 0.25 points for sign)

a. -19.5 pcm (+/- 2 pcm) (-3.9 x 5) (0.5)
b. +99 pcm (+/- 5 pcm) (-330 x -.3) (0.5)
c. -16 pcm (+/- 2 pcm) (0.5)
d. +9 pcm (+/- 1 pcm) (0.5)
e. -35 pcm (+/- 3 pcm) (0.5)

REFERENCE
NCSU, PDS, Vol. II, pp. 15 and 16

ANSWERS -- NORTH CAROLINA STATE UNIV.-86/04/24-JERRY DOUGLAS

ANSWER K.01 (1.00)

c

REFERENCE
General Physics, HT & FF, pp. 239 and 240

ANSWER K.02 (1.00)

b

REFERENCE
VEGP, Training Text, Vol. 9, p. 21-17

ANSWER K.03 (1.00)

b

REFERENCE
NUS, Reactor Theory

ANSWER K.04 (1.00)

c

REFERENCE
Westinghouse Nuclear Training Operations, pp. I-4.19 - 21

ANSWER K.05 (1.00)

d

REFERENCE
NCSU, PDS, Vol. II, p. 4

ANSWER K.06 (1.00)

d

ANSWERS -- NORTH CAROLINA STATE UNIV.-86/04/24-JERRY DOUGLAS

REFERENCE
NCSU, Ops Manual, p. 3-36

ANSWER K.07 (1.00)

a

REFERENCE
NCSU, TS, p. 9

ANSWER K.08 (1.00)

d

REFERENCE
NUS, Vol 4, pp 3.3-2
Turkey Point, Thermal-Hydraulic Principles and Applications, pp. 13-17 - 20

ANSWER K.09 (1.00)

b

REFERENCE
Westinghouse Reactor Physics, pp. I-4.19 - 24
DPC, Fundamentals of Nuclear Reactor Engineering, pp. 120 - 129

ANSWER K.10 (2.00)

a. FALSE (0.5)
b. FALSE (0.5)
c. FALSE (0.5)
d. FALSE (0.5)

REFERENCE
NCSU, Special Procedure 3.2, pp. 1 - 3

ANSWERS -- NORTH CAROLINA STATE UNIV.-86/04/24-JERRY DOUGLAS

ANSWER K.11 (1.50)

a. DECREASE (0.5)
b. DECREASE (0.5)
c. DECREASE (0.5)

REFERENCE
NCSU, PDS, Vol. II, p. 29

ANSWER K.12 (1.00)

1. Uranium Dioxide (0.5)
2. Ziracoly (0.5)

REFERENCE
NCSU, Ops Manual, p. 1-3

ANSWER K.13 (1.00)

1. Postioned at least 400 pcm below ECP (0.5)
2. Positoned at least 400 pcm withdrawn (0.5)

REFERENCE
NCSU, Special Procedure 3.2, p. 1

ANSWER K.14 (1.50)

1. Fuel assembly in transit stored in recorded location (0.5)
2. Fuel handling tool disconnected from fuel (0.5)
3. Evacuate Reactor Bay (0.5)

REFERENCE
NSCU, Special Procedure 3.2, p. 1

ANSWERS -- NORTH CAROLINA STATE UNIV.-86/04/24-JERRY DOUGLAS

ANSWER K.15 (1.00)

1. Keff less than 0.8 (0.5)
2. Temperature less than 90 degrees C (0.5)

REFERENCE
NCSU, TS, p. 35

ANSWER K.16 (1.00)

1. 3 fixed area monitors (West Wall, Over-the-Pool, VAMP, or Control Room) (0.2 points each) (0.6)
2. Stack Particulate (0.2)
3. Stack Gas (0.2)

REFERENCE
NCSU, TS, p. 22

ANSWER K.17 (2.00)

Delta Tave = 13.8/2 = 6.9 degrees F (0.5)
pcm (Delta Tave) = 6.9 x -3.9 = -27 pcm (0.5)
pcm (Delta Tfuel) = -330 - -27 = -303 pcm (0.5)
Delta Tfuel = -303/-1.6 = 189 degrees F (0.5)

REFERENCE
NCSU, PDS, Vol. II, p. 15

ANSWERS -- NORTH CAROLINA STATE UNIV.-86/04/24-JERRY DOUGLAS

ANSWER L.01 (1.00)

b

REFERENCE
NCSU, TS, p. 24

ANSWER L.02 (1.00)

a. TRUE (0.5)
b. TRUE (0.5)

REFERENCE
10CFR55.41 and 10CFR55.31(e)

ANSWER L.03 (1.50)

1. a (0.25)
2. b (0.25)
3. b (0.25)
4. b (0.25)
5. e (0.25)
6. e (0.25)

REFERENCE
NCSU, Ops Manual, pp. 2-25 & 26 and 3-36

ANSWER L.04 (2.00)

1. DSRO (0.3) - May be on call (0.2) (0.5)
2. RO (0.3) - At the facility (0.2) (0.5)
3. ROA (0.3) - At the facility (0.2) (0.5)
4. RHP (0.3) - May be on call (0.2) (0.5)

REFERENCE
NCSU, Ops Manual, pp. 2-4 & 5

ANSWERS -- NORTH CAROLINA STATE UNIV.-86/04/24-JERRY DOUGLAS

ANSWER L.05 (1.00)

1. Less than one minute in duration (0.5)
2. Reactor in "Auto" (0.25) or rods seated (0.25) (0.5)

REFERENCE
NCSU, Ops Manual, p. 2-6

ANSWER L.06 (2.00)

a. Licensed operators (0.25) and ROAs (0.25) (0.5)
b. CRM (0.25) or RS (0.25) (0.5)
c. Initiator (0.25) or SRO (0.25) (0.5)
d. RED (0.5)

REFERENCE
NCSU, Ops Manual, pp. 2-17 & 18

ANSWER L.07 (1.00)

1. Second person present (0.2)
2. Tools insulated (0.2)
3. Safety glasses (0.2)
4. Work with one hand (0.2)
5. Insulated work mat (0.2)

REFERENCE
NCSU, Ops Manual, p. 2-19

ANSWER L.08 (1.50)

1. Power (0.3) - 3.8 MW (0.2) (0.5)
2. Level (0.3) - 14 feet above top of core (0.2) (0.5)
3. Inlet Temperature (0.3) - 120 degrees F (0.2) (0.5)

REFERENCE
NCSU, TS, p. 5

ANSWERS -- NORTH CAROLINA STATE UNIV.-86/04/24-JERRY DOUGLAS

ANSWER L.09 (1.50)

a. 1720 pcm (0.5)
b. 300 pcm (0.5)
c. 100 pcm/sec (0.5)

REFERENCE
NCSU, TS, p. 14

ANSWER L.10 (.50)

Reactor Safeguards Advisory Group (RSAG) (0.5)

REFERENCE
NCSU, TS, p. 40

ANSWER L.11 (1.50)

1. ACP not within 200 pcm of ECP (0.5)
2. Unanticipated change (100 pcm) in reactivity (0.5)
3. Significant variation in reactivity value of experiment (0.5)

REFERENCE
NCSU, Ops Manual, p. 3-56

ANSWER L.12 (1.00)

1. Reactor shutdown (0.25)
2. Magnet power off (0.2) and key removed (0.05) (0.25)
3. Flapper open (0.1), or, when closed, primary pump operating at 500 gpm (0.15) (0.25)
4. No work involving fuel (0.1), in-core experiments (0.05), or rods (0.1) (0.25)

REFERENCE
NCSU, TS, p. 1

ANSWERS -- NORTH CAROLINA STATE UNIV.-86/04/24-JERRY DOUGLAS

ANSWER L.13 (2.00)

1. Do not change original intent (0.4)
2. Approved by NOA (AD) prior to implementation (0.4)
3. Log of Temporary Changes in Operations Manual (0.4)
4. Maximum use of two months (0.4)
5. Submitted to RPC within two months (0.4)

REFERENCE
NCSU, Ops Manual, p. 2-12

ANSWER L.14 (1.00)

Minimize N-16 release (0.7) aided by steam bubble rise during upflow during natural convection (0.3) (1.0)

REFERENCE
NCSU, TS, p. 11

ANSWER L.15 (1.50)

(Any THREE at 0.5 points each)
1. SSS less conservative than LSSS
2. Violation of LCO
3. Incident which prevented (or could have) intended safety function of ESF or RSS
4. Release of fission products from fuel
5. Uncontrolled or unanticipated change in reactivity
6. Inadequacy of procedural controls

REFERENCE
NCSU, TS, p. 2

QUESTION	VALUE	REFERENCE
H.01	1.00	WGD0000192
H.02	1.00	WGD0000515
H.03	1.00	WGD0000518
H.04	1.00	WGD0000519
H.05	1.00	WGD0000520
H.06	1.00	WGD0000561
H.07	1.00	WGD0000599
H.08	1.00	WGD0000665
H.09	1.00	WGD0000668
H.10	1.00	WGD0000883
H.11	1.00	WGD0000976
H.12	1.00	WGD0001026
H.13	1.00	WGD0001027
H.14	1.00	WGD0001028
H.15	1.00	WGD0001029
H.16	1.50	WGD0000660
H.17	2.00	WGD0000659
H.18	1.50	WGD0000418
	20.00	
I.01	1.00	WGD0000647
I.02	1.00	WGD0000648
I.03	1.00	WGD0000892
I.04	1.00	WGD0000893
I.05	1.00	WGD0000895
I.06	1.00	WGD0000896
I.07	1.00	WGD0001032
I.08	2.00	WGD0000891
I.09	1.50	WGD0000894
I.10	1.50	WGD0000897
I.11	1.50	WGD0000900
I.12	.50	WGD0001030
I.13	2.00	WGD0001031
I.14	.50	WGD0001033
I.15	1.00	WGD0001034
I.16	1.50	WGD0001035
I.17	1.00	WGD0001036
	20.00	
J.01	1.00	WGD0000957
J.02	1.50	WGD0000959
J.03	1.50	WGD0000977
J.04	.50	WGD0001037
J.05	2.00	WGD0000974
J.06	.50	WGD0000970
J.07	2.50	WGD0000971
J.08	1.50	WGD0000987
J.09	1.00	WGD0000960

QUESTION	VALUE	REFERENCE
J.10	1.00	WGD0000969
J.11	1.00	WGD0000975
J.12	2.00	WGD0000982
J.13	1.50	WGD0000997
J.14	2.50	WGD0000972
	20.00	
K.01	1.00	WGD0001048
K.02	1.00	WGD0000101
K.03	1.00	WGD0000517
K.04	1.00	WGD0000663
K.05	1.00	WGD0001043
K.06	1.00	WGD0001044
K.07	1.00	WGD0001047
K.08	1.00	WGD0001049
K.09	1.00	WGD0001050
K.10	2.00	WGD0001040
K.11	1.50	WGD0001046
K.12	1.00	WGD0000956
K.13	1.00	WGD0001038
K.14	1.50	WGD0001039
K.15	1.00	WGD0001041
K.16	1.00	WGD0001042
K.17	2.00	WGD0001045
	20.00	
L.01	1.00	WGD0001060
L.02	1.00	WGD0001065
L.03	1.50	WGD0001056
L.04	2.00	WGD0001051
L.05	1.00	WGD0001052
L.06	2.00	WGD0001054
L.07	1.00	WGD0001055
L.08	1.50	WGD0001057
L.09	1.50	WGD0001059
L.10	.50	WGD0001061
L.11	1.50	WGD0001062
L.12	1.00	WGD0001063
L.13	2.00	WGD0001053
L.14	1.00	WGD0001058
L.15	1.50	WGD0001064
	20.00	
	100.00	