ENCLOSURE 2

PENNSTATE

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College of Engineering

Radiation Science and Engineering Center

Breazeale Nuclear Reactor Building
The Pennsylvania State University
University Park, PA 16802

March 27, 1991

Nuclear Regulatory Commission
Attention: Dave Silk
475 Allendale Road
King of Prussia, Pa. 19406

Dear Sir:

The Penn State Breazeale Reactor would like to make the following comments concerning the Reactor Operator Written Exam given to Pat Boyle by you on March 25, 1991.

C. Plant and Radiation Monitoring Systems - Question #19

Which one of the following instruments monitors the radiation level at the primary pool water surface? NRC answer is c. - A GM tube attached to the bridge section at the primary tank top. NRC reference is PSU TRIGA MARK II General Characteristics Section 7.A.2., a document not submitted by PSU as training material.

Facility comment - The above reference document was probably prepared by General Atomics, the Triga manufacturer, 25 years ago and is not a current document. The present monitoring on the reactor bridge consists of ion chambers. So the correct answer is b. - An ion chamber attached to the bridge section at the primary tank top. PSU reference is section 4.14 of the training manual submitted to the NRC for exam preparation.

C. Plant and Radiation Monitoring Systems - Question #20

While performing experiment 39, Bath Coefficient of Reactivity, primary coolant temperature has been reduced to 7 degrees C. Which one of the following methods is used to increase the temperature? NRC answer is d. - Use underwater light and heat from the pumps. NRC reference is PSU TRIGA MARK II General Characteristics Section 7.A.2., a document not submitted by PSU as training material.

Facility comment - The above reference document was probably prepared by General Atomics, the Triga manufacturer, 25 years ago and is not a current document. Penn State requests that this question be removed from the exam, since there is not reason to expect that the license candidate would have knowledge of this experiment. It should be noted that the training manager, who has worked at the Penn State Breazeale Reactor for 23 years, has no knowledge of this experiment.

Operating Test

During the operating test the examiner had the license candidate use procedure EP-4, Loss of Pool Water, section C.2. on page 3, to show how to provide pool water fill using university water through the demineralizer. During this exercise, the candidate was unable to locate valves 33, 34, and 39. The reactor staff has determined that these valves no longer exist; they were in service at one time as a part of a fission product monitor system that is no longer in service. The necessary changes will be made to procedure EP-4.

Sincerely,

Marcus Voth
Facility Director

NRC RESOLUTIONS TO FACILITY WRITTEN EXAMINATION COMMENTS

Question #	Resolution
C.19	Based upon the PSU reference, Section 4.14 of the training manual, the NRC will accept choice "b." instead of "c." as the correct response.
C.20	Due to the fact that the reference cited is no longer current or applicable, the NRC will delete this question from the examination.

ENCLOSURE 3

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

FACILITY: Pennsylvania State Univ.

REACTOR TYPE: TRIGA III

DATE ADMINISTERED: 91/03/25

REGION: 1

CANDIDATE: Master Copy

LICENSE APPLIED FOR: Reactor Operator

INSTRUCTIONS TO CANDIDATE:

Answers are to be written on the exam page itself, or the answer sheet provided. Write answers one side ONLY. Attach any answer sheets to the examination. Points for each question are indicated in parentheses for each question. A 70% in each section 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	~~33.33~~ ~~32.79~~ 03			A. REACTOR THEORY, THERMODYNAMICS AND FACILITY OPERATING CHARACTERISTICS
21.00	~~35.00~~ ~~34.42~~ 03			B. NORMAL AND EMERGENCY OPERATING PROCEDURES AND RADIOLOGICAL CONTROLS
~~19.00~~ ~~20.00~~ 03	31.67 ~~32.79~~ 03			C. PLANT AND RADIATION MONITORING SYSTEMS
~~60.00~~ ~~61.00~~ 03				TOTALS
		FINAL GRADE	%	

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

Candidate's Signature

NRC RULES AND GUIDELINES FOR LICENSE EXAMINATIONS

During the administration of this examination the following rules apply:

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

2. After the examination has been completed, you must sign the statement on the cover sheet indicating that the work is your own and you have not received or given assistance in completing the examination. This must be done after you complete the examination.

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

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

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

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

7. You may write your answers on the examination question page or on a separate sheet of paper. USE ONLY THE PAPER PROVIDED AND DO NOT WRITE ON THE BACK SIDE OF THE PAGE.

8. If you write your answers on the examination question page and you need more space to answer a specific question, use a separate sheet of the paper provided and insert it directly after the specific question. DO NOT WRITE ON THE BACK SIDE OF THE EXAMINATION QUESTION PAGE.

9. Print your name in the upper right-hand corner of the first page of each section of your answer sheets whether you use the examination question pages or separate sheets of paper. Initial each page.

10. Before you turn in your examination, consecutively number each answer sheet, including any additional pages inserted when writing your answers on the examination question page.

11. If you are using separate sheets, number each answer as to category and number (i.e. Plant Systems # 04, EPE # 10) and skip at least 3 lines between answers to allow space for grading.

12. Write "End of Category" at the end of your answers to a category.

13. Start each category on a new page.

14. Write "Last Page" on the last answer sheet.

15. Use abbreviations only if they are commonly used in facility literature. Avoid using symbols such as < or > signs to avoid a simple transposition error resulting in an incorrect answer. Write it out.

16. The point value for each question is indicated in parentheses after the question. The amount of blank space on an examination question page is NOT an indication of the depth of answer required.

17. Show all calculations, methods, or assumptions used to obtain an answer.

18. Partial credit may be given. Therefore, ANSWER ALL PARTS OF THE QUESTION AND DO NOT LEAVE ANY ANSWER BLANK. NOTE: partial credit will NOT be given on multiple choice questions.

19. Proportional grading will be applied. Any additional wrong information that is provided may count against you. For example, if a question is worth one point and asks for four responses, each of which is worth 0.25 points, and you give five responses, each of your responses will be worth 0.20 points. If one of your five responses is incorrect, 0.20 will be deducted and your total credit for that question will be 0.80 instead of 1.00 even though you got the four correct answers.

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

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

22. To pass the examination, you must achieve at least 70% in each category.

23. There is a time limit of (3) hours for completion of the examination. (or some other time if less than the full examination is taken.)

24. When you are done and have turned in your examination, leave the examination area as defined by the examiner. If you are found in this area while the examination is still in progress, your license may be denied or revoked.

EQUATION SHEET

$f = ma$

$w = mg$

$v = s/t$

$s = V_o t + \frac{1}{2} at^2$

$a = (V_f - V_o)/t$

$V_f = V_o + at$

$E = mc^2$

$KE = \frac{1}{2} mv^2$

$PE = mgh$

$w = \theta/t$

$W = \nu \Delta P$

$A = (\Pi D^2)/4$

$\Delta E = 931\ \Delta m$

$\dot{m} = V_{av} A \varphi$

$\dot{Q} = \dot{m} C_p \Delta t$

$\dot{Q} = UA\Delta t$

$Pwr = W_f \Delta h$

$P = P_o 10^{sur(t)}$

$P = P_o e^{t/T}$

$SUR = 26.06/T$

$SUR = 26\varphi/\ell^* + (\beta - \varphi)T$

$T = \ell/(\varphi - \beta)$

$\varphi = (k_{eff}^{-1})/K_{eff} = \Delta K_{eff}/K_{eff}$

$\varphi = [(\ell^*/(T\ K_{eff})] + [\bar{\beta}_{eff}/(1 + \bar{\lambda}T)]$

$P = (\Sigma \phi V)/(3 \times 10^{10})$

$\Sigma = \delta N$

$A = \lambda N$

$A = A_o e^{-\lambda t}$

$\lambda = \ln 2/t_{\frac{1}{2}} = 0.693/t_{\frac{1}{2}}$

$I = I_o e^{-\Sigma x}$

$I = I_o e^{-\mu x}$

$I = I_o\ 10^{-x/TVL}$

$TVL = 1.3/\mu$

$HVL = -0.693/\mu$

$SCR = S/(1 - K_{eff})$

$CR_x = S/(1 - K_{effx})$

$CR_1(1 - K_{eff1}) = CR_2(1 - K_{eff2})$

$M = 1/(1 - K_{eff}) = CR_1/CR_o$

$M = (1 - K_{effo})/(1 - K_{eff1})$

$SDM = (1 - K_{eff})/Keff$

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

$\bar{\lambda} = 0.1$ seconds^{-1}

$I_1 d_1 = I_2 d_2$

$I_1 d_1^2 = I_2 d_2^2$

$R/hr = (0.5\ CE)/d^2$ (meters)

$R/hr = 6\ CE/d^2$ (feet)

$T = (\ell^*/\varphi) + [(\beta - \varphi)/\bar{\lambda}\varphi]$

$T = (\beta - \varphi)/(\bar{\lambda}\varphi)$

Cycle efficiency = (Net work out)/(Energy in)

Water Parameters

1 gal. = 8.345 lbm.

1 gal. = 3.78 liters

1 ft^3 = 7.48 gal.

Density = 62.4 lbm/ft^3

Density = 1 gm/cm^3

Heat of vaporization = 970 Btu/lbm

Heat of fusion = 144 Btu/lbm

1 Atm = 14.7 psi = 29.9 in Hg.

1 ft. H_2O = 0.4335 lbf/in.

Miscellaneous Conversions

1 Curie = 3.7×10^{10} dps

1 kg = 2.21 lbm

1 hp = 2.54×10^3 Btu/hr

1 mw = 3.41×10^6 Btu/hr

1 in = 2.54 cm

°F = 9/5°C + 32

°C = 5/9(°F - 32)

1 Btu = 778 ft-lbf

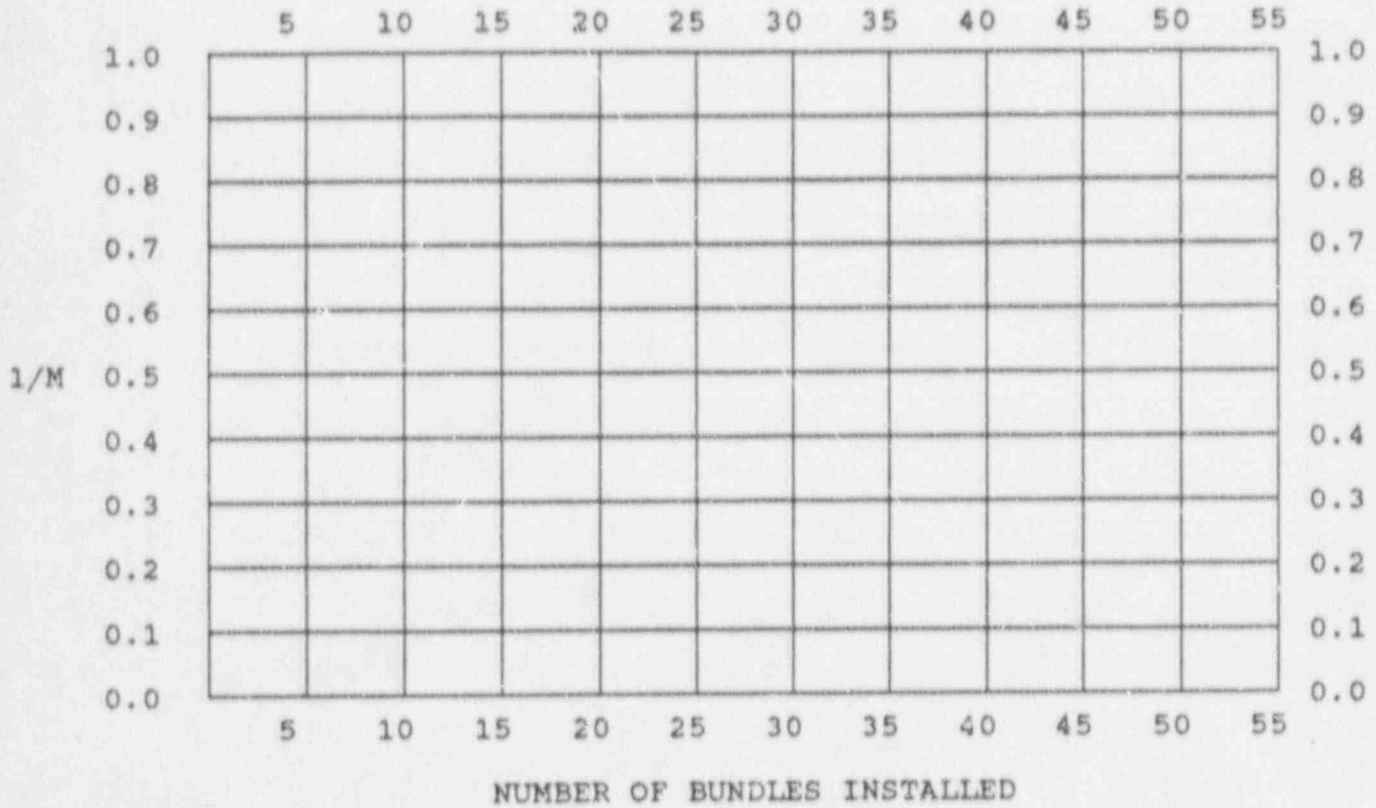
5 10 15 20 25 30 35 40 45 50 55
1.0
0.9
0.8
0.7
0.6
1/M 0.5
0.4
0.3
0.2
0.1
0.0
NUMBER OF BUNDLES INSTALLED

Figure 1

QUESTION: 001 (1.00)

A complete core load is in progress at PSBR. The following data has been taken.

Number of Elements Installed	Detector A (cpm)	Detector B (cpm)
0	16	30
12	22	32
24	29	37
36	48	60
42	70	140

Using the inverse count rate figure # 1 provided, determine which of the following is the approximate number of fuel elements that will be required to be loaded for a critical mass.

a. 45

b. 50

c. 55

d. 60

QUESTION: 002 (1.00)

Which one of the following changes in the PSBR reactor would result in less fuel being required to take the reactor critical?

a. Moving the reactor closer to the Deuterium tank

b. Placing graphite reflectors in positions around the core

c. Replacing the graphite on the end of the fuel elements with stainless steel

d. Decreasing the fuel volume to surface area of the core

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

QUESTION: 003 (1.00)

Which one of the following is the design feature of the PSBR reactor that is the MAJOR contributor to the large prompt negative temperature coefficient.

a. Doppler effect. The increased energy of the U-238 atoms causes a broadening of the resonance peaks

b. Core leakage. As the moderator heats up there are more neutrons a higher energies causing increased core leakage

c. Zirconium absorption. As the zirconium heats up its resonance absorption cross section increases causing more neutron absorption

d. Cell effect. As the fuel heats up the neutron energy loss increases due to hydrogen atoms in the Zirconium hydride fuel mixture

QUESTION: 004 (1.00)

In the subcritical range of start-up, the reactor operator observes an increase in neutron population on the log count rate recorder, but notices there is not a corresponding indication on the period meter.
Which one of the following explains this response?

a. The compensating voltage on the Linear channel is set too low and thus is not reflecting counts and period

b. The gamma-to-neutron ratio is so high that count rate must be increased significantly before there is any period indication

c. The fission chamber is in saturation and therefore not producing a period indication

d. The flux level during the subcritical range of startup is not high enough to register an indication on the log N channel.

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

QUESTION: 005 (1.00)

A pulse is only allowed from below a certain power level. Which one of the following is the primary concern which requires this limitation?

a. Fuel temperature could exceed the design values for the fuel elements

b. Power level could peak at a value higher than the Technical Specification maximum value

c. The power excursion could exceed the capability of the control rods to terminate the power rise

d. A high power pulse could cause damage to the graphite boron carbide in the control rods

QUESTION: 006 (1.00)

Which one of the following is the ideal arrangement of the detector, neutron source, and the fuel being added for a critical mass experiment?

a. The neutron source should be between the fuel being added and the detector

b. The detector should be between the fuel being added and the source

c. The fuel being added should be between the source and the detector

d. The source should be located 90 degrees from a line of sight between the fuel and the detector

QUESTION: 007 (1.00)

Which one of the following best describes the relative control rod worths?

a. The regulating rod is worth more than the transient rod

b. The shim rod is worth twice as much as the regulating rod

c. The safety rod and the shim rod have approximately equal worths

d. The safety rod is worth much more than the regulating rod or the shim rod

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

QUESTION: 008 (1.00)

Which one of the following is the approximate power level at which the fuel negative temperature coefficient becomes significant for the Penn State reactor?

a. 0.5 KW

b. 1 KW

c. 10 KW

d. 50 KW

QUESTION: 009 (1.00)

While the reactor is operating in the automatic mode at 800 kW, the fuel temperature increases from 400 to 405 degrees C. Assume the temperature coefficient for the reactor is -1.4 EE-4 delta k/k/degrees C, and the regulating rod is worth 0.1% delta k/k/inch.
Which one of the following describes the regulating rod movement?
ASSUME none of the other control rods move.

a. 0.35 inches Out

b. 0.35 inches In

c. 0.70 inches Out

d. 0.70 inches In

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

QUESTION: 010 (1.00)

Which one of the following is classified as a high or medium "Z" material for shielding?

a. Cadmium

b. Polyethylene

c. Steel

d. Masonite

QUESTION: 011 (1.00)

Assume that the primary cooling system heat exchanger had a significant buildup of corrosion products and deposits on the INSIDE of the tubes. (Assume flow through the heat exchanger is held constant.) Which one of the following would be the effect on the differential temperature and the pressure drop of the fluid flow through the tubes as compared to a clean exchanger?

a. The delta-T would increase and the pressure drop would increase

b. The delta-T would decrease and the pressure drop would decrease

c. The delta-T would increase and the pressure drop would decrease

d. The delta-T would decrease and the pressure drop would increase

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

QUESTION: 012 (1.00)

With the reactor critical at 30 watts, the reactor operator withdraws the regulating rod a small amount. As power increases, an initial doubling time (DT) of 24 seconds is recorded. (Assume a lambda of 0.1 sec-1) Which one of the following is the reactivity added to the core by the reactor operator?

a. 0.14% delta K/K

b. 0.16% delta K/K

c. 0.18% delta K/K

d. 0.20% delta K/K

QUESTION: 013 (1.00)

Two different neutron sources are used during two reactor startups. The neutron source used in the first startup emits twice as many neutrons as the neutron source used in the second startup.
Which one of the following compares the reactor response for the two startups? (Assume all other core parameters for the two startups are equal).

a. Both startups will have the same power levels for any given reactivity addition but the critical rod position for the first startup will be lower

b. Both startups will have the same power levels for any given reactivity addition, but the critical rod position for the first startup will be higher

c. The first startup will have a higher power level for any given reactivity addition, but the critical rod positions will be the same for both startups

d. The first startup will have a lower power level for any given reactivity addition, but the critical rod positions will be the same for both startups

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

QUESTION: 014 (1.00)

A 10 curie Cobalt 60 source has been dropped from its cask.

Which one of the following is the amount of lead shielding required to prevent an individual from receiving 100 mrem in 2.5 hours 3 feet from the source?
(Consider a point source and two gamma's of 1.17 and 1.33 Mev and the linear attenuation for lead to be 0.516 cm-1)

a. 1.7 inches

b. 4.6 inches

c. 7.8 inches

d. 11.7 inches

QUESTION: 015 (1.00)

Which one of the following statements describes Xenon poisoning in the reactor?

a. The equilibrium level of Xenon in the reactor is INDEPENDENT of the reactor power but DEPENDENT on the length of time at a specific power level

b. If the reactor scrams following prolonged operation at rated power Xenon concentration peaks in approximately 10 hours and then decays to zero

c. During a reactor startup five (5) hours after a scram from power, rod insertion will be required between criticality and the point of adding heat to maintain a steady period

d. Immediately after an increase to 100% power following prolonged operation at 50% power, power level will decrease with no operator or automatic action

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

QUESTION: 016 (1.00)

Which one of the following is the major disadvantage of using Boron 10 as an absorber in the PSBR control rods?

a. Boron 10 has a high burnout rate which rapidly reduces control rod worth when exposed to a thermal neutron flux

b. Boron 10 is not readily machinable, and therefore difficult to fabricate as part of the control rod assembly

c. Even mixing of the Boron 10 with the graphite in the control rod is difficult and expensive

d. Boron 10 emits helium gas when irradiated with thermal neutrons which builds up pressure inside the control rod

QUESTION: 017 (1.00)

Reactor power has increased from 100 watts to 150 KW on a stable reactor period in 247 seconds.
Which one of the following was the stable reactor period which resulted in the power change?

a. 28 seconds

b. 34 seconds

c. 42 seconds

d. 55 seconds

QUESTION: 018 (1.00)

Which of the following are the properties of a good moderator?

a. Low scattering cross section and low absorption cross section

b. Low scattering cross section and high absorption cross section

c. High scattering cross section and low absorption cross section

d. High scattering cross section and high absorption cross section

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

QUESTION: 019 (1.00)

Which one of the following produces the major portion of the energy released during the fission process?

a. Kinetic energy of the fission products

b. Fission product decay

c. Fast neutrons

d. Prompt gamma rays

QUESTION: 020 (1.00)

Which one of the following describes the interaction of a gamma ray with an atom resulting in pair production?

a. A gamma ray imparts its energy to an orbital electron of an atom resulting in a free electron and an excited nucleus

b. A gamma ray imparts its energy to an orbital electron resulting in the formation of a free electron and a free positron

c. A gamma ray is absorbed by the nucleus of an atom resulting in the formation of a free electron and a free positron

d. A gamma ray is absorbed by the nucleus of an atom resulting in the ejection of a proton and a neutron

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

QUESTION: 001 (1.00)

Which one of the following is the maximum dose that can be authorized by the Emergency Director for emergency team members during life saving actions?

a. 25 rem

b. 50 rem

c. 75 rem

d. 100 rem

QUESTION: 002 (1.00)

Which one of the following is a correct statement concerning the results of the application of the inverse square law with respect to dose rate calculations?

a. For distances that are relatively close to the source, application of the inverse square law may give a dose rate HIGHER than actual because the source will show characteristics of a plane source

b. For distances that are especially far from the source, application of the inverse square law may give a dose rate LOWER than actual because the inverse square law does not include a factor for discounting background radiation

c. For distances that are relatively close to the source, application of the inverse square law may give a dose rate HIGHER than actual since it does not include a factor for detector geometry

d. For distances that are especially far from the source, application of the inverse square law may give a dose rate HIGHER than actual because the inverse square law does not include a factor for attenuation in air

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

QUESTION: 003 (1.00)

Which one of the following is the Technical Specification requirement for irradiated fuel storage?

a. Stored in an array which assures that Keff is less than 0.8 and fuel temperature remains less than 1150 deg C

b. Stored in an array which assures a Keff of less than 0.85 but in no case less than six (6) inches center to center

c. Stored in an array which assures a Keff of less than 0.9 and fuel temperature remains less than 900 deg C

d. Stored in an array which assures a Keff of less than 0.95 but in no case less than nine (9) inches center to center

QUESTION: 004 (1.00)

Which one of the following is the maximum allowable reactor pool water conductivity during power operation in accordance with the PSBR Technical Specifications?

a. 0.1 micromhos/cm

b. 1.0 micromhos/cm

c. 5.0 micromhos/cm

d. 10.0 micromhos/cm

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

QUESTION: 005 (2.00)

For each measuring channel listed in Column I SELECT the operational mode in which it is required from Column II. (Each operational mode in Column II may be used once, more than once or not at all. Only one answer may occupy each answer space)

(Four answers required at 0.50 each)

	COLUMN I MEASURING CHANNEL		COLUMN II OPERATIONAL MODE
_____a	Fuel Element Temperature	1	Pulse Mode
_____b	Linear Power	2	Square Wave Mode
_____c	Log Power	3	Manual and Automatic Modes
_____d	Count Rate	4	Pulse and Square Wave Modes
		5	Square Wave, Manual and Automatic Modes
		6	Square Wave, Pulse Manual and Automatic Modes

QUESTION: 006 (1.00)

Which one of the following is the maximum pulse reactivity insertion for demonstration and training purposes as per SOP-1?

a. $1.00 (0.0072 delta-K/K)

b. $1.50 (0.010 delta-K/K)

c. $2.00 (0.014 delta-K/K)

d. $2.50 (0.018 delta-K/K)

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

QUESTION: 007 (1.00)

Which one of the following is the definition of a "MOVABLE EXPERIMENT" in accordance with SOP-5, Experiment Evaluation and Authorization?

a. An experiment which may be removed from a beamport, extension tube or thermal column while the reactor is operating

b. An experiment which may be moved in or near the core or into and out of the reactor while the reactor is operating

c. An experiment with positive reactivity which may be removed from the core while the reactor is operating

d. An experiment with negative reactivity of less than 0.28% delta K/K which may be moved into or out of the core with the reactor operating

QUESTION: 008 (1.00)

Upon removal of an experiment from the Breazeale Reactor, radiation readings indicate 12 Rem/hr at one (1) foot from the experiment. Two (2) hours later a reading of 9.8 Rem/hr is recorded at one (1) foot. If the experiment has to be less than 10 mrem/hr at one (1) foot to be worked on, which one of the following is the total length of time after removal before it can be worked?

a. 7 hours

b. 22 hours

c. 37 hours

d. 70 hours

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

QUESTION: 009 (1.00)

Which one of the following is the quarterly radiation exposure limit for an individual with a completed NRC Form 4, in accordance with 10CFR20?

a. 0.30 REM

b. 1.25 REM

c. 3.0 REM

d. 5.0 REM

QUESTION: 010 (1.00)

Which one of the following accurately describes the method used for calculating the power calibration for the new fuel load?

a. Stabilize reactor power at 500 KW and make six (6) consecutive hourly readings of the delta T across the secondary heat exchanger

b. Stabilize reactor power at 1 MW and compare the average pool temperature to the previous core loading temperature at 1 MW

c. Take the average pool temperature increase per hour at a stable reactor power and compare to data taken experimentally by heating the pool with the heat exchanger

d. Take the average pool temperature increase per hour at a stable reactor power and determine the rod withdrawal necessary to maintain reactor power

QUESTION: 011 (1.00)

Which of the following is one of the actions that the reactor operator is required to take according to SOP-9, "Pneumatic Transfer Systems Operation" if a damaged Rabbit I capsule is returned from the reactor core?

a. Close the Carbon Dioxide (CO2) supply valve to the pneumatic tube

b. Turn the FAN ON or FIRE PERMIT switch to the ON position

c. Begin an immediate shutdown of the reactor

d. Immediately scram the reactor

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

QUESTION: 012 (1.00)

Which one of the following radiation emitters would result in the highest dose to an individual if taken internally?

a. 50 milirad Beta

b. 100 milirad Gamma

c. 100 milirad thermal neutrons

d. 35 milirad Alpha

QUESTION: 013 (1.00)

Which one of the following operating conditions is required for the removal of the reactor emergency exhaust system from service for maintenance, in accordance with PSBR Administrative Procedure AP-5?

a. If the system is going to be inoperable for more than one (1) hour the reactor shall be shutdown and placed in the STANDBY mode

b. Reactor operation may continue provided the emergency exhaust system is returned to service within 48 hours

c. Reactor operation may continue provided the facility exhaust system is operable and operating

d. Reactor operation may continue provided the Continuous Air Monitor (CAM) shows no indication of increased air activity

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

QUESTION: 014 (1.00)

Paper towels and waste from cleanup of an experiment after irradiation are placed in a radioactive waste container.
Which one of the following activity levels would NOT require labeling the container with the isotope, activity and date?

a. One (1) microcurie or greater with a half life of one (1) day or greater

b. Ten (10) microcuries or greater with a half life of one (1) day or greater

c. One (1) microcurie or greater with a half life of less than 1/2 day

d. Ten (10) microcuries or greater with a half life of less than 1/2 day

QUESTION: 015 (1.00)

An experiment that will not react with water is to be irradiated in a polyethylene bag in the core.
Which one of the following is the maximum irradiation (in Megawatt Hours) that the experiment is allowed to receive?

a. 1 MWH

b. 3 MWH

c. 5 MWH

d. 8 MWH

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

QUESTION: 016 (1.00)

During the performance of SOP-4, Radiation, Evacuation and Alarm Checks, Police Services informs the operator that in addition to receiving the Reactor Pool Level High alarm he also received an Intrusion alarm. Which one of the following statements explains the reason why the intrusion alarm is expected or unexpected?

a. This is an expected alarm which is activated by the level instruments on the Reactor Pool or the Hold-up Tank level alarms when they are tested

b. This is an expected alarm since the alarm is activated when the operator turns the intrusion alarm system key switch prior to conducting the test

c. This is an unexpected alarm since the alarm should have been bypassed when the operator turns the intrusion alarm system key switch prior to conducting the test

d. This is an unexpected alarm since it should only be activated if the Fuel Storage Room door or the Reactor Beam Hole door is opened with the reactor operating

QUESTION: 017 (1.00)

Only one of the three neutron flux and power detectors shall be moved at a time in accordance with SOP-3, Core Loading and Fuel Handling. Which one of the following conditions would make it permissible to move more than one detector at a time?

a. The core is subcritical with all rods fully withdrawn and the Director has specified in writing that more than one detector may be moved

b. The fuel elements adjacent to each detector to be moved have been removed and at least one control rod is fully withdrawn and the SRO on shift has given his permission

c. The core has been unloaded to where the K excess is less than $1.00 and the Director has specified in writing that more than one detector may be moved

d. The shutdown margin has been demonstrated to be greater than 2.55 EE -3 delta K/K with the highest reactivity worth rod fully withdrawn and the SRO on shift has given his permission

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

QUESTION: 018 (1.00)

Which one of the following conditions is considered a "TAG OUT" of a beamport plug?

a. A warning sign is placed on the beamport door that the plug has been removed.

b. A tagout form is initiated by the person removing the plug and authorized by the On Duty SRO

c. A "Beamport Plug Removed" alarm is activated when the plug is removed

d. The operator activates the "Beamport Plug Removed" indicator light with a pushbutton

QUESTION: 019 (1.00)

Which one of the following is a definition of an inadvertent power failure, in accordance with EP-3, Power Failure?.

a. An unplanned electrical interruption of sufficient duration that the UPS transfers to battery operation

b. An unplanned electrical interruption of sufficient duration that the Primary or Secondary pumps trip

c. An unplanned electrical interruption of sufficient duration that the Facility Exhaust Fans trip

d. An unplanned electrical interruption of sufficient duration that the console clock needs to be reset

QUESTION: 020 (1.00)

In accordance with SOP-1, Reactor Operating Procedure, which one of the following detecting channels must the operator use to assure the 1 MW license limit is not exceeded?

a. Log N

b. Linear

c. Steady State Gamma Ion

d. Peak Power Gamma Ion

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

QUESTION: 001 (1.00)

Which one of the following are Engineered Safety Features at the PSBR facility as defined by the Technical Specifications?

a. The facility exhaust system and the emergency exhaust system

b. The reactor control and reactor safety systems

c. The Primary and Secondary coolant systems

d. The Radiation Monitoring and Building Isolation systems

QUESTION: 002 (1.00)

Which one of the following is a design feature of the Central Thimble which minimizes personnel radiation exposure when removing an irradiated sample from the thimble?

a. The thimble can unbolted from the bridge and lowered under the water to remove the sample

b. Samples are lowered through the open bottom of the thimble and retrieved with a special tool

c. A ten-foot top section of the thimble can be removed allowing removal of the sample underwater

d. A cutaway section of the thimble allows samples to be removed underwater without removing the thimble

QUESTION: 003 (1.00)

Which one of the following fuel rod areas is monitored by the thermocouples in an instrumented fuel rod?

a. Surface of the fuel rod cladding

b. Outer surface of the fuel

c. Interior of the fuel

d. Center of the zirconium rod

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

QUESTION: 004 (1.00)

Which one of the following is the response of the detector output if compensating voltage were lost on the Log N Detector when operating at 1 MW?

a. Detector output would decrease 3 to 5 percent due to loss of the gamma signal

b. The detector output would increase 3 to 5 percent due to increased ion collection from gamma radiation

c. The detector would fail downscale due to total recombining of the ions prior to reaching the collector

d. There would essentially be no change in the output since gamma represents only a small amount of the signal at power

QUESTION: 005 (1.00)

Which one of the following would be an indication of a leak in the Pool Heat Exchanger?

a. Increased radioactivity in the pond water

b. Decreased delta T across the Pool Heat Exchanger

c. Excessive makeup to the pool

d. Increased pool level

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

QUESTION: 006 (1.00)

A reactor startup is being accomplished with a low core residual. The operator observes after establishing a stable reactor period, the period begins to increase.
Which one of the following is a correct statement concerning this period increase?

a. The initial period is correct and the increased period is incorrect due to the overcompensation of the Log N Chamber

b. The initial period is correct and the increased period is incorrect due to the undercompensation of the Log N Chamber

c. The initial period is incorrect and the increased period is correct due to the undercompensation of the Log N Chamber

d. The initial period is incorrect and the increased period is correct due to the overcompensation of the Log N Chamber

QUESTION: 007 (1.00)

Which one of the following is a function of the low count rate bistable?

a. Initiates an automatic withdrawal of the count rate fission chamber when the count rate reaches 800 cps

b. Initiates a scram if the period exceeds three (3) seconds during reactor startup

c. Prevents control rod withdrawal if the signal from the count rate amplifier is less than two (2) cps

d. Switches the count rate recorder switch from the count rate channel to the Log N channel when power exceeds 1 KW

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

QUESTION: 008 (1.00)

Which one of the following statements correctly describes the operation of the Log N period channel?

a. Provides the signal to automatically withdraw or insert the count rate channel detector

b. Provides over five decades of reactor period indication

c. Provides a power level trip at 110% power

d. Utilizes an ion chamber that operates in the Geiger-Mueller region

QUESTION: 009 (1.00)

Which one of the following is the normal period maintained by the inverse period signal for changes in power when the mode switch is in AUTOMATIC?

a. 10 second

b. 15 second

c. 20 second

d. 30 second

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

QUESTION: 010 (1.00)

A loss of pool water accident has occurred at the Breazeale Reactor with an estimated leak of 70 gpm.
Which one of the following would be the acceptable system/method for restoring the pool water level?

a. The 6000 gallon Evaporator Storage Tank pumping through the Processed Water Pump to the pool

b. The university water supply through the pool floor drains using a fire hose

c. The university water supply through the demineralizer and Purification Pump

d. A fire department pumper stationed on the outside of the building and filling via fire hoses

QUESTION: 011 (1.00)

Which one of the following is the basis for the 100 deg F maximum reactor pool temperature?

a. Preclude damage to demineralizer resins

b. Minimize Nitrogen-16 release to the building

c. Minimize evaporation from the pool

d. Preclude void formation on the fuel elements

QUESTION: 012 (1.00)

Which one of the following interlocks may be defeated during fuel loading, in accordance with the fuel loading procedure?

a. Simultaneous manual withdrawal of two rods

b. Movement of any rod except the transient rod

c. Shim and regulating rod withdrawal with less than two neutron induced counts on the startup channel

d. Application of air to the transient rod unless regulating and shim rods are fully inserted

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

QUESTION: 013 (1.00)

Which one of the following is the design purpose of the Nitrogen-16 Diffuser?

a. Remove oxygen from the water above the core and thereby reduce the N-16 radiation level at the top of the pool.

b. Provide a 20 gpm stream of pool water to the reactor pool recirculation system to dilute the N-16 and O-16 concentration.

c. Increase transport time for N-16 from the top of the core to the pool surface.

d. Dissolve the gas bubbles of O-16 and thereby reduce N-16 formation.

QUESTION: 014 (1.00)

The Automatic Control System utilizes a SLAVE CONTROLLER to regulate reactor power.
Which one of the following describes the operation of the slave controller?

a. When the regulating rod reaches 75% of its travel the slave controller initiates a withdrawal of the shim rod

b. When the regulating rod reaches 25% of its travel the slave controller initiates a withdrawal of the shim rod

c. When power level reaches the demand level the power level is maintained by the slave controller

d. The slave controller operates the regulating rod to maintain a constant reactor period as set by the period circuit

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

QUESTION: 015 (1.00)

The Breazeale Reactor Technical Specifications require that fuel be arranged in a close packed array.
Which one of the following is the exception to that requirement?

a. The fuel elements need not be in a close packed array if the enrichment of all the fuel elements is less than 8.5% by weight

b. The fuel elements need not be in a close packed array if square wave operation results in fuel temperatures less than 700 deg C

c. The fuel elements need not be in a close packed array if an instrumented fuel element is within four (4) inches of the center of the core

d. The fuel elements need not be in a close packed array if the Keff of the core is less than 0.99 with all control rods at their upper limit

QUESTION: 016 (1.00)

Which one of the following is the largest conceived accident used for analysis in the design basis Loss of Coolant Accident (LOCA) for PSBR?

a. A rupture of the wall in the small pool with a failure of the removable gate to be inserted

b. A rupture in the bottom of the large pool with free access to drain the pool

c. A rupture of the six (6) inch line connected to the bottom of the pool with no isolation

d. A rupture of a seven (7) inch beamport with a complete failure of isolation capability

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

QUESTION: 017 (1.00)

Which one of the following is the purpose of the 12 X 16 aluminum plate suspended below the bottom grid plate of the core?

a. Prevents the water transferred from the storage tank transfer pump from discharging directly onto the core

b. Provides structural support for the lower grid plate and the suspended core

c. Provides a "catch plate" for small tools and hardware dropped while working on the core

d. Prevents the control rods from dropping out of the core if the mechanical connections fail

QUESTION: 018 (1.00)

Which one of the following describes the indication provided by the status light(s) on the control/status panel for the Emergency Exhaust System?

a. The light indicates that the control/status panel has automatically started on initiation of the evacuation alarm.

b. The light indicates that there is insufficient flow in the emergency exhaust duct with the fans running

c. Two lights indicate that power is available and the system has initiated on an evacuation alarm.

d. Two lights indicate that power is available and there is air flow in the system

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

C. PLANT AND RAD MONITORING SYSTEMS

QUESTION: 019 (1.00)

Which one of the following instruments monitors the radiation level at the primary pool water surface?

a. A GM tube detector mounted on the edge of the pool at the water surface

b. An ION chamber attached to the bridge section at the primary tank top

c. A GM tube attached to the bridge section at the tank top

d. An ION chamber mounted on the edge of the pool at the water surface

QUESTION: 020 (1.00)

While performing experiment 39, Bath Coefficient of Reactivity, primary coolant temperature has been reduced to 7 degrees C. Which one of the following methods is used to increase the temperature?

a. Bring the reactor critical and operate at 10 KW

b. Valve in the Reactor-Bay Hot Water to the heat exchanger

c. Circulate water through the core to utilize decay heat

d. Use underwater light and heat from the pumps

Deleted

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

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a. A GM tube detector mounted on the edge of the pool at the water surface

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c. A GM tube attached to the bridge section at the primary tank top

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c. Circulate water through the core to utilize decay heat

d. Use underwater light and heat from the pumps

Deleted

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

ANSWER: 001 (1.00)

a.

REFERENCE:

PSBR Reactor Theory and Miscellaneous Items Section C pp 8-4

ANSWER: 002 (1.00)

b.

REFERENCE:

PSBR Training Manual, pg 2-4, 3-37

ANSWER: 003 (1.00)

d.

REFERENCE:

PSBR Training Manual, Section 2.23.3 pp 2-34

ANSWER: 004 (1.00)

d.

REFERENCE:

PSBR General Operating Characteristics Section 5.1 pp 5-1

ANSWER: 005 (1.00)

a.

REFERENCE:

PSBR SAR, p. IX-3.

ANSWER: 006 (1.00)

c.

REFERENCE:

PSBR Training Manual Chapter 2 Section A pp 2-12

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

ANSWER: 007 (1.00)

d.

REFERENCE:

PSBR General Operating Characteristics Section C pp 5-9.

ANSWER: 008 (1.00)

b.

REFERENCE:

PSBR Principles of Reactor Operation Section 2.13.3 pp 2-34.

ANSWER: 009 (1.00)

c.

REFERENCE:

PSBR Principle of Reactor Operation Section 2.21 pp. 2-26

ANSWER: 010 (1.00)

c.

REFERENCE:

PSBR Theory Section 7.14 pp 7-33, 7-34

ANSWER: 011 (1.00)

d.

REFERENCE:

Lamarsh pp 321-326

ANSWER: 012 (1.00)

b.

REFERENCE:

PSBR Principle of Reactor Operation Section 2.17 pp 21

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

ANSWER: 013 (1.00)

c.

REFERENCE:

PSBR Principle of Reactor Operation pp. 14,15,21-22a

ANSWER: 014 (1.00)

b.

REFERENCE:

PSBR Theory Section 7.13.5 pp 7-31

ANSWER: 015 (1.00)

b.

REFERENCE:

PSBR Principles of Reactor Operation Section 2.23.2 pp 2-23

ANSWER: 016 (1.00)

d.

REFERENCE:

PSBR Principle of Reactor Operation Section 2.2 pp 2-23

ANSWER: 017 (1.00)

b.

REFERENCE:

PSBR Principle of Reactor Operation Section 2.19 pp 2-23

ANSWER: 018 (1.00)

c.

REFERENCE:

PSBR Principle of Reactor Operation Section 2.3 pp 2-4

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

ANSWER: 019 (1.00)

a.

REFERENCE:

PSBR Principle of Reactor Operation Section 2.3 pp 2-4

ANSWER: 020 (1.00)

c.

REFERENCE:

PSBR Reactor Physics Section 1.7.2.3 pp 1-20

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

ANSWER: 001 (1.00)

d.

REFERENCE:

PSBR: Emergency Preparedness Plan pp 16

ANSWER: 002 (1.00)

d.

REFERENCE:

PSBR Training Manual Chapter 7.13 pp 7-28 through 7-32.

ANSWER: 003 (1.00)

a.

REFERENCE:

PSBR Technical Specifications AP-5.4 pp 28
PSBR Technical Specifications 2.1 pp 7

ANSWER: 004 (1.00)

c.

REFERENCE:

PSBR Technical Specifications AP-5 pp 16
Penn State SAR pp VII-3

ANSWER: 005 (2.00)

a 6

b 5

c 5

d 3 (Four answers required at 0.50 each)

REFERENCE:

PSBR Technical Specifications Section 3.2.3

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

ANSWER: 006 (1.00)

c.

REFERENCE:

PSBR SOP-1, Reactor Operating Procedure Section E.2.a pp 9

ANSWER: 007 (1.00)

b.

REFERENCE:

PSBR SOP-5, Experiment Evaluation and Authorization Section B.3
PSBR Technical Specifications 1.1.19

ANSWER: 008 (1.00)

d.

REFERENCE:

PSBR Theory Section 1.6.7 pp 1-14

ANSWER: 009 (1.00)

c.

REFERENCE:

Code of Federal Regulations Title 10 Section 20.101

ANSWER: 010 (1.00)

c.

REFERENCE:

PSBR Principles of Reactor Operation Section 2.24 pp 2-35

ANSWER: 011 (1.00)

d.

REFERENCE:

PSBR SOP-9, Pneumatic Transfer System Operation, Section A.13.c pp 2

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

ANSWER: 012 (1.00)

d.

REFERENCE:

PSBR Theory Section 7.0.3 pp 7-2

ANSWER: 013 (1.00)

b.

REFERENCE:

PSBR Administrative Procedure AP-5, Technical Specifications Section 3.5 pp 17

ANSWER: 014 (1.00)

c.

REFERENCE:

PSBR SOP-8, Release of Irradiated Experiments Section A.9.e pp 2

ANSWER: 015 (1.00)

a.

REFERENCE:

PSBR SOP-6, Experiment Encapsulation Section B.2 pp 1

ANSWER: 016 (1.00)

b

REFERENCE:

PSBR SOP-4, Radiation, Evacuation and Alarm Checks, Section A.3 pp 1

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

ANSWER: 017 (1.00)

a.

REFERENCE:

PSBR SOP-3, Core Loading and Fuel Handling Section A.3 pp 1

ANSWER: 018 (1.00)

d.

REFERENCE

PSBR Administrative Policy AP-7, Console Indicator Lights, Abnormal Conditions Section C.1 pp 1

ANSWER: 019 (1.00)

d.

REFERENCE:

PSBR Emergency Procedure EP-3, Power Failure Section C.1 pp 1

ANSWER: 020 (1.00)

b.

REFERENCE:

PSBR SOP-1, Reactor Operating Procedure page 1

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

ANSWER: 001 (1.00)

a.

REFERENCE:

PSBR Technical Specifications, 3.5

ANSWER: 002 (1.00)

d.

REFERENCE:

PSBR Training Manual Chapter 3 Section 3.26 pp 3-39

ANSWER: 003 (1.00)

c.

REFERENCE:

PSBR Training Manual, pp 3-7

ANSWER: 004 (1.00)

d.

REFERENCE:

PSBR General Operating Characteristics Section 5.2 pp 5-2

ANSWER: 005 (1.00)

d.

REFERENCE:

PSBR Training Manual Section 3.11 pp 3-17

ANSWER: 006 (1.00)

c.

REFERENCE:

PSBR General Operating Characteristics Section 5.1 pp 5.1

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

ANSWER: 007 (1.00)

c.

REFERENCE:

PSBR Training Manual Chapter 4.20 pp 4-20
PSBR SAR pp VII-3

ANSWER: 008 (1.00)

a.

REFERENCE:

PSBR Training Manual Chapter 4 Section C pp 4-20.

ANSWER: 009 (1.00)

b.

REFERENCE:

PSBR Instrumentation and Control Section 4.27 pp 4-22.

ANSWER: 010 (1.00)

b.

REFERENCE:

PSBR Emergency Procedure EP-4, Loss of Pool Water Section C pp 2 through 5

ANSWER: 011 (1.00)

a.

REFERENCE:

PSBR Technical Specification, AP-5, Section 3.3.6 pp 17
PSBR SAR pp IV-5
PSBR SP-3, Pool Cooling System, Section A.1 pp 1
PSBR Training Manual, Chapter 3, Section B.3.9 pp 3-14, 15 and 3-15.

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

ANSWER: 012 (1.00)

c .

REFERENCE:

PSU TRIGA MARK II Tech Specs Table II

ANSWER: 013 (1.00)

c.

REFERENCE:

PSBR Training Manual, Chapter 3 pp 3-19

ANSWER: 014 (1.00)

a.

REFERENCE:

PSBR Instrumentation and Control Section 4.27 pp 4-22 through 4-24

ANSWER: 015 (1.00)

d.

REFERENCE:

PSBR Technical Specifications 3.1.5.c pp 12

ANSWER: 016 (1.00)

c.

REFERENCE:

SAR IX D

ANSWER: 017 (1.00)

d.

REFERENCE:

PSBR SAR Section III.B.3 pp III-3

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

ANSWER: 018 (1.00)

d.

REFERENCE:

PSBR Safety Analysis Report pp V-5

ANSWER: 019 (1.00)

DS ~~a.~~ b.

REFERENCE:

PSU TRIGA MARK II General Characteristics Section 7.A.2

ANSWER: 020 (1.00)

DS ~~a.~~ Deleted

REFERENCE:

PSU TRIGA MARK II Experiment 39, Bath Coefficient of Reactivity

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

A N S W E R K E Y

ANSWER SHEET

001	a
002	b
003	d
004	d
005	e
006	c
007	d
008	b
009	c
010	c
011	d
012	b
013	c
014	b
015	b
016	d
017	b
018	c
019	a
020	c

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

A N S W E R K E Y

001 d

002 d

003 a

004 c

005 match with selected number in the blank

a 6

b 5

c 3

d 3

006 c

007 b

008 d

009 c

010 c

011 d

012 d

013 b

014 c

015 a

016 b

017 a

018 d

019 d

020 b

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

A N S W E R K E Y

001 a

002 d

003 c

004 d

005 d

006 c

007 c

008 a

009 b

010 b

011 e

012 c

013 c

014 a

015 d

016 c

017 d

018 a

019 05/b

~~e~~ 05 Deleted

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

eqb.3 % *END