July 3, 2003

Dr. C. Frederick Sears, Director
Penn State Breazeale Reactor
Pennsylvania State University
University Park, PA 16802-1504

SUBJECT: INITIAL EXAMINATION REPORT NO. 50-005/OL-03-01, PENNSYLVANIA STATE UNIVERSITY

Dear Dr. Sears:

During the week of June 9, 2003, the NRC administered initial examinations to employees of your facility who had applied for a license to operate your Pennsylvania State University reactor. The examination was conducted in accordance with NUREG-1478, "Non-Power Reactor Operator Licensing Examiner Standards," Revision 1. At the conclusion of the examination, the examination questions and preliminary findings were discussed with those members of your staff identified in the enclosed report.

In accordance with 10 CFR 2.790 of the Commission's regulations, a copy of this letter and the enclosures will be available electronically for public inspection in the NRC Public Document Room or from the Publicly Available Records (PARS) component of NRC's document system (ADAMS). ADAMS is accessible from the NRC Web site at (the Public Electronic Reading Room) http://www.nrc.gov/NRC/ADAMS/index.html. The NRC is forwarding the individual grades to you in a separate letter which will not be released publicly. Should you have any questions concerning this examination, please contact Mr. Warren Eresian at 301-415-1833 or internet e-mail wje@nrc.gov.

Sincerely,

/RA by Daniel E. Hughes, Acting for/

Patrick M. Madden, Section Chief
Research and Test Reactors Section
New, Research and Test Reactors Program
Division of Regulatory Improvement Programs
Office of Nuclear Reactor Regulation

Docket No. 50-005

Enclosures: 1. Initial Examination Report No. 50-005/OL-03-01
2. Examination and answer key

cc w/encls:

Please see next page

cc:

Mr. Eric J. Boeldt, Manager of
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Department of Environmental Protection
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Please see next page

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WEresian
PMadden

ADAMS PACKAGE ACCESSION NO.: ML030500506
ADAMS REPORT ACCESSION NO.: ML031750311 **TEMPLATE #: NRR-074**

OFFICE	RORP:CE		IEHB:LA		RORP:SC	
NAME	WEresian:rdr		EBarnhill		PMadden	
DATE	06/ 27 /2003		07/ 01 /2003		07/ 03 /2003	

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

REPORT NO.:	50-005/OL-03-01
FACILITY DOCKET NO.:	50-005
FACILITY LICENSE NO.:	R-2
FACILITY:	Pennsylvania State University
EXAMINATION DATES:	June 9-10, 2003
EXAMINER:	Warren Eresian, Chief Examiner

SUBMITTED BY: ***/RA/*** 06/ 27 /2003
Warren Eresian, Chief Examiner Date

SUMMARY:

During the week of June 9, 2003, the NRC administered operator licensing examinations to two Senior Reactor Operator (Instant) candidates. Each candidate passed the examinations.

ENCLOSURE 1

REPORT DETAILS

1. Examiner: Warren Eresian, Chief Examiner

2. Results:

	RO PASS/FAIL	SRO PASS/FAIL	TOTAL PASS/FAIL
Written	**N/A**	**2/0**	**2/0**
Operating Tests	**N/A**	**2/0**	**2/0**
Overall	**N/A**	**2/0**	**2/0**

3. Exit Meeting:

Dr. C. Frederick Sears, Director
Mr. Terry Flinchbaugh, Operations Manager
Warren Eresian, NRC Chief Examiner

The NRC thanked the facility staff for their cooperation during the examination. The facility provided comments on the written examination. The Chief Examiner noted that each candidate was deficient in the area of radiation hazards associated with Argon-41 and Nitrogen-16.

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

FACILITY: Penn State University

REACTOR TYPE: TRIGA

DATE ADMINISTERED: 06/09/2003

REGION: I

CANDIDATE:_____

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 category is required to pass the examination.

Examinations will be picked up three (3) hours after the examination starts.

CATEGORY VALUE	% OF TOTAL	CANDIDATE'S SCORE	% OF CATEGORY VALUE	CATEGORY
20	33.3	_____	_____	A. REACTOR THEORY, THERMODYNAMICS, AND FACILITY OPERATING CHARACTERISTICS
20	33.3	_____	_____	B. NORMAL AND EMERGENCY OPERATING PROCEDURES AND RADIOLOGICAL CONTROLS
20	33.3	_____	_____	C. FACILITY AND RADIATION MONITORING SYSTEMS
60			_____% FINAL GRADE	

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

_____
Candidate's Signature

ENCLOSURE 2

NRC RULES AND GUIDELINES FOR LICENSE EXAMINATIONS

During the administration of this examination the following rules apply:

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

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

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

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

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

6. Print your name in the upper right-hand corner of the answer sheets.

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

8. 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.

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

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

11. 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.

QUESTION: 001 (1.00)

A factor in the six-factor formula which is most affected by control rod position is:

a. Resonance escape probability

b. Fast fission factor

c. Neutron reproduction factor

d. Thermal utilization factor

QUESTION: 002 (1.00)

Which ONE of the following is a description of a thermal neutron?

a. A neutron possessing thermal energy rather than kinetic energy.

b. A neutron that has been produced in a significant time (on the order of seconds) after fission occurred.

c. A neutron that is not captured in resonance peaks.

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

QUESTION: 003 (1.00)

With the reactor on a constant period, which transient requires the LONGEST time to occur?

A reactor power change of:

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

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

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

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

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

QUESTION: 004 (1.00)

During a reactor startup, the count rate is increasing linearly with time, with no rod motion. This means:

a. the reactor is subcritical and the count rate increase is due to the buildup of delayed neutron precursors

b. the reactor is critical and the count rate increase is due to source neutrons

c. the reactor is subcritical and the count rate increase is due to source neutrons

d. the reactor is critical and the count rate increase is due to the buildup of delayed neutron precursors

QUESTION: 005 (1.00)

Which ONE of the following statements describes the difference between Differential and Integral (IRW) rod worth curves?

a. DRW relates the worth of the rod per increment of movement to rod position. IRW relates the total reactivity added by the rod to the rod position.

b. DRW relates the time rate of reactivity change to rod position. IRW relates the total reactivity in the core to the time rate of reactivity change.

c. IRW relates the worth of the rod per increment of movement to rod position. DRW relates the total reactivity added by the rod to the rod position.

d. IRW is the slope of the DRW at a given rod position

QUESTION: 006 (1.00)

Which ONE of the following elements will slow down fast neutrons <u>most</u> quickly, i.e. produces the greatest energy loss per collision?

a. Oxygen-16

b. Uranium-238

c. Hydrogen-1

d. Boron-10

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

QUESTION: 007 (1.00)

The term "Prompt Critical" refers to:

a. the instantaneous jump in power due to a rod withdrawal.

b. a reactor which is supercritical using only prompt neutrons.

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

d. a reactivity insertion which is less than Beta-effective.

QUESTION: 008 (1.00)

A reactor has been operating at full power for one week when a scram occurs. Twelve hours later, the reactor is brought critical and quickly raised to full power. Considering xenon effects only, to maintain a constant power level for the next few hours, control rods must be:

a. inserted

b. maintained at the present position

c. withdrawn

d. withdrawn, then inserted to the original position

QUESTION: 009 (1.00)

Which ONE of the answers below is correct to complete the following statement?

The majority of the energy from the fission event is transferred into heat by:

a. the transfer of kinetic energy from the fission fragments.

b. the transfer of kinetic energy from fission neutrons to the hydrogen in the reactor moderator.

c. the absorption of gamma rays from the interaction with reactor components.

d. the deceleration and absorption of beta particles from the interaction with reactor components.

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

QUESTION: 010 (1.00)

With the reactor critical at 50 watts, the reactor operator withdraws the regulating rod a small amount. As power increases, an initial doubling time (DT) of 16 seconds is observed. Which ONE of the following is the reactivity added to the core?

a. 0.14% ΔK/K

b. O.16% ΔK/K

c. 0.21% ΔK/K

d. 0.26% ΔK/K

QUESTION: 011 (1.00)

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

a. Mass of the nucleus of the moderator approximates the mass of a U-235, low scattering cross section and low absorption cross section.

b. Mass of the nucleus of the moderator approximates the mass of a neutron, high scattering cross section and low absorption cross section.

c. Mass of the nucleus of the moderator approximates the mass of a neutron, low scattering cross section and high absorption cross section.

d. Mass of the nucleus of the moderator approximates the mass of a neutron, high scattering cross section and high absorption cross section.

QUESTION: 012 (1.00)

As moderator temperature increases (zirconium hydride), the resonance escape probability:

a. increases, since the moderator becomes less dense.

b. decreases, since the time required for a neutron to reach thermal energy increases.

c. remains constant, since the effect of moderator temperature change is relatively small.

d. increases, since the moderator-to-fuel ratio increases.

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

QUESTION: 013 (1.00)

A power calibration is to be done on a reactor located in a pool containing 70,000 gallons of water. Pool water flows through a heat exchanger at a rate of 400 gpm, and the temperature drop across the primary side of the heat exchanger is 17 degrees F. Ignoring heat losses to the atmosphere, the power of this reactor is approximately:

a. 400 kW.

b. 600 kW.

c. 800 kW.

d. 1000 kW.

QUESTION: 014 (1.00)

A 1/M curve is being generated as fuel is loaded into a core. After some fuel elements have been loaded, the count rate existing at that time is taken to be the new initial count rate, CR_o. Additional elements are then loaded and the inverse count rate ratio continues to decrease. As a result of changing the initial count rate:

a. criticality will occur with the same number of elements loaded.

b. criticality will occur earlier (i.e. with fewer elements loaded.)

c. criticality will occur later (i.e. with more elements loaded.)

d. criticality will be completely unpredictable.

QUESTION: 015 (1.00)

In a critical reactor, 100 fast neutrons are produced from fission and start to slow down. 20 neutrons are captured in resonance peaks and 10 leak out of the core after they have reached thermal energy. The remaining neutrons are absorbed in fuel and other materials. Each fission produces 2.5 neutrons, and 85% of the neutrons absorbed in fuel result in fissions. For this reactor, the thermal utilization factor is:

a. 0.47

b. 0.62

c. 0.67

d. 1.61

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

QUESTION: 016 (1.00)

Which ONE of the reactions below is an example of a photoneutron source?

a. $_{1}H^{2} + \gamma \rightarrow {}_{1}H^{1} + n$

b. $_{92}U^{238} \rightarrow {}_{35}Br^{87} + {}_{57}La^{148} + 3n + \gamma$

c. $_{51}Sb^{123} + n \rightarrow {}_{51}Sb^{124} + \gamma$

d. $_{4}Be^{9} + \alpha \rightarrow {}_{6}C^{12} + n$

QUESTION: 017 (1.00)

The effective neutron multiplication factor, K_{eff}, is defined as:

a. production/(absorption + leakage)

b. (production + leakage)/absorption

c. (absorption + leakage)/production

d. absorption/(production + leakage)

QUESTION: 018 (1.00)

Two different neutron sources were used during two reactor startups. The source used in the first startup emits ten times as many neutrons per second as the source used in the second startup. Assume all other factors are the same for the second startup. Which ONE of the following states the expected result at criticality?

a. Neutron flux will be higher for the first startup.

b. Neutron flux will be higher for the second startup.

c. The first startup will result in a higher rod position (rods further out of the core).

d. The second startup will result in a higher rod position (rods further out of the core).

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

QUESTION: 019 (1.00)

A step insertion of positive reactivity in a critical reactor causes a momentary rapid increase in the neutron population, known as a *prompt jump*. Which ONE of the following describes the cause of this increase?

a. The positive reactivity insertion due to the rapid fuel temperature coefficient feedback.

b. An immediate increase in the prompt neutron population.

c. The step insertion produces a rate of reactivity addition which exceeds the delayed neutron fraction, β_{eff} .

d. A shortening of the delayed neutron generation when power increases.

QUESTION: 020 (1.00)

The reactor is operating in the automatic mode at 50% power. A problem in the secondary cooling system causes the primary coolant temperature to increase by 5 degrees F. Given that the primary coolant temperature coefficient is -7.0×10^{-5} Δ k/k/deg. F and the differential rod worth of the regulating rod is
8.75×10^{-5} Δk/k/inch, the change in the position of the regulating rod will be:

a. eight (8) inches in.

b. eight (8) inches out.

c. four (4) inches in.

d. four (4) inches out.

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

QUESTION: 001 (1.00)

Following an evacuation alarm, the persons investigating the alarm encounter a high radiation area. They should immediately:

a. rope off the area

b. attempt to minimize or prevent radiation releases

c. prepare to possibly activate the EPP

d. move to the ESC

QUESTION: 002 (1.00)

Which ONE of the following requires the presence of a licensed Senior Reactor Operator in the control room or reactor bay?

a. Insertion of a $2.50 pulse.

b. A student operating the reactor for training as part of a course.

c. A reactor operator trainee during a normal startup.

d. an unlicensed individual moving fuel within the core.

QUESTION: 003 (1.00)

A radioactive sample (1.0 Mev gamma radiation) from an experiment results in a dose rate of 100 mR/hr at a distance of one foot from the sample. One-half inch thick lead sheets are available for shielding, and the half-thickness value of lead is one-quarter inch. The minimum number of sheets required to lower the dose rate to below 5 mR/hr at a distance of one foot is:

a. 3

b. 4

c. 5

d. 6

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

QUESTION: 004 (1.00)

A radiation survey of an area reveals a general radiation reading of 1 mrem/hr. There is, however, a small pipe (point source) which reads 10 mrem/hr at one (1) meter. Which ONE of the following defines the posting requirements for the area in accordance with 10CFR20?

a. Restricted Area.

b. Caution Radiation Area.

c. Caution High Radiation Area.

d. Grave Danger, Very High Radiation Area.

QUESTION: 005 (1.00)

The Safety System Channels required to be operable in all modes of operation are:

a. fuel element temperature, reactor high power and manual scram.

b. fuel element temperature, watchdog circuit and manual scram.

c. watchdog circuit, reactor high power and manual scram.

d. detector power supply, fuel element temperature and manual scram.

QUESTION: 006 (1.00)

In accordance with SOP-9, "Pneumatic Transfer System Operation," which ONE of the following actions is the Reactor Operator required to take if a damaged Rabbit 1 capsule is returned from the reactor core?

a. Begin an immediate shutdown of the reactor.

b. Notify the Senior Reactor Operator.

c. Close the CO_2 supply valve to the pneumatic tube.

d. Toggle the RABBIT 1 Fan control switch to the ON position.

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

QUESTION: 007 (1.00)

Limiting Safety System Settings (LSSS) are:

a. limits on important process variables which are found to be necessary to reasonably protect the integrity of certain of the physical barriers which guard against the uncontrolled release of radioactivity.

b. constraints included in the Technical Specifications that are required for safe operation of the facility.

c. devices which prevent some action, associated with reactor operation, until certain reactor operation conditions are satisfied.

d. settings for automatic protective devices related to variables having significant safety functions.

QUESTION: 008 (1.00)

In accordance with the Technical Specifications, which ONE condition below is permissible when the reactor is operating?

a. Conductivity of bulk pool water > 0.5 micromho/cm.

b. Reactor bay truck door open.

c. Seventeen (17) feet of water above the top grid.

d. Facility exhaust system inoperable.

QUESTION: 009 (1.00)

Which ONE of the following completes the following statement?

There shall be at least _____ persons at the facility whenever the reactor is not secured, of which there shall be at least _____.

a. Two; one Reactor Operator and one Senior Reactor Operator.

b. Three; one Reactor Operator and one Senior Reactor Operator.

c. Three; two Reactor Operators and one Senior Reactor Operator.

d. Four; two Reactor Operators and one Senior Reactor Operator.

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

QUESTION: 010 (1.00)

To maintain an active senior operator license, the functions of a senior operator must be actively performed for at least:

a. one hour per month.

b. three hours per calendar quarter.

c. four hours per calendar quarter.

d. sixteen hours per year.

QUESTION: 011 (1.00)

Column A below lists four activities in which a senior operator might participate. Column B lists four categories of procedures in which the activities are described. Match the procedure in Column B to the activity in Column A. Each procedure is used only once.

Column A	Column B
a. Transfer a fuel element from the core to the storage rack.	1. Administrative Procedure
b. Add water to the reactor pool (non-emergency).	2. Standard Operating Procedure
c. Issue a Radiation Work Permit.	3. Special Procedure
d. Perform smear survey.	4. Auxiliary Operating Procedure

QUESTION: 012 (1.00)

An Emergency Action Level is:

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

b. a class of accidents for which predetermined emergency measures should be taken or considered.

c. a procedure that details the implementation actions and methods required to achieve the objectives of the Emergency Plan.

d. a specific instrument reading or observation which may be used as a threshold for initiating appropriate emergency procedures.

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

QUESTION: 013 (1.00)

The reactor is shutdown when it is:

a. subcritical by at least $1.00.

b. subcritical by at least $1.00 with the highest worth rod withdrawn.

c. subcritical by at least $0.25.

d. subcritical by at least $0.25 with the highest worth rod withdrawn.

QUESTION: 014 (1.00)

Prior to insertion into a pneumatic transfer system, a rabbit sample must be inspected by:

a. the reactor operator.

b. the Health Physics office.

c. the experimenter.

d. a senior reactor operator.

QUESTION: 015 (1.00)

“There shall be a minimum of three operable control rods in the reactor core.” This is an example of a:

a. safety limit.

b. limiting safety system setting.

c. limiting condition for operation.

d. surveillance requirement.

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

QUESTION: 016 (1.00)

Which ONE statement below describes the basis for the Safety Limit applicable to fuel element temperature?

a. Excessive gas pressure between the fuel-moderator and cladding may result in loss of fuel element cladding integrity.

b. High fuel temperature combined with lack of adequate cooling could result in fuel melt.

c. Excessive hydrogen produced as a result of the zirconium-water reaction is potentially explosive.

d. Pulsing the reactor at high fuel temperature could result in loss of fuel element cladding integrity.

QUESTION: 017 (1.00)

Which ONE of the following is true regarding the Technical Specifications related to reactivity worth?

a. A reactivity check shall be made on all movable experiments with estimated worth more than an absolute 20 cents.

b. The limit on pulse reactivity is not affected by moveable experiment worth.

c. The reactivity insertion rate is limited to $2.50/second to limit control rod worth.

d. The excess reactivity Technical Specification requirements is only designed to account for fuel depletion and experimental worth.

QUESTION: 018 (1.00)

Which ONE of the following actions should be taken FIRST for any minor fire that may involve radioactive material per EP-2, “Fire and Explosion.”

a. Extinguish the fire.

b. Sound the building fire alarm system.

c. Call Police Services.

d. Contact health physics.

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

QUESTION: 019 (1.00)

Which ONE of the following are the potential sources of major gaseous radioactive release per EP-5, “Gaseous Release.”

a. A loss of coolant accident, and the reactivity insertion accident

b. A loss of coolant accident, and a rupture of one or more fuel elements

c. The reactivity insertion accident, and leakage or rupture of an irradiated sample or experimental apparatus

d. A rupture of one or more fuel elements, and leakage or rupture of an irradiated sample or experimental apparatus

QUESTION: 020 (1.00)

Which ONE of the following is a “shift change” requirement specified in SOP-1, “Reactor Operating Procedure?”

a. The supervisor and operator identification shall be recorded in the DCC-X at the start of the shift.

b. Each supervisor or operator relieving one another, when the reactor is secured or not secured, shall note the change in the reactor startup book.

c. The supervisor must review the reactor log book for the period since last on shift, but the operator need not.

d. When the reactor is secured, the operator or senior operator shall assure that the reactor log book is complete.

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

QUESTION: 001 (1.00)

The Emergency Exhaust System is activated when:

a. the facility exhaust system is secured.

b. the reactor bay has a positive pressure with respect to the atmosphere.

c. a building evacuation is initiated.

d. the pressure drop across the facility exhaust system filters doubles.

QUESTION: 002 (1.00)

Carbon dioxide is used in the pneumatic transfer system instead of compressed air because:

a. it is more compressible.

b. it does not retain moisture.

c. it minimizes Ar-41 production.

d. it minimizes N-16 production.

QUESTION: 003 (1.00)

For a standard control rod, the drive up arrow is green, the drive down arrow is red, and rod bottom arrow is red. This indicates that:

a. the rod and drive are not in contact, the rod is full up and the drive is full down.

b. the rod and drive are both full up.

c. the rod and drive are both full down.

.

d. the rod and drive are not in contact, the drive is full up and the rod is full down.

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

QUESTION: 004 (1.00)

Which ONE of the following is a control rod interlock?

a. Above reactor power of 1 kW, the transient rod cannot be operated in the pulse mode.

b. Only one standard rod at a time can be moved in the pulse mode.

c. Control rods cannot be withdrawn unless the count rate is greater than 1 CPS in the manual mode.

d. Two control rods cannot be moved at the same time above 1 kW in the manual mode.

QUESTION: 005 (1.00)

When the Automatic Mode Menu is displayed, rod mode "2" is selected. This means that the rods selected for regulation are the:

a. regulating rod and safety rod.

b. regulating rod and shim rod.

c. safety rod and shim rod.

d. regulating rod and transient rod.

QUESTION: 006 (1.00)

In the PSBR Water Handling System, pool water conductivity is measured:

a. at the suction of the purification pump.

b. downstream of the skimmer.

c. between the filter and purification pump.

d. at the inlet of the demineralizer.

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

QUESTION: 007 (1.00)

In the Automatic Control mode, the controlling signal is:

a. reactor power as measured by the Power Range Monitor.

b. reactor period as measured by the GIC.

c. reactor power as measured by the Wide Range Monitor.

d. reactor period as measured by the Power Range Monitor.

QUESTION: 008 (1.00)

Which ONE of the following conditions will initiate a reactor STEPBACK?

a. Interlock validation failure.

b. High radiation from the East Bay Monitor.

c. Reactor Operation Inhibit.

d. Square Wave termination request.

QUESTION: 009 (1.00)

Which ONE of the following is correct for the air compressors?

a. Compressed air for the facility is provided by two air compressors located in the demineralizer room.

b. Either air compressor can supply the entire system through valve repositioning in the mechanical equipment room.

c. Normally, the 20 horsepower air compressor supplies the reactor transient rod, and the 1.5 horsepower air compressor supplies the rest of the facility.

d. Both compressors are set to start at 80 psig and stop at 105 psig, are equipped with a low pressure alarm at 55 psig, and deliver air at about 80 psig to both the transient rod and the rest of the facility.

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

QUESTION: 010 (1.00)

Coolant flow in the primary loop is measured by a flow meter located:

a. at the discharge of the primary pump.

b. at the outlet of a heat exchanger.

c. at the suction of the primary pump.

d. between the two heat exchangers.

QUESTION: 011 (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.

QUESTION: 012 (1.00)

When the reactor is operated against the D_2O tank, the neutron flux as seen by the power range channel would be higher than the flux seen by the wide range channel. This is because the D_2O tank:

a. reflects more neutrons toward the power range channel.

b. results in fewer gammas being produced in the D_2O.

c. absorbs more neutrons.

d. makes the graphite reflector elements more effective when located near D_2O.

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

QUESTION: 013 (1.00)

Which ONE of the following describes how a graphite reflector element can be identified as compared to a fuel element?

a. The spacer block at the top of the tube is colored blue.

b. The tube is taller than the rest of the core.

c. The instrument wires can be seen at the top of the element.

d. The tip of the top end-fixture is machined to a unique shape.

QUESTION: 014 (1.00)

Which ONE of the following will initiate a Reactor Scram and a Reactor Operation Inhibit?

a. High pool temperature.

b. Both East and West Bay Radiation Trips defeated.

c. High Radiation Co-60 Lab Monitor

d. Reactor Bay Truck Door open.

QUESTION: 015 (1.00)

Which ONE of the following is true for all control rods (i.e., the safety, shim, regulating and transient rod.)

a. A stroke of about 15 inches.

b. A length of about 43 inches.

c. A fuel follower of about 15 inches.

d. Stainless steel cladding.

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

QUESTION: 016 (1.00)

Pool water temperature is limited to 100 degrees F in order to ensure that:

a. there is an adequate heat sink for the full thermal power of the reactor.

b. the anion bed in the demineralizer is not damaged.

c. the expansion of pool water at higher temperatures does not reduce the moderating capability of the coolant.

d. nucleate boiling does not occur on fuel element surfaces.

QUESTION: 017 (1.00)

When an evacuation alarm occurs:

a. the Emergency Exhaust System activates and the Facility Exhaust System continues to operate.

b. the Facility Exhaust System fans turn off but the louvers remain open.

c. the Emergency Exhaust System activates and the Facility Exhaust System is secured.

d. the Facility Exhaust System fans turn off, and must be manually restarted when the evacuation is cleared.

QUESTION: 018 (1.00)

Which ONE of the following initiates a reactor operation inhibit by DCC-X?

a. Emergency exhaust system operating.

b. Reactor pool level below normal.

c. Both east and west bay or air radiation trips are defeated.

d. Fuel temperature is high.

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

QUESTION: 019 (1.00)

Which ONE of the following is a source of water available to the reactor pool through permanently installed piping?

a. Water from the Co-60 pool can be pumped by the primary cooling system pump to the reactor pool.

b. The University water system can supply the pool through the demineralizer.

c. The University water system can supply a high flow rate to the emergency pool flooding system.

d. The heat exchanger secondary side can supply the pool drain lines.

QUESTION: 020 (1.00)

When the primary pump starter switch is pushed:

a. the primary pump starts. After a 10-second time delay, pneumatically operated valves 80A and 82A automatically open.

b. valve 80A opens. After a 10-second time delay, valve 82A opens and the primary pump starts.

c. valve 82A opens. After a 10-second time delay, valve 80A opens and the primary pump starts.

d. valves 80A and 82A open. After a 10-second time delay, the primary pump starts.

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

A. REACTOR THEORY, THERMODYNAMICS & FACILITY OPERATING CHARACTERISTICS

ANSWER SHEET

MULTIPLE CHOICE (Circle or X your choice)
If you change your answer, write your selection in the blank.

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

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

B. NORMAL/EMERGENCY PROCEDURES & RADIOLOGICAL CONTROLS

ANSWER SHEET

MULTIPLE CHOICE (Circle or X your choice)
If you change your answer, write your selection in the blank.

001 a b c d _____

002 a b c d _____

003 a b c d _____

004 a b c d _____

005 a b c d _____

006 a b c d _____

007 a b c d _____

008 a b c d _____

009 a b c d _____

010 a b c d _____

011 a_____b_____ c_____ d _____

012 a b c d _____

013 a b c d _____

014 a b c d _____

015 a b c d _____

016 a b c d _____

017 a b c d _____

018 a b c d _____

019 a b c d _____

020 a b c d _____

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

C. FACILITY AND RADIATION MONITORING SYSTEMS

ANSWER SHEET

MULTIPLE CHOICE (Circle or X your choice)
If you change your answer, write your selection in the blank.

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

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

EQUATION SHEET

$Q = m\ c_p\ \Delta T$

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

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

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

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

$DR_1D_1^2 = DR_2D_2^2$

$DR = DR_oe^{-\lambda t}$

$DR = 6CiE/D^2$

$\rho = (Keff\text{-}1)/Keff$

$1\ ft^3$ (water) = 7.48 gallons

1 kW = 3413 Btu/hour

1 gallon (water) = 8.34 pounds

$°F = 9/5°C + 32$

$°C = 5/9\ (°F - 32)$

A. REACTOR THEORY, THERMODYNAMICS & FACILITY OPERATING CHARACTERISTICS

ANSWER: 001 (1.00)
D.
REFERENCE:
PSBR Training Manual, Page 2-23

ANSWER: 002 (1.00)
D.
REFERENCE:
PSBR Training Manual, Page 8-3

ANSWER: 003 (1.00)
A.
REFERENCE:
PSBR Training Manual, Page 2-16

ANSWER: 004 (1.00)
B.
REFERENCE:
PSBR Training Manual, Page 2-22a

ANSWER: 005 (1.00)
A.
REFERENCE:
PSBR Training Manual, Page 2-27

ANSWER: 006 (1.00)
C.
REFERENCE:
PSBR Training Manual, Page 8-1

ANSWER: 007 (1.00)
B.
REFERENCE:
PSBR Training Manual, Page 2-19

ANSWER: 008 (1.00)
A.
REFERENCE:
PSBR Training Manual, Pages 2-28 through 2-32

ANSWER: 009 (1.00)
A.
REFERENCE:
PSBR Training Manual, Page 2-2

ANSWER: 010 (1.00)
C.
REFERENCE:
PSBR Training Manual, Page 2-21
Doubling Time = 0.693T; T = 16 seconds/0.693 = 23.09 seconds
$T = (\beta - \rho)/\rho\lambda$; $\rho = \beta/(\lambda T + 1)$
$\beta = 0.007$; $\lambda = 0.1$ seconds^{-1} ; $\rho = 0.007/((0.1 \text{ seconds}^{-1})(23.09 \text{ seconds}) + 1)$
$\rho = 0.0021 = 0.21\% \Delta K/K$

ANSWER: 011 (1.00)
B.
REFERENCE:
PSBR Training Manual, Page 8-1

ANSWER: 012 (1.00)
B.
REFERENCE:
PSBR Training Manual, Page 2-34

ANSWER: 013 (1.00)
D.
REFERENCE:
PSBR Training Manual, Page 2-35. Power = (mass flow rate)(specific heat)(temperature change)
Power = (400 gal/min)(1 ft^3/7.48 gal)(60 min/hr)(1 Btu/lb°F)(62.4 lb/ft^3)(17°F)/3413 Btu/hr/kW

ANSWER: 014 (1.00)
A.
REFERENCE:
PSBR Training Manual, Page 8-5

ANSWER: 015 (1.00)
C.
REFERENCE:
PSBR Training Manual, Page 2-9. A total of 70 thermal neutrons (100-20-10) are absorbed in the fuel plus other materials. Since the reactor is critical, there were 40 fissions (40x2.5 = 100). Since 85% of the absorptions result in fission, there were 40/0.85 = 47 neutrons absorbed in the fuel. The thermal utilization = 47/70 = 0.67.

ANSWER: 016 (1.00)
A.
REFERENCE:
PSBR Training Manual, Page 1-23

ANSWER: 017 (1.00)
A.
REFERENCE:
PSBR Training Manual, Page 2-8

ANSWER: 018 (1.00)
A.
REFERENCE:
PSBR Training Manual, Page 8-5

ANSWER: 019 (1.00)
B.
REFERENCE:
PSBR Training Manual, Page 2-19

ANSWER: 020 (1.00)
D.
REFERENCE:
PSBR Training Manual, Page 2-34
Since the coolant temperature increased, negative reactivity was added. Therefore, the rod must add positive reactivity, i.e. withdrawn. $7x5x10^{-5}/8.75x10^{-5}$ = 4 inches.

B. NORMAL/EMERGENCY PROCEDURES & RADIOLOGICAL CONTROLS

ANSWER: 001 (1.00)
C.
REFERENCE:
EP-1

ANSWER: 002 (1.00)
D.
REFERENCE:
AP-1

ANSWER: 003 (1.00)
A.
REFERENCE:
PSBR Training Manual, Page 7-27

ANSWER: 004 (1.00)
C.
REFERENCE:
PSBR Training Manual, Pages 7-7, 7-28. Radiation level of 10 mrem/hr at 1 meter (100 cm) results in 111 mrem/hr at 30 cm.

ANSWER: 005 (1.00)
B.
REFERENCE:
PSBR Technical Specifications, 3.2.4, AP-5.

ANSWER: 006 (1.00)
B.
REFERENCE:
SOP-9, Page A-1.

ANSWER: 007 (1.00)
D.
REFERENCE:
PSBR Technical Specifications, 1.1.14, AP-5.

ANSWER: 008 (1.00)
A, C.
REFERENCE:
PSBR Technical Specifications, 3.4, AP-5.

ANSWER: 009 (1.00)
A.
REFERENCE:
AP-1, Page 1.

ANSWER: 010 (1.00)
C.
REFERENCE:
AP-3, Page 4.

ANSWER: 011 (1.00)
A,2; B,3; C,1; D,4
REFERENCE:
SOP-3; SP-2; AP-17; AOP-4

ANSWER: 012 (1.00)
D.
REFERENCE:
PSBR Emergency Preparedness Plan, Section 4.1.

ANSWER: 013 (1.00)
A.
REFERENCE:
PSBR Technical Specifications, 1.1.30, AP-5.

ANSWER: 014 (1.00)
D.
REFERENCE:
SOP-9.

ANSWER: 015 (1.00)
C.
REFERENCE:
PSBR Technical Specifications, 3.2, AP-5.

ANSWER: 016 (1.00)
A.
REFERENCE:
PSBR Technical Specifications, 2.1, AP-5.

ANSWER: 017 (1.00)
A.
REFERENCE:
SOP-6, PSBR Training Manual Pages 2-25 and 2-26, section 2.22, and Technical Specifications 3.1.2, 3.1.3, 3.2.2, and 3.7.a

ANSWER: 018 (1.00)
B.
REFERENCE:
EP-2, “Fire and Explosion,” page 1.

ANSWER: 019 (1.00)
D.
REFERENCE:
EP-5, “Gaseous Release,” page 1.

ANSWER: 020 (1.00)
D.
REFERENCE:
SOP- 1, page 4.

C. FACILITY AND RADIATION MONITORING SYSTEMS

ANSWER: 001 (1.00)
C.
REFERENCE:
PSBR Training Manual, Page 3-24

ANSWER: 002 (1.00)
C.
REFERENCE:
PSBR Training Manual, Page 3-30

ANSWER: 003 (1.00)
B.
REFERENCE:
PSBR Training Manual, Page 6-5

ANSWER: 004 (1.00)
A.
REFERENCE:
PSBR Training Manual, Page 4-20

ANSWER: 005 (1.00)
B.
REFERENCE:
PSBR Training Manual, Page 6-7

ANSWER: 006 (1.00)
D.
REFERENCE:
PSBR Training Manual, Page 3-16

ANSWER: 007 (1.00)
C.
REFERENCE:
PSBR Training Manual, Page 5-2

ANSWER: 008 (1.00)
C.
REFERENCE:
PSBR Training Manual, Page 4-28.

ANSWER: 009 (1.00)
B.
REFERENCE:
PSBR Training Manual, Pages 3-19 through 3-22.

ANSWER: 010 (1.00)
B.
REFERENCE:
PSBR Training Manual, Page 3-18.

ANSWER: 011 (1.00)
D.
REFERENCE:
PSBR Training Manual, Page 3-17.

ANSWER: 012 (1.00)
A.
REFERENCE:
PSBR Training Manual, Page 5-2.

ANSWER: 013 (1.00)
A.
REFERENCE:
PSBR Training Manual, Page 3-8.

ANSWER: 014 (1.00)
D.
REFERENCE:
PSBR Training Manual, Pages 4-28 and 4-29.

ANSWER: 015 (1.00)
A.
REFERENCE:
PSBR Training Manual, Page 3-8.

ANSWER: 016 (1.00)
B.
REFERENCE:
PSBR Training Manual, page 3-12.

ANSWER: 017 (1.00)
C.
REFERENCE:
PSBR Training Manual, page 3-24.

ANSWER: 018 (1.00)
C.
REFERENCE:
PSBR Training Manual, page 4-29.

ANSWER: 019 (1.00)
B.
REFERENCE:
PSBR Training Manual, page 3-11.

ANSWER: 020 (1.00)
D.
REFERENCE:
PSBR Training Manual, page 3-17.