April 27, 2000

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-00-01

Dear Dr. Sears:

During the week of April 3, 2000, the NRC administered an initial examination to an employee 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 placed in the NRC Public Document Room. 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 J. Eresian at 301-415-1833.

Sincerely,

/RA/

Ledyard B. Marsh, Chief
Events Assessment, Generic Communications
and Non-Power Reactors Branch
Division of Regulatory Improvement Programs
Office of Nuclear Reactor Regulation

Docket No. 50-005

Enclosures: 1. Initial Examination Report No. 50-005/OL-00-01
2. Examination and answer key

cc w/encls:
Please see next page

cc:

Mr. Eric J. Boeldt, Manager
of Radiation Protection
The Pennsylvania State University
304 Old Main
University Park, PA 16802-1504

Mr. William P. Dornsife, Director
Bureau of Radiation Protection
Department of Environmental Protection
13th Floor, Rachel Carson State Office Building
P.O. Box 8469
Harrisburg, PA 17105-8469

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DOCUMENT NAME: ML003700842 **TEMPLATE #: NRR-074**
***Please see previous concurrence**

OFFICE	DIPM:IOLB		REXB:CE		REXB:BC	
NAME	*EBarnhill		*WEresian		LMarsh	
DATE	04/ 17 /2000		04/ 17 /2000		04/ 27 /2000	

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

REPORT NO.: 50-005/OL-00-01

FACILITY DOCKET NO.: 50-005

FACILITY LICENSE NO.: R-2

FACILITY: Pennsylvania State University

EXAMINATION DATES: April 5-6, 2000

EXAMINER: Warren Eresian, Chief Examiner

SUBMITTED BY: ***/RA/*** 04/10/2000
Warren Eresian, Chief Examiner Date

SUMMARY:

During the week of April 3, 2000, the NRC administered an operator licensing examination to one Senior Reactor Operator (Instant) candidate. The candidate passed all portions of the examination.

ENCLOSURE 1

REPORT DETAILS

1. Examiner: Warren Eresian, Chief Examiner

2. Results:

	RO PASS/FAIL	SRO PASS/FAIL	TOTAL PASS/FAIL
Written	**N/A**	**1/0**	**1/0**
Operating Tests	**N/A**	**1/0**	**1/0**
Overall	**N/A**	**1/0**	**1/0**

3. Exit Meeting:

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

The NRC thanked the facility staff for their cooperation during the examination. The facility provided a comment on the written examination concerning an outdated question.

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

FACILITY: Penn StateUniversity

REACTOR TYPE: TRIGA

DATE ADMINISTERED: 04/05/00

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)

Which ONE of the following is the principal source of energy (heat generation) in the reactor 15 minutes following a reactor shutdown from extended operation at full power?

a. Production of delayed neutrons.

b. Subcritical multiplication of neutrons.

c. Spontaneous fission of U-238.

d. Decay of fission products.

QUESTION: 002 (1.00)

A reactor with an initial population of 240,000 neutrons is operating with K_{eff} = 1.001. Considering only the increase in neutron population, how many neutrons (of the increase) will be prompt when the neutron population changes from the current generation to the next? Assume β = 0.007.

a. 24

b. 238

c. 2,400

d. 240,240

QUESTION: 003 (1.00)

During the neutron cycle from one generation to the next, several processes occur that may increase or decrease the available number of neutrons. Which ONE of the following factor describes an INCREASE in the number of neutrons during the cycle.

a. Thermal utilization factor.

b. Resonance escape probability.

c. Thermal non-leakage probability.

d. Fast fission factor.

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

QUESTION: 004 (1.00)

As a reactor continues to operate over time, for a constant power level, the average thermal neutron flux:

a. decreases, due to the increase in fission product poisons.

b. decreases, because fuel is being depleted.

c. increases, in order to compensate for fuel depletion.

d. remains the same.

QUESTION: 005 (1.00)

Which ONE of the following is the reason for operating with thermal neutrons rather than fast neutrons?

a. Probability of fission is increased since thermal neutrons are less likely to leak out of the core.

b. As neutron energy increases, neutron absorption in non-fuel materials increases exponentially.

c. The absorption cross-section of U-235 is much higher for thermal neutrons.

d. The fuel temperature coefficient becomes positive as neutron energy increases.

QUESTION: 006 (1.00)

A reactor is slightly supercritical with the following values for each of the factors in the six-factor formula:

Fast fission factor =	1.03
Fast non-leakage probability =	0.84
Resonance escape probability =	0.96
Thermal non-leakage probability =	0.88
Thermal utilization factor =	0.70
Reproduction factor =	1.96

A control is inserted to bring the reactor back to critical. Assuming all other factors remain unchanged, the new value for the thermal utilization factor is:

a. 0.698

b. 0.702

c. 0.704

d. 0.708

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

QUESTION: 007 (1.00)

Which ONE of the following describes the response of the subcritical reactor to equal insertions of positive reactivity as the reactor approaches criticality at low power?

a. Each reactivity insertion causes a SMALLER increase in the neutron flux, resulting in a LONGER time to stabilize.

b. Each reactivity insertion causes a LARGER increase in the neutron flux, resulting in a LONGER time to stabilize.

c. Each reactivity insertion causes a SMALLER increase in the neutron flux, resulting in a SHORTER time to stabilize.

d. Each reactivity insertion causes a LARGER increase in the neutron flux, resulting in a SHORTER time to stabilize.

QUESTION: 008 (1.00)

Which ONE of the following is true concerning the differences between prompt and delayed neutrons?

a. Prompt neutrons account for less than one percent of the neutron population while delayed neutrons account for approximately ninety-nine percent of the neutron population.

b. Prompt neutrons are released during fast fissions while delayed neutrons are released during thermal fissions.

c. Prompt neutrons are released during the fission process while delayed neutrons are released during the decay of fission products.

d. Prompt neutrons are the dominating factor in determining the reactor period while delayed neutrons have little effect on the reactor period.

QUESTION: 009 (1.00)

The fuel temperature coefficient of reactivity is -1.25E-4 delta K/K/deg.C. When a control rod with an average rod worth of 0.1% delta K/K/inch is withdrawn 10 inches, reactor power increases and becomes stable at a higher level. At this point, the fuel temperature has:

a. increased by 80 deg C.

b. decreased by 80 deg C.

c. increased by 8 deg C.

d. decreased by 8 deg C.

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

QUESTION: 010 (1.00)

For U-235, the thermal fission cross-section is 582 barns, and the capture cross-section is 99 barns. When a thermal neutron is absorbed by U-235, the probability that a fission will occur is:

a. 0.146

b. 0.170

c. 0.620

d. 0.855

QUESTION: 011 (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: 012 (1.00)

The major contributor to the production of Xenon-135 in a reactor operating at full power is:

a. directly from the fission of Uranium-235

b. from the radioactive decay of Iodine

c. from the radioactive decay of Promethium

d. directly from the fission of Uranium-238

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

QUESTION: 013 (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% ρK/K

b. 0.16% ρK/K

c. 0.21% ρK/K

d. 0.26% ρK/K

QUESTION: 014 (1.00)

A reactor is subcritical with a K_{eff} of 0.955. A positive reactivity of 3.5% delta k/k is inserted into the core. At this point, the reactor is:

a. supercritical.

b. exactly critical.

c. prompt critical.

d. subcritical.

QUESTION: 015 (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: 016 (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: 017 (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: 018 (1.00)

Inelastic scattering is the process whereby a neutron collides with a nucleus and:

a. recoils with a lower kinetic energy, with the nucleus emitting a gamma ray.

b. recoils with the same kinetic energy it had prior to the collision.

c. is absorbed by the nucleus, with the nucleus emitting a gamma ray.

d. recoils with a higher kinetic energy, with the nucleus emitting a gamma ray.

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

QUESTION: 019 (1.00)

Which ONE of the following elements will slow down fast neutrons least quickly, i.e. produces the smallest energy loss per collision?

a. Oxygen-16

b. Boron-10

c. Hydrogen-1

d. Uranium-238

QUESTION: 020 (1.00)

A reactor contains three control rods and a regulating rod. Which ONE of the following would result in a determination of the excess reactivity of this reactor?

a. The reactor is critical at a low power level, with all control rods full out and the regulating rod at some position. The reactivity remaining in the regulating rod (i.e. its rod worth from its present position to full out) is the excess reactivity.

b. All four rods are full in. The control rods and the regulating rod are withdrawn until the reactor becomes critical. The total rod worth withdrawn is the excess reactivity.

c. The reactor is at full power. The total rod worth of all rods withdrawn is the excess reactivity.

d. The reactor is at full power. The total rod worth remaining in all rods (i.e. their rod worths from their present positions to full out) is the excess reactivity.

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

QUESTION: 001 (1.00)

In accordance with the Technical Specifications, which ONE situation below is NOT permissible when the reactor is operating?

a. Scram time of a control rod = 1 second.

b. Depth of water above the top of the bottom grid plate = 18 feet.

c. Conductivity of bulk pool water = 5 micromhos/cm.

d. Reactivity insertion rate by a control rod = 0.12% delta k/k per second.

QUESTION: 002 (1.00)

Which ONE of the following is a Technical Specification requirement related to experiments at PSBR?

a. A single secured experiment shall be limited to a maximum of 2.59% delta k/k.

b The sum of the reactivity worth of all experiments shall be less than 2.45% delta k/k.

c. The reactivity of the movable experiment and/or movable portions of a secured experiment shall have a reactivity worth less than 2.59% delta k/k.

d. When the movable experiment is worth more than 0.14% delta k/k the maximum allowed pulse shall be reduced below the allowed pulse reactivity insertion of 2.59% delta k/k.

QUESTION: 003 (1.00)

Which ONE of the following would be classified as an OPERATIONAL EVENT?

a. Operation in violation of a safety limit

b. Release of fission products from a fuel element

c. Unanticipated reactivity change greater than $1.00

d. Reactor scram

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

QUESTION: 004 (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: 005 (1.00)

Which ONE of the following describes the transmission of coded alarms to the Police Services from the Breazeale Reactor? Alarms are generated by:

a. the DCC-X computer and transmitted over a hard wired transmission system.

b. the DDC-Z computer and transmitted over the FAX telephone line.

c. a hard wired system and transmitted over a dedicated phone line.

d. a hard wired system and transmitted over the FAX line and a dedicated phone line.

QUESTION: 006 (1.00)

Which ONE of the following defines the initiation and removal of DO NOT OPERATE TAG-OUT tags?

a. An RO or SRO may date, initial the tag, and enter it into the Reactor Log Book, but only an SRO may remove the tag.

b. Only an SRO may date, initial the tag, and enter it into the Reactor Log Book, but an RO or SRO may authorize the removal of the tag.

c. The Director shall be responsible for dating and initialing the tag and entering it into the Reactor Log Book, and the tag may removed by the Director, operations Manager or their designate.

d. The Operations manager shall be responsible for dating and initialing the tag and entering it in the Reactor Log Book, and the tag can only be removed by an SRO.

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

QUESTION: 007 (1.00)

The OPERATIONS BOUNDARY is defined as:

a. the reactor building and all connected structures.

b. the chain-link fence surrounding the facility.

c. the reactor bay (room 123) and control room (room 119).

d. the "red" area (radiochemical storage, control room, reactor bay, hot cells).

QUESTION: 008 (1.00)

You are the Duty SRO and have been notified by Police Services that the reactor facility intrusion alarm system Zone 03 is in the activated in-alarm condition. You should immediately:

a. notify the Operations Manager.

b. notify the Director of the PSBR.

c. activate the Emergency Plan.

d. proceed to the reactor.

QUESTION: 009 (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 Policy
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

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

QUESTION: 010 (1.00)

The Reactor Emergency Call List contains the names of senior reactor operators and the month during which they will be normally available for emergency calls. If the person designated cannot be reached:

a. the Facility Director should be called.

b. the Operations Manager should be called.

c. the next person down the list should be called.

d. the Health Physicist should be called.

QUESTION: 011 (1.00)

In accordance with the Technical Specifications, which ONE of the following conditions is permissible when the reactor is operating?

a. Reactor core cooled by natural convective water flow.

b. One control rod is inoperable but fully inserted into the core.

c. A single secured experiment having a reactivity worth of 2.59% delta k/k.

d. Operating in square wave mode with the linear power channel inoperable.

QUESTION: 012 (1.00)

Which ONE of the following does NOT require the direct supervision of a licensed Senior Reactor Operator?

a. Recovery from an unplanned scram.

b. Relocation of an in-core experiment worth $1.50.

c. A reactor operator trainee during a pulse operation.

d. A licensed Reactor Operator moving fuel within the core.

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

QUESTION: 013 (1.00)

In accordance with 10 CFR Part 20, which ONE of the following defines “Total Effective Dose Equivalent?”

a. The sum of internal exposure and external exposure.

b. The dose received by the whole body from sources outside the body.

c. The sum of external exposure and organ dose.

d. The dose to a specific organ or tissue resulting from an intake of radioactive material.

QUESTION: 014 (1.00)

Reactor operations are being conducted around the clock over the weekend, during which time the Reactor Operator (RO) becomes ill and is taken to the hospital. Only the Senior Reactor Operator (SRO) and an operator trainee remain in the facility. Reactor operations:

a. must be discontinued because the trainee can only operate the reactor under the direction of an RO.

b. must be discontinued because both an RO and an SRO must be present at the facility.

c. may continue until a replacement RO can arrive at the facility, up to a maximum of 30 minutes.

d. may continue since the SRO can monitor the console while the trainee makes periodic tours.

QUESTION: 015 (1.00)

Match the 10 CFR Part 55 requirements listed in Column A for an actively licensed operator with the correct time period from Column B. Column B answers may be used once, more than once, or not at all.

	Column A		Column B
a.	License Expiration	1.	1 year
b.	Medical Examination	2.	2 years
c.	Requalification Written Examination	3.	3 years
d.	Requalification Operating Test	4.	6 years

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

QUESTION: 016 (1.00)

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

a. The source level interlock is momentarily defeated.

b. Bulk pool water temperature = 95 degrees F.

c. The Continuous Air (Radiation) Monitor is temporarily out of service and has been replaced by a portable monitor.

d. The reactor bay truck door is open for ten minutes.

QUESTION: 017 (1.00)

A high radiation area is established in a room for an experiment, and the area has been posted as a High Radiation Area. Which ONE of the following additional actions must be taken?

a. Equip the entry door with a surveillance camera with a monitor in the control room.

b. Place portable radiation monitors in the room.

c. Equip the door with an audible or visible alarm in the control room.

d. Place a lock on the door.

QUESTION: 018 (1.00)

At 8:00 am, prior to the start of reactor operation, a checkout procedure is performed in accordance with SOP-2. The reactor is started up, operated, and then secured at 1:00 pm. At 4:00 pm, the reactor is to be started up again for an extended run into the next day. In accordance with SOP-2:

a. a new checkout procedure must be performed.

b. the checkout procedure does not need to be performed.

c. only the power range monitor checks and tests, and fuel temperature 1 and 2 channel checks and tests must be performed.

d. only the manual scram channel test must be performed.

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

QUESTION: 019 (1.00)

Which ONE of the following is an action the reactor operator is required to take according to SOP-9, “Pneumatic Transfer Systems Operation” if the Rabbit 1 (Pneumatic Transfer System I) surge tank radiation alarm sounds.

a. Close the Carbon Dioxide (CO_2) supply valve to the pneumatic tube.

b. Turn ON the fan to drive the radioactive material to the surge vol ume.

c. Scram the reactor.

d. Begin an manual insertion of control rods to shutdown the reactor.

QUESTION: 020 (1.00)

Which ONE of the following operating conditions Is required for the removal of the reactor emergency exhaust system from service for maintenance or repair?

a. If the system is going to be inoperable for more than eight hours, the reactor must be shutdown and placed in the STANDBY mode.

b. Reactor operation may continue indefinitely provided the facility exhaust system is operable with both fans running.

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

d. Reactor operation may continue provided the emergency exhaust system is isolated and the Reactor Bridge Air and Radiation Monitors are operable to isolate the facility exhaust system.

(***** 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)

All operational interlocks and safety trips required by technical specifications are performed by the:

a. Digital Control Computer (DCC-Z)

b. Digital Control Computer (DCC-X)

c. protection, control and monitoring system (PCMS)

d. reactor safety system (RSS)

QUESTION: 003 (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 ion chamber count rate is greater than 1 CPS in the manual mode

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

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

QUESTION: 004 (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: 005 (1.00)

For a standard control rod, the rod drive up arrow is red, the rod drive down arrow is red, and the rod drive magnet block is yellow. This indicates that:

a. the rod and drive are in contact, and are both full down

b. the rod and drive are in contact, and are both full up

c. the rod and drive are not in contact, and the rod and drive are somewhere between full up and full down

d. the rod and drive are in contact, and are somewhere between full up and full down

QUESTION: 006 (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

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

QUESTION: 007 (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: 008 (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: 009 (1.00)

Which ONE of the following describes the purpose of the flux trap in the D_2O Thermal Column?

a. Provides high energy (fast) neutrons for use directly at the Beam Port.

b. Provides a shield to prevent high energy (fast) neutrons from penetrating low energy (thermal) neutron areas.

c. Provides a volume filled with air to provide optimum flux to the central thimble.

d. Provides correct thickness of D_2O between the reactor and the trap for optimum flux to the beam port.

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

QUESTION: 010 (1.00)

Which ONE of the following is the purpose of the 12 inch by 16 inch aluminum safety plate suspended below the bottom grid plate of the core?

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

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

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

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

QUESTION: 011 (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: 012 (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.

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

QUESTION: 013 (1.00)

SOP-1 requires balanced rods when power is above 900 kW. The reason for this requirement is:

a. to prevent flux tilting which may affect the reading from the Wide Range Monitor.

b. to prevent an uneven distribution of power generation which would result in uneven fuel burnup.

c. to ensure that the period signal from the Wide Range Monitor accurately reflects the true rate of change of power.

d. to ensure that the output of the Power Range Monitor is not affected by fission product decay gammas as power becomes higher.

QUESTION: 014 (1.00)

Which ONE of the following is a correct description of the design response of the emergency lighting system when AC current is lost?

a. A relay closes so that the un-interruptible power supply (UPS) provides power to the emergency lighting system.

b. A relay closes so that emergency generator power is supplied to the emergency lighting system lights.

c. A relay closes so that emergency lighting system battery DC power is supplied to the emergency lighting system lights.

d. An alarm indication is sent to the DCC-X which initiates transfer to the facility transformer.

QUESTION: 015 (1.00)

Several sources of water are available for adding water to the pool. Which ONE of the methods described below can be used?

a. The distillate from the waste evaporator can be valved into the primary pump suction line.

b. Water from the University water system can be connected, via a fire hose, to the outlet of the primary side of the heat exchanger.

c. Water from the University water system can be connected, via a fire hose, to the pool drain lines.

d. Water from the pool water storage tank can be pumped directly (via the storage tank transfer pump) into the discharge of the primary pump.

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

QUESTION: 016 (1.00)

Which ONE of the following describes a PSBR fuel-moderator element?

	Cladding	Weight% Uranium	Fuel Length
a.	Stainless Steel	8.5	15 inches
b.	Zirconium	8.5	22 inches
c.	Zirconium	12.0	15 inches
d.	Stainless Steel	12.0	22 inches

QUESTION: 017 (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.

QUESTION: 018 (1.00)

A signal of notification to Penn State University Police Services is initiated by:

a. reactor bay truck door open

b. UPS battery low

c. emergency exhaust system initiation

d. DCC-Z watchdog trip

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

QUESTION: 019 (1.00)

Reclaimed water from the Liquid Waste Evaporator System is transferred to the reactor pool as makeup water by the:

a. makeup pump

b. processed water pump

c. distillate pump

d. storage tank transfer pump

QUESTION: 020 (1.00)

Which ONE of the following types of detector is used in the Reactor Bay East and West Monitors?

a. Geiger-Mueller tube

b. Scintillation detector

c. Ionization chamber

d. Proportional counter

(***** 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

$Q = m\ c_p\ \rho T$

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

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

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

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

$DR_1 D_1^{\ 2} = DR_2 D_2^{\ 2}$

$DR = DR_o e^{-\rho t}$

$DR = 6CiE/D^2$

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

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

1 kW = 3413 Btu/hour

1 gallon (water) = 8.34 pounds

$°F = 9/5°C + 32$

$°C = 5/9\ (°F - 32)$

ENCLOSURE 2

A. REACTOR THEORY, THERMODYNAMICS & FACILITY OPERATING CHARACTERISTICS

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

ANSWER: 002 (1.00)
B.
REFERENCE:
PSBR Training Manual, page 2-16
240,000x0.001 = 240 neutron increase.
Prompt neutrons = 240x(1-beta) = 240x0.993 = 238.

ANSWER: 003 (1.00)
D.
REFERENCE:
PSBR Training Manual, page 2-5

ANSWER: 004 (1.00)
C.
REFERENCE:
PSBR Training Manual, page 2-28
Reaction Rate = macroscopic cross section x thermal neutron flux. For a constant reaction rate (constant power), as the macroscopic cross section decreases due to fuel burnup, the thermal flux increases.

ANSWER: 005 (1.00)
C.
REFERENCE:
PSBR Training Manual, page 2-1

ANSWER: 006 (1.00)
A.
REFERENCE:
PSBR Training Manual, page 2-8
Since Keff decreases, the thermal utilization must decrease.

ANSWER: 007 (1.00)
B.
REFERENCE:
PSBR Training Manual, page 2-22

ANSWER: 008 (1.00)
C.
REFERENCE:
PSBR Training Manual, page 2-16

ANSWER: 009 (1.00)
A.
REFERENCE:
PSBR Training Manual, page 2-34

ANSWER: 010 (1.00)
D.
REFERENCE:
PSBR Training Manual, page 2-6

ANSWER: 011 (1.00)
B.
REFERENCE:
PSBR Training Manual, page 2-22a

ANSWER: 012 (1.00)
B.
REFERENCE:
PSBR Training Manual, page 2-28

ANSWER: 013 (1.00)
C.
REFERENCE:
PSBR Training Manual, page 2-2.
Doubling Time = O.693T; T = 16 seconds/0.693 = 23.09 seconds
T = (B-p)/Lp
B = 0.007; L = 0.1 seconds^{-1}
p = 0.0021 or 0.21%

ANSWER: 014 (1.00)
D.
REFERENCE:
PSBR Training Manual, page 2-14. For K = 0.955, reactivity = (K-1)/K = -4.7% delta k/k. When +3.5% delta k/k is added, the new reactivity will be -4.7% + 3.5% = -1.2%, i.e. subcritical.

ANSWER: 015 (1.00)
B.
REFERENCE:
PSBR Training Manual, page 2-34.

ANSWER: 016 (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^{o}F)(62.4 lb/ft^3)(17^{o}F)/3413 Btu/hr/kW

ANSWER: 017 (1.00)
A.
REFERENCE:
PSBR Training Manual, page 8-5.

ANSWER: 018 (1.00)
A.
REFERENCE:
PSBR Training Manual, page 1-22.

ANSWER: 019 (1.00)
D.
REFERENCE:
PSBR Training Manual, page 8-1.

ANSWER: 020 (1.00)
A.
REFERENCE:
PSBR Technical Specifications, 1.1.9.

B. NORMAL/EMERGENCY PROCEDURES & RADIOLOGICAL CONTROLS

ANSWER: 001 (1.00)
A.
REFERENCE:
PSBR Technical Specifications, section 3.2.6

ANSWER: 002 (1.00)
B.
REFERENCE:
PSBR Technical Specifications, section 3.7

ANSWER: 003 (1.00)
D.
REFERENCE:
AP-4, section V.C

ANSWER: 004 (1.00)
D.
REFERENCE:
SOP-9, section IV.A.4

ANSWER: 005 (1.00)
D.
REFERENCE:
PSBR Training Manual, page 3-22

ANSWER: 006 (1.00)
A.
REFERENCE:
AP-10, section V.A.3, 5

ANSWER: 007 (1.00)
A.
REFERENCE:
EP-1, page A-9

ANSWER: 008 (1.00)
D.
REFERENCE:
EP-11, page 1

ANSWER: 009 (1.00)
A,2; B,3; C,1; D,4
REFERENCE:
SOP-3; SP-2; AP-17; AOP-4

ANSWER: 010 (1.00)
C.
REFERENCE:
EP-1, page A-1

ANSWER: 011 (1.00)
A.
REFERENCE:
PSBR Technical Specifications, section 5.6

ANSWER: 012 (1.00)
C.
REFERENCE:
AP-1

ANSWER: 013 (1.00)
A.
REFERENCE:
PSBR Training Manual, page 7-3

ANSWER: 014 (1.00)
B.
REFERENCE:
AP-1

ANSWER: 015 (1.00)
A,4: B,2; C,2; D,1.
REFERENCE:
AP-3

ANSWER: 016 (1.00)
B.
REFERENCE:
PSBR Technical Specifications, section 3.3.6

ANSWER: 017 (1.00)
D.
REFERENCE:
PSBR Training Manual, page 7-10.

ANSWER: 018 (1.00)
B.
REFERENCE:
SOP-2, section V.B.1

ANSWER: 019 (1.00)
C.
REFERENCE:
SOP-9, page 4.

ANSWER: 020 (1.00)
C.
REFERENCE:
PSBR Technical Specifications, section 3.7

C. FACILITY AND RADIATION MONITORING SYSTEMS

ANSWER: 001 (1.00)
C.
REFERENCE:
PSBR Training Manual, page 3-23

ANSWER: 002 (1.00)
D.
REFERENCE:
PSBR Training Manual, page 4-15

ANSWER: 003 (1.00)
A.
REFERENCE:
PSBR Training Manual, page 4-37.

ANSWER: 004 (1.00)
B.
REFERENCE:
PSBR Training Manual, page 6-7

ANSWER: 005 (1.00)
D.
REFERENCE:
PSBR Training Manual, page 6-5

ANSWER: 006 (1.00)
C.
REFERENCE:
PSBR Training Manual, page 5-2

ANSWER: 007 (1.00)
C.
REFERENCE:
PSBR Training Manual, page 4-28.

ANSWER: 008 (1.00)
D.
REFERENCE:
Penn State Training Manual, Page 3-17.

ANSWER: 009 (1.00)
D.
REFERENCE:
Penn State SAR, page VI-4

ANSWER: 010 (1.00)
A.
REFERENCE:
Penn State SAR, page III-3

ANSWER: 011 (1.00)
A.
REFERENCE:
PSBR Training Manual, page 3-8.

ANSWER: 012 (1.00)
C.
REFERENCE:
PSBR Training Manual, page 3-23.

ANSWER: 013 (1.00)
A.
REFERENCE:
PSBR Training Manual, page 5-2.

ANSWER: 014 (1.00)
C.
REFERENCE:
PSBR Training Manual, page 3-22.

ANSWER: 015 (1.00)
C.
REFERENCE:
PSBR Training Manual, page 3-12.

ANSWER: 016 (1.00)
A.
REFERENCE:
PSBR Training Manual, page 3-5.

ANSWER: 017 (1.00)
D.
REFERENCE:
PSBR Training Manual, page 3-17.

ANSWER: 018 (1.00)
B.
REFERENCE:
PSBR Training Manual, Page 4-30

ANSWER: 019 (1.00)
B.
REFERENCE:
PSBR Training Manual, Page 3-20

ANSWER: 020 (1.00)
A.
REFERENCE:
PSBR Training Manual, Page 4-11