June 23, 2005

Dr. C. Frederick Sears, Director
Radiation Science and Engineering Center
Breazeale Nuclear Reactor Building
Pennsylvania State University
University Park, PA 16802-2301

SUBJECT: INITIAL EXAMINATION REPORT NO. 50-5/OL-05-01, PENNSYLVANIA STATE UNIVERSITY

Dear Dr. Sears:

During the week of June 6, 2005, 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 2.390 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/reading-rm/adams.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/

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. 50-5

Enclosures: 1. Initial Examination Report No. 50-5/OL-05-01
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

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

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

Test, Research, and Training
Reactor Newsletter
University of Florida
202 Nuclear Sciences Center
Gainesville, FL 32611

June 23, 2005

Dr. C. Frederick Sears, Director
Radiation Science and Engineering Center
Breazeale Nuclear Reactor Building
Pennsylvania State University
University Park, PA 16802-2301

SUBJECT: INITIAL EXAMINATION REPORT NO. 50-5/OL-05-01, PENNSYLVANIA STATE UNIVERSITY

Dear Dr. Sears:

During the week of June 6, 2005, 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 2.390 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/reading-rm/adams.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/

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. 50-5

Enclosures: 1. Initial Examination Report No. 50-5/OL-05-01
2. Examination and answer key

cc w/encls: Please see next page

DISTRIBUTION:

PUBLIC	RNRP\R&TR r/f	Facility File (EBarnhill)
MMendonca, PM	WEresian	PMadden

EXAMINATION PACKAGE ACCESSION NO.: ML051710100
EXAMINATION REPORT ACCESSION NO.: ML051710207 **TEMPLATE No.: NRR-074**

OFFICE	RNRP:CE		IROB:LA		RNRP:SC	
NAME	WEresian		EBarnhill		PMadden	
DATE	6/21/05		6/22/05		6/23/05	

C = COVER **E = COVER & ENCLOSURE** **N = NO COPY**
OFFICIAL RECORD COPY

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

REPORT NO.:	50-5/OL-05-01
FACILITY DOCKET NO.:	50-5
FACILITY LICENSE NO.:	R-2
FACILITY:	Pennsylvania State University
EXAMINATION DATES:	June 6-7, 2005
EXAMINERS:	Warren Eresian, Chief Examiner
SUBMITTED BY:	**/RA/** 06/21/2005
	Warren Eresian, Chief Examiner Date

SUMMARY:

During the week of June 6, 2005, the NRC administered an operator licensing examination to one Senior Reactor Operator (Instant) candidate. The candidate passed the examination.

ENCLOSURE 1

REPORT DETAILS

1. Examiners: 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:

Warren Eresian, NRC Chief Examiner
Terry Flinchbaugh, Associate Director for Operations

The NRC thanked the facility staff for their cooperation during the examination. No generic concerns were noted. The facility reviewed the written examination and provided no comments.

U. S. NUCLEAR REGULATORY COMMISSION
RESEARCH REACTOR LICENSE EXAMINATION

FACILITY: Pennsylvania State University

REACTOR TYPE: TRIGA

DATE ADMINISTERED: 06/06/2005

REGION: 1

CANDIDATE:_____

INSTRUCTIONS TO CANDIDATE:

Answers are to be written on the answer sheets provided. Attach all answer sheets to the examination. Points for each question are indicated in parentheses for each question. A score of 70 percent in each category is required to pass the examination.

Examinations will be picked up 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 PROCEDURES AND RADIOLOGICAL CONTROLS
20	33.3	_____	_____	C. FACILITY AND RADIATION MONITORING SYSTEMS
60	100	_____	_____	
			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. 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.

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

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

10. 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)

In a subcritical reactor, K_{eff} is increased from 0.861 to 0.946. Which ONE of the following is the amount of reactivity that was added to the reactor core?

a. 0.085 delta k/k

b. 0.104 delta k/k

c. 0.161 delta k/k

d. 0.218 delta k/k

QUESTION: 002 (1.00)

Which ONE of the following describes the difference between reflectors and moderators?

a. Reflectors decrease core leakage while moderators thermalize neutrons

b. Reflectors shield against neutrons while moderators decrease core leakage

c. Reflectors decrease thermal leakage while moderators decrease fast leakage

d. Reflectors thermalize neutrons while moderators decrease core leakage

QUESTION: 003 (1.00)

A reactor is operating at a steady-state power level of 1.000 MW. Reactor power is increased to a new steady-state power level of 1.004 MW. At the higher level, K_{eff} is:

a. 1.004

b. 1.000

c. 0.004

d. 0.000

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

QUESTION: 004 (1.00)

Which ONE of the following is NOT true regarding neutron cross sections?

a. Nuclear cross section is the sum of the neutron scattering and absorption cross sections for a specific material.

b. Microscopic cross section is the area of neutron interaction for a wall of material one atom thick.

c. Macroscopic cross section is the product of the microscopic cross section and the number of nuclei per unit volume.

d. Nuclear cross section is the sum of the microscopic and macroscopic cross sections for a specific material.

QUESTION: 005 (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 coolant.

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.

QUESTION: 006 (1.00)

Which ONE of the following is NOT true regarding delayed neutrons?

a. Delayed neutrons comprise less than one percent of the total neutrons.

b. Delayed neutrons are produced from unstable nuclides or fission products.

c. Delayed neutrons are produced at the same energy as prompt neutrons.

d. The fraction of delayed neutrons in a TRIGA core depends on fuel element spacing.

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

QUESTION: 007 (1.00)

The reaction $+ {}_0n^1 + {}_5B^{10} \longrightarrow {}_5B^{11*} \longrightarrow {}_3Li^7 + {}_2He$ is primarily used in which ONE of the following processes?

a. Instrumentation for the detection of neutrons.

b. Neutron moderation for reactors.

c. Elastic scattering of neutrons.

d. Inelastic scattering of neutrons.

QUESTION: 008 (1.00)

Reactor power has increased in 305 seconds from 50 watts to 75 KW on a stable reactor period. Which ONE of the following was the stable reactor period of the power change?

a. 0.24 seconds.

b. 42 seconds.

c. 61 seconds.

d. 752 seconds.

QUESTION: 009 (1.00)

Which ONE of the following describes the purposes of the neutron source for a reactor?

a. To provide delayed neutrons to ensure reactor control, and to provide a steady source of neutrons to increase count rate.

b. To provide neutrons during reactor start-up, and to provide an initial neutron flux field to which the neutron detectors are sensitive.

c. To provide neutrons for reactor startup, and to decrease the amount of time it takes for subcritical multiplication to level off during reactor startup.

d. To provide an initial neutron flux field to which the neutron detectors are sensitive, and to absorb neutrons at high power densities.

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

QUESTION: 010 (1.00)

In the Penn State TRIGA reactor, which ONE of the following represents the reactivity losses for which compensation must be provided?

a. U-238 depletion, control rod depletion, temperature effects, and graphite reflectors depletion

b. fuel depletion, control rod depletion, void effects, and experimental worth

c. U-238 depletion, fission product poisoning, void effects, and graphite reflectors depletion

d. fuel depletion, fission product poisoning, temperature effects, and experimental worth

QUESTION: 011 (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. Production of gammas.

QUESTION: 012 (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

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

QUESTION: 013 (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.

QUESTION: 014 (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: 015 (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: 016 (1.00)

Which ONE of the following parameter changes will require control rod INSERTION to maintain constant power level following the change?

a. Pool water temperature increase.

b. Insertion of a void into the core.

c. Removal of an experiment containing cadmium.

d. Buildup of samarium in the core.

QUESTION: 017 (1.00)

Which ONE of the following is the time period during which the MAXIMUM amount of Xenon-135 will be present in the core?

a. 10 to 12 hours after a startup to 100% power.

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

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

d. 10 to 12 hours after shutdown from 100% power.

QUESTION: 018 (1.00)

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

a. The order of fuel placement.

b. The source strength.

c. The location of the source in the core.

d. The location of the detector (or detectors) in the core.

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

QUESTION: 019 (1.00)

Which ONE of the following is the principal moderator in the Penn State TRIGA reactor?

a. Graphite.

b. Heavy water (D_20).

c. Water.

d. Zirconium hydride.

QUESTION: 020 (1.00)

Which ONE of the following is NOT a major contributor to the prompt negative temperature coefficient at the Penn State TRIGA reactor?

a. The U-235 Doppler effect.

b. The U-238 Doppler effect.

c. The ZrH cell effect.

d. The core leakage effect.

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

QUESTION: 001 (1.00)

The Safety Limit for fuel element temperature is:

a. 1150 deg F.

b. 1150 deg C.

c. 650 deg F.

d. 650 deg C.

QUESTION: 002 (1.00)

The measuring channel required to be operable in ALL modes of reactor operation is:

a. fuel element temperature.

b. power level (linear).

c. reactor period/SUR.

d. log power.

QUESTION: 003 (1.00)

In accordance with AP-4, which ONE of the following would be classified as an OPERATIONAL EVENT?

a. Operation in violation of a safety limit.

b. Failure of a safety circuit or system it controls.

c. A restricted area not properly posted as a Radiation Area.

d. Reactor scram

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

QUESTION: 004 (1.00)

When performing an emergency shutdown of the pool cooling system, the operator should:

a. verify that valves 80 and 82 automatically close when the primary pump is stopped.

b. manually close tagged valves 80A and 82A after stopping the primary pump.

c. open valves 80 and 82 and verify that valves 80A and 82A automatically open.

d. close valves 80 and 82 and verify that valves 80A and 82A automatically close.

QUESTION: 005 (1.00)

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

a. The Emergency Exhaust System is inoperable for three days for repairs

b. A single secured experiment with a reactivity worth of 2.31% delta k/k

c. The reactivity insertion rate for standard control rods is 6.3% delta k/k per second

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

QUESTION: 006 (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.

(*****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)

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: 009 (1.00)

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

a. Reactor core cooled by natural convective water flow.

b. An aluminum-clad fuel element.

c. A single moveable experiment having a reactivity worth of 2.45% delta k/k.

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

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

QUESTION: 010 (1.00)

The REACTOR SITE 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 reactor bay, Co-60 facility, and control room.

QUESTION: 011 (1.00)

A survey instrument with a window probe is used to measure low energy beta and gamma radiation from an irradiated experiment. The dose rate is 100 mrem/hour with the window open and 60 mrem/hour with the window closed. The gamma dose rate is:

a. 100 mrem/hour.

b. 60 mrem/hour.

c. 40 mrem/hour.

d. 160 mrem/hour.

QUESTION: 012 (1.00)

Which ONE of the following is NOT required by the Technical Specifications?

a. When the K_{eff} of the core is less than 1 with all control rods at their upper limit and no experiments in or near the core, any experiment may be added without limit.

b. The two dedicated fire hoses that provide supply water to the pool in an emergency shall be visually inspected for damage and wear annually, not to exceed 15 months.

c. The reactor shall be housed in a room (reactor bay) designed to restrict leakage with a minimum free volume of 1900 cubic meters.

d. A licensed operator in the control room, a second person at the facility able to carry out written instructions, and a senior reactor operator available by telephone and able to be at the facility within 30 minutes.

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

QUESTION: 013 (1.00)

Which ONE of the following is NOT true for reactor power calibration?

a. The objective is to verify the performance and operability of the power measuring channel.

b. A thermal power level channel calibration will ensure that the reactor is operated at or below the authorized power level.

c. A thermal power channel calibration shall be made on the linear power level monitoring channel biennially, not to exceed 30 months.

d. The percent power level monitor of the Power Range channel shall be used as the official indication to verify that the reactor is operated at or below the authorized power level.

QUESTION: 014 (1.00)

A radioactive sample was removed from the reactor core, reading 25 rem/hour. Four (4) hours later, the sample reads 2.5 rem/hour. What is the approximate time required for the sample to decay to 100 mrem/hour from the 2.5 rem/hour point?

a. 1.9 hours.

b. 3.8 hours.

c. 5.6 hours.

d. 7.8 hours.

QUESTION: 015 (1.00)

Which ONE of the answers correctly fills in the blanks to describe Technical Specification requirements for fuel storage for the following sentence?

K_{eff} less than ____ for all conditions of moderation, and irradiated fuel elements must be stored in an array that allows _____ convection by water such that the fuel element temperature shall not exceed the _____

a. 0.95, forced, and safety limit.

b. 0.90, natural, and limiting condition of operation.

c. 0.80, natural, and limiting safety system setting.

d. 0.80, natural, and safety limit.

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

QUESTION: 016 (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 Associate Director for Operations.

b. notify the Director of the PSBR.

c. activate the Emergency Plan.

d. proceed immediately to the PSBR.

QUESTION: 017 (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.

QUESTION: 018 (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, in accordance with PSBR Technical Specifications?

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.

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

QUESTION: 019 (1.00)

Which ONE of the following answers correctly completes the statement “Shutdown margin assures that the reactor can be shut down:

a. with all moveable experiments, experiments with moveable parts, and experimental facilities in their most reactive state and with the highest reactivity worth control rod fully withdrawn, and the limiting safety system setting will not be exceeded.

b. with all moveable experiments, experiments with moveable parts, and experimental facilities in their most reactive state and with the highest reactivity worth control rod fully withdrawn, and the safety limit will not be exceeded.

c. with the highest reactivity worth control rod fully withdrawn, and the reactivity worth of moveable experiments will not be exceeded.

d. with all moveable experiments, experiments with moveable parts, and experimental facilities in their most reactive state, and the excess reactivity limit will not be exceeded.

QUESTION: 020 (1.00)

The capsule in a pneumatic transfer system fails to return from the reactor core at the proper time. The reactor operator must:

a. close the CO_2 supply valve and then open it again.

b reduce power and notify an SRO.

c. scram the reactor if the capsule cannot be returned within the next one (1) hour.

d. immediately scram the reactor.

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

QUESTION: 001 (1.00)

The TRIGA fuel elements consist of a mixture of zirconium hydride and:

a. 20% enriched uranium with stainless steel clad.

b. 12% enriched uranium with stainless steel clad.

c. 8.5% enriched uranium with stainless steel clad.

d. 20% enriched uranium with zirconium clad.

QUESTION: 002 (1.00)

The top grid plate in the reactor:

a. supports the weight of the fuel assemblies.

b. aligns and supports the nuclear detectors.

c. maintains lateral fuel alignment.

d. serves as a reflector over the top of the core.

QUESTION: 003 (1.00)

The Wide Range power monitor uses a (an):

a. uncompensated ion chamber.

b. compensated ion chamber.

c. fission chamber.

d. boron-trifluoride detector.

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

QUESTION: 004 (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: 005 (1.00)

Pool water temperature is limited to 140EF in order to ensure that:

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

b. the ion exchanger resins in the demineralizer are 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: 006 (1.00)

Streaming of radiation from the central thimble is prevented by:

a. a graphite shield box over the top of the tube.

b. the tube being filled with water.

c. a boral plug inserted into the top of the tube.

d. large radius bend in the tube.

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

QUESTION: 007 (1.00)

A reactor stepback is initiated by:

a. east or west bay monitor high radiation.

b. east and west facility exhaust fans off.

c. high fuel temperature.

d. pulse timer timed out.

QUESTION: 008 (1.00)

The purpose of the boral plate on top of the D_2O tank is to:

a. reduce radiation escaping from the core.

b. minimize production of gamma radiation resulting from neutron activation of the pool water.

c. reduce gamma interactions with the pool wall.

d. absorb reflected neutrons so that the outputs of the power range channel and wide range channel are in agreement.

QUESTION: 009 (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.

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

QUESTION: 010 (1.00)

The thermocouples in the instrumented fuel elements measure temperature at the:

a. interior surface of the cladding.

b. center of the zirconium rod.

c. outer surface of the fuel.

d. interior of the fuel.

QUESTION: 011 (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 60 psig and stop at 120 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.

QUESTION: 012 (1.00)

The RSS SCRAM logic is designed to meet the single failure criterion. Which ONE pair of parameters below are in the correct circuits?

	SCRAM Circuit # 1	SCRAM Circuit #2
a.	FC Power High	Fuel Temperature High
b.	GIC Bias Voltage Low	FC Bias Voltage Low
c.	GIC Power High	FC Power High
d.	Fuel Temperature High	Keyswitch Off

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

QUESTION: 013 (1.00)

In the Automatic Control mode, the controlling signal is:

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

b. reactor period as measured by the GIC.

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

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

QUESTION: 014 (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: 015 (1.00)

Which ONE of the following describes an RSS operational interlock function while in the PULSE mode of operation?

a. Prevents manual withdrawal of more than one rod.

b. Prevents application of air to the transient rod if the drive is not fully down.

c. Prevents manual withdrawal of any rod.

d. Prevents movement of all rods except the transient rod.

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

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

Which ONE of the following is a condition under which air can be applied to the cylinder of the transient rod on the DCC-X?

a. Pulse mode and initial power up to 100 kw.

b. Transient rod drive is at the bottom end of travel position.

c. Square wave mode and initial power greater than 1 kw.

d. The counter clockwise limit switch is closed.

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

QUESTION: 019 (1.00)

Which ONE of the following is a correct description of the design response of the facility 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 diesel 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: 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: 001 (1.00)
B.
REFERENCE:
PSBR Training Manual, Chapter 2, page 17.

ANSWER: 002 (1.00)
A.
REFERENCE:
PSBR Training Manual, Chapter 2, page 5.

ANSWER: 003 (1.00)
B.
REFERENCE:
PSBR Training Manual, Chapter 2, page 6.

ANSWER: 004 (1.00)
D.
REFERENCE:
PSBR Training Manual, Chapter 1, pages 30-32.

ANSWER: 005 (1.00)
A.
REFERENCE:
PSBR Training Manual, Chapter 2, page 3.

ANSWER: 006 (1.00)
C.
REFERENCE:
PSBR Training Manual, Chapter 2, page 21.

ANSWER: 007 (1.00)
A.
REFERENCE:
PSBR Training Manual, Chapter 1, page 29.

ANSWER: 008 (1.00)
B.
REFERENCE:
PSBR Training Manual, Chapter 2, page 22.

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

$P = 75{,}000$ W; $P_0 = 50$ W; $t = 305$ seconds

$T = t/(\ln P/P_0) = 42$ sec.

ANSWER: 009 (1.00)
B.
REFERENCE:
PSBR Training Manual, Chapter 2, page 26.

ANSWER: 010 (1.00)
D.
REFERENCE:
PSBR Training Manual, Chapter 2, page 35.

ANSWER: 011 (1.00)
D.
REFERENCE:
PSBR Training Manual, Chapter 2, page 3.

ANSWER: 012 (1.00)
B.
REFERENCE:
PSBR Training Manual, Chapter 2, page 19.

240,000x0.001 = 240 neutron increase; prompt neutrons = 240x(1-beta) = 240x0.993 = 238.

ANSWER: 013 (1.00)
D.
REFERENCE:
PSBR Training Manual, Chapter 2, page 6.
ANSWER: 014 (1.00)
C.
REFERENCE:
PSBR Training Manual, Chapter 2, page 5.

ANSWER: 015 (1.00)
A.
REFERENCE:
PSBR Training Manual, Chapter 2, page 10.
Since K_{eff} decreases, the thermal utilization must decrease.

ANSWER: 016 (1.00)
C.
REFERENCE:
PSBR Training Manual, Chapter 2, page 43.
Insertion of a control rod inserts negative reactivity to balance the positive reactivity added when removing a neutron absorber.

ANSWER: 017 (1.00)
D.
REFERENCE:
PSBR Training Manual, Chapter 2, page 38.

ANSWER: 018 (1.00)
B.
REFERENCE:
PSBR Training Manual, Chapter 2, page 14.

ANSWER: 019 (1.00)
D.
REFERENCE:
PSBR Training Manual, Chapter 2, page 5.

ANSWER: 020 (1.00)
A.
REFERENCE:
PSBR Training Manual, Chapter 2, page 42.

B. NORMAL/EMERGENCY PROCEDURES AND RADIOLOGICAL CONTROLS

ANSWER: 001 (1.00)
B.
REFERENCE:
PSBR Technical Specifications, Section 2.1

ANSWER: 002 (1.00)
A.
REFERENCE:
PSBR Technical Specifications, Section 3.2.3, Table 1.

ANSWER: 003 (1.00)
D.
REFERENCE:
AP-4, Section C.1.

ANSWER: 004 (1.00)
D.
REFERENCE:
SP-3, Section D.

ANSWER: 005 (1.00)
B.
REFERENCE:
PSBR Technical Specifications, Section 3.7.b.

ANSWER: 006 (1.00)
D.
REFERENCE:
PSBR Training Manual, Chapter 3, page 23.

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

ANSWER: 008 (1.00)
C.
REFERENCE:
EP-1, page A-1.

ANSWER: 009 (1.00)
A.
REFERENCE:
PSBR Technical Specifications, Section 5.6.

ANSWER: 010 (1.00)
B.
REFERENCE:
EP-1, page A-9.

ANSWER: 011 (1.00)
B.
REFERENCE:
PSBR Training Manual, Chapter 4, page 6. Low energy beta radiation cannot penetrate the window, so the gamma dose rate is the dose rate measured with the window closed.

ANSWER: 012 (1.00)
A.
REFERENCE:
PSBR Technical Specifications, Section 3.7.c.

ANSWER: 013 (1.00)
D.

REFERENCE:
PSBR Technical Specifications, Section 4.1.1.

ANSWER: 014 (1.00)
C.
REFERENCE:
PSBR Training Manual, Chapter 1, page 17.
$DR/DR_o = 0.1 = e^{-\lambda t}$; t = 4 hours ; $\lambda = 0.576$/hour
$DR/DR_o = 0.04 = e^{-0.576t}$; t = 5.6 hours.

ANSWER: 015 (1.00)
D.
REFERENCE:
PSBR Technical Specifications, Section 5.4.

ANSWER: 016 (1.00)
D.
REFERENCE:
EP-11, Section C.1.

ANSWER: 017 (1.00)
C.
REFERENCE:
AP-1, Section B.

ANSWER: 018 (1.00)
C.
REFERENCE:
PSBR Technical Specifications. Section 3.5.a.

ANSWER: 019 (1.00)
B.
REFERENCE:
PSBR Technical Specifications, Section 3.1.3.

ANSWER: 020 (1.00)
D.
REFERENCE:
SOP-9, Section C.2.b.

C. FACILITY AND RADIATION MONITORING SYSTEMS

ANSWER: 001 (1.00)
A.
REFERENCE:
PSBR Training Manual, Chapter 3, page 5.

ANSWER: 002 (1.00)
C.
REFERENCE:
PSBR Training Manual, Chapter 3, page 1.

ANSWER: 003 (1.00)
C.
REFERENCE:
PSBR Training Manual, Chapter 4, page 9.

ANSWER: 004 (1.00)
B.
REFERENCE:
PSBR Training Manual, Chapter 3, page 14.

ANSWER: 005 (1.00)
B.
REFERENCE:
PSBR Training Manual, Chapter 3, page 12.

ANSWER: 006 (1.00)
B.
REFERENCE:
PSBR Training Manual, Chapter 3, page 34.

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

ANSWER: 008 (1.00)
D.
REFERENCE:
PSBR Training Manual, Chapter 5, page 2.

ANSWER: 009 (1.00)
A.
REFERENCE:
PSBR Training Manual, Chapter 4, page 11.

ANSWER: 010 (1.00)
D.
REFERENCE:
PSBR Training Manual, Chapter 3, page 5.

ANSWER: 011 (1.00)
B.
REFERENCE:
PSBR Training Manual, Chapter 3, page 19.

ANSWER: 012 (1.00)
D.
REFERENCE:
PSBR Training Manual, Chapter 4, page 35.

ANSWER: 013 (1.00)
C.
REFERENCE:
PSBR Training Manual, Chapter 5, page 2.

ANSWER: 014 (1.00)
A.
REFERENCE:
PSBR Training Manual, Chapter 3, page 1.

ANSWER: 015 (1.00)
D.
REFERENCE:
PSBR Training Manual, Chapter 4, page 20.

ANSWER: 016 (1.00)
A.
REFERENCE:
PSBR Training Manual, Chapter 5, page 2.

ANSWER: 017 (1.00)
B.
REFERENCE:
PSBR Training Manual, Chapter 3, page 18.

ANSWER: 018 (1.00)
B.
REFERENCE:
PSBR Training Manual, Chapter 4, page 45.

ANSWER: 019 (1.00)
B.
REFERENCE:
PSBR Training Manual, Chapter 3, page 24.

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

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 AND 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

$Q = mc\Delta T$

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

$\lambda = 0.08 \text{ seconds}^{-1}$

$(DR) = (DR_o)e^{-\lambda t}$

$\rho = (K-1)/K$

1 Curie = 3.7×10^{10} dps

1 Btu = 778 ft-lbf

1 MW = 3.41×10^{6} BTU/hr

$N = S/(1-K)$

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

$\tau = (\ell^*/\rho) + [(\beta-\rho)/\lambda\rho]$

$(DR_1)D_1^2 = (DR_2)D_2^2$

$(DR) = 6CiE/D^2$

$(CR_1)\,(1-K_1) = (CR_2)\,(1-K_2)$

1 gallon water = 8.34 pounds

$EF = 9/5EC + 32$

$EC = 5/9\,(EF - 32)$