June 29, 2001

Dr. Rodney A. Erickson
Vice President and Dean
of the Graduate School
Pennsylvania State University
304 Old Main
University Park, PA 16802-1504

SUBJECT: INITIAL EXAMINATION REPORT NO. 50-005/OL-01-01

Dear Dr. Erickson:

During the week of May 21, 2001, the NRC administered 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 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 Patrick Isaac at 301-415-1019.

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-01-01
2. Examination and answer key

cc w/enclosures:
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
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Department of Environmental Protection
13th Floor, Rachel Carson State Office Bldg.
P.O. Box 8469
Harrisburg, PA 17105-8469
:

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Office of Nuclear Reactor Regulation

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

cc w/enclosures:
Please see next page

DISTRIBUTION:

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PIsaac	LMarsh
MMendonca, PM	DMatthews
Facility File (EBarnhill - O6-D17)	LTremper, LFDCB (T9-E10)

ADAMS ACCESSION #: ML011640495 **TEMPLATE #: NRR-074**

OFFICE	DIPM:IOLB	REXB:CE	REXB:BC
NAME	EBarnhill	PIsaac	LMarsh
DATE	06/ 19 /2001	06/ 18 /2001	06/ 26 /2001

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

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

REPORT NO.:	50-005/OL-01-01
FACILITY DOCKET NO.:	50-005
FACILITY LICENSE NO.:	R-2
FACILITY:	Pennsylvania State University
EXAMINATION DATES:	05/24/2001
EXAMINER:	Patrick Isaac, Chief Examiner

SUBMITTED BY: ***/RA/*** 06/10/2001
Patrick Isaac, Chief Examiner Date

SUMMARY:

During the week of May 21, 2001, NRC administered Operator Licensing Examinations to one Reactor Operator (RO) and one Senior Reactor Operator Upgrade (SROU) candidate. Both candidates passed the examinations.

ENCLOSURE 1

REPORT DETAILS

1. Examiners:

   Patrick J. Isaac

2. Results:

	RO PASS/FAIL	SRO PASS/FAIL	TOTAL PASS/FAIL
Written	**1/0**	**N/A**	**1/0**
Operating Tests	**1/0**	**1/0**	**2/0**
Overall	**1/0**	**1/0**	**2/0**

3. Exit Meeting:

   Mr. Terry Flinchbaugh, Ops. Manager
   Patrick Isaac, Chief Examiner

   The NRC thanked the Pennsylvania State University staff for their efforts in support of the examination.

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

FACILITY: Penn State University

REACTOR TYPE: TRIGA

DATE ADMINISTERED: 2001/05/24

CANDIDATE: ____________________________

INSTRUCTIONS TO CANDIDATE:
Answers are to be written on the answer sheet provided. Attach all answer sheets to the examination. Point values 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
20.00	**33.3**	_____________	_____	**A.**	**REACTOR THEORY, THERMODYNAMICS AND FACILITY OPERATING CHARACTERISTICS**
20.00	**33.3**	_____________	_____	**B.**	**NORMAL AND EMERGENCY OPERATING PROCEDURES AND RADIOLOGICAL CONTROLS**
20.00	**33.3**	_____________	_____	**C.**	**FACILITY AND RADIATION MONITORING SYSTEMS**
60.00		_____________ **FINAL GRADE**	_____	**%**	**TOTALS**

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

____
Candidate's Signature

A. RX THEORY, THERMO & FAC OP CHARS

A N S W E R   S H E E T

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   ___

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

B. NORMAL/EMERG PROCEDURES & RAD CON

A N S W E R   S H E E T

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 ___

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

C. PLANT AND RAD MONITORING SYSTEMS

A N S W E R   S H E E T

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

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 neither received nor 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 <u>only</u> to facilitate legible reproductions.

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

6. Mark your answers on the answer sheet provided. USE ONLY THE PAPER PROVIDED AND DO NOT WRITE ON THE BACK SIDE OF THE PAGE.

7. The point value for each question is indicated in [brackets] after the question.

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. Ensure all information you wish to have evaluated as part of your answer is on your answer sheet. Scrap paper will be disposed of immediately following the examination.

11. To pass the examination you must achieve a grade of 70 percent or greater in each category.

12. There is a time limit of three (3) hours for completion of the examination.

QUESTION A.1 [2.0 points, 0.5 each]
Match each term in column A with the correct definition in column B.

Column A	Column B
a. Prompt Neutron	1. A neutron in equilibrium with its surroundings.
b. Fast Neutron	2. A neutron born directly from fission.
c. Thermal Neutron	3. A neutron born due to decay of a fission product.
d. Delayed Neutron	4. A neutron at an energy level greater than its surroundings.

QUESTION A.2 [1.0 point]
Which one of the following is the percentage of the total neutron flux made up by THERMAL neutrons while operating at 10 KW?

a. 10%

b. 33%

c. 50%

d. 75%

QUESTION A.3 [1.0 point]
Which one of the following describes the **MAJOR** contributor to the production and depletion of Xenon respectively in a **STEADY-STATE OPERATING** reactor?

	Production	Depletion
a.	Radioactive decay of Iodine	Radioactive Decay
b.	Radioactive decay of Iodine	Neutron Absorption
c.	Directly from fission	Radioactive Decay
d.	Directly from fission	Neutron Absorption

QUESTION A.4 [1.0 point]
Which factor of the Six Factor formula is most easily varied by the reactor operator?

a. Thermal Utilization Factor (f)

b. Reproduction Factor (η)

c. Fast Fission Factor (ε)

d. Fast Non-Leakage Factor (L_f)

QUESTION A.5 [1.0 point]
The reactor is operating at 100 KW. The reactor operator withdraws the control rod allowing power to increase. The operator then inserts the same rod to its original position, decreasing power. In comparison to the rod withdrawal, the rod insertion will result in:

a. a slower period due to long lived delayed neutron precursors.

b. a faster period due to long lived delayed neutron precursors.

c. the same period due to equal amounts of reactivity being added.

d. the same period due to equal reactivity rates from the rod.

QUESTION A.6 [1.0 point]
Excess reactivity is:

a. a measure of the additional fuel loaded to overcome fission product poisoning.

b. a measure of remaining control rod worth with the reactor exactly critical.

c. the combined control rod negative reactivity worth required to keep the reactor shutdown.

d. The maximum reactivity by which the reactor can be shutdown with one control rod fully withdrawn.

QUESTION A.7 [1.0 point]
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 A.8 [1.0 point]
Which one of the following atoms will cause a neutron to lose the most energy in an elastic collision?

a. $Uranium^{238}$

b. $Carbon^{12}$

c. $Hydrogen^{2}$

d. $Hydrogen^{1}$

QUESTION A.9 [1.0 point]
K_{eff} for the reactor is 0.98. If you place an experiment worth **+$1.00** into the core, what will the new K_{eff} be?

a. 0.982

b. 0.987

c. 1.013

d. 1.018

QUESTION A.10 [1.0 point]
About two minutes following a reactor scram, period has stabilized, and is decreasing at a CONSTANT rate. If reactor power is 10^{-5} % full power what will the power be in the following three minutes.

a. 5×10^{-6} % full power

b. 2×10^{-6} % full power

c. 10^{-6} % full power

d. 5×10^{-7} % full power

QUESTION A.11 [1.0 point]
Reactor A increases power from 10% to 20% with a period of 50 seconds. Reactor B increases power from 20% to 30% with a period of also 50 seconds. Compared to Reactor A, the time required for the power increase of Reactor B is:

a. longer than A.

b. exactly the same as A.

c. twice that of A.

d. shorter than A.

QUESTION A.12 [1.0 point]
INELASTIC SCATTERING is the process by which a neutron collides with a nucleus and …

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

b. is absorbed, with the nucleus emitting a gamma ray and a neutron with a lower kinetic energy.

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

d. recoils with a higher kinetic energy than it had prior to the collision with the nucleus emitting a gamma ray.

QUESTION A.13 [1.0 point]
For most materials the neutron microscopic cross-section for absorption σ_a generally …

a. increases as neutron energy increases

b. decreases as neutron energy increases

c. increases as target nucleus mass increases

d. decreases as target nucleus mass increases

QUESTION A.14 [1.0 point]
Following a significant reactor power increase, the moderator temperature coefficient becomes increasingly more negative. This is because:

a. as moderator density decreases, less thermal neutrons are absorbed by the moderator than by the fuel.

b. the change in the thermal utilization factor dominates the change in the resonance escape probability.

c. a greater density change per degree F occurs at higher reactor coolant temperatures.

d. the core transitions from an under-moderated condition to an over-moderated condition.

QUESTION A.15 [1.0 point]
Which one of the following is the **MAJOR** source of energy released during fission?

a. Kinetic energy of the fission neutrons.

b. Kinetic energy of the fission fragments.

c. Decay of the fission fragments.

d. Prompt gamma rays.

QUESTION A.16 [1.0 point]
As primary coolant temperature increases, rod worth:

a. increases due to higher reflector efficiency.

b. decreases due to higher neutron absorption in the moderator.

c. increases due to the increase in thermal diffusion length.

d. remains the same due to constant poison cross-section of the control rods.

QUESTION A.17 [1.0 point]
The term ***PROMPT JUMP*** refers to …

a. the instantaneous change in power due to withdrawal of a control rod.

b. a reactor which has attained criticality on prompt neutrons alone.

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

d. a negative reactivity insertion which is less than β_{eff}.

QUESTION A.18 [1.0 point]
The following data was obtained during a reactor fuel load.

No. of Elements	Detector A (cps)
0	20
8	30
16	50
24	150
28	4000

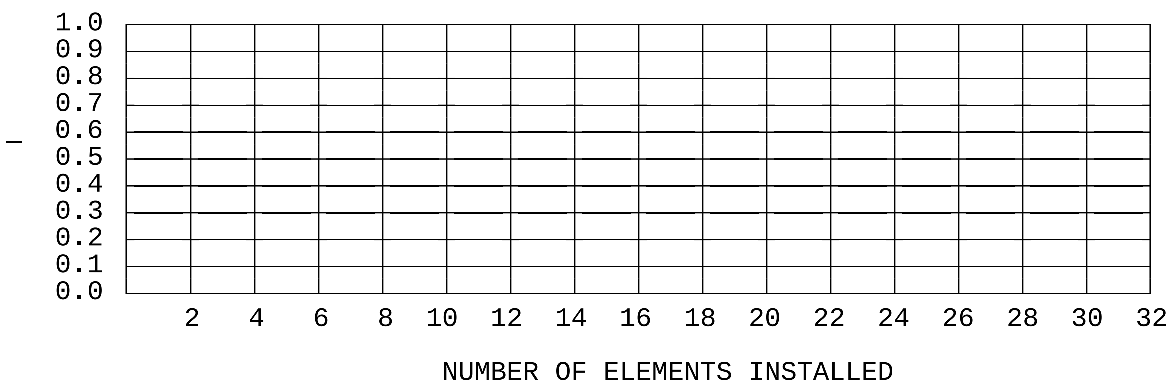
Which one of the following is the closest number of fuel elements required to make the reactor critical? (The attached figure may be used to determine the correct response.)

a. 16

b. 28

c. 32

d. 40



QUESTION A.19 [1.0 point]
Which one of the following is the correct reason that delayed neutrons enhance control of the reactor?

a. There are more delayed neutrons than prompt neutrons.

b. Delayed neutrons increase the average neutron generation time.

c. Delayed neutrons are born at higher energies than prompt neutrons and therefore have a greater effect.

d. Delayed neutrons take longer to reach thermal equilibrium.

QUESTION B.1 [1.0 point]
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 = 0.91 seconds

b. depth of water above the top of the bottom grid plate = 19.5 feet

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

d. maintenance is being performed on the evacuation alarm which renders it inoperable.

QUESTION B.2 [2.0 points, 0.5 each]
Match the type of radiation in column A with its associated Quality Factor (10CFR20) from column B.

Column A	Column B
a. alpha	1
b. beta	2
c. gamma	5
d. neutron (unknown energy)	10
	20

QUESTION B.3 [2.0 points, 0.5 each]
Match the radiation reading from column A with its corresponding radiation area classification (per 10 CFR 20) listed in column B.

COLUMN A	COLUMN B
a. 10 mrem/hr	1. Unrestricted Area
b. 150 mrem/hr	2. Radiation Area
c. 10 Rem/hr	3. High Radiation Area
d. 550 Rem/hr	4. Very High Radiation Area

QUESTION B.4 [1.0 point]
10CFR50.54(x) states: *"A licensee may take reasonable action that departs from a license condition or a technical specification (contained in a license issued under this part) in an emergency when this action is immediately needed to protect the public health and safety and no action consistent with license conditions and technical specifications that can provide adequate or equivalent protection is immediately apparent.* 10CFR50.54(y) states that the minimum authority to authorize the aforementioned action shall be …

a. a Reactor Operator licensed at facility.

b. a Senior Reactor Operator licensed at facility.

c. the Facility Director.

d. the NRC.

QUESTION B.5 [1.0 point]
A small radioactive source is to be stored in the reactor bay with no shielding. The source reads 2 R/hr at 1 foot. A "Radiation Area" barrier would have to be erected approximately ___ from the source.

a. 400 feet

b. 40 feet

c. 20 feet

d. 10 feet

QUESTION B.6 [1.0 point]
Which one of the following is the 10 CFR 20 definition of **TOTAL EFFECTIVE DOSE EQUIVALENT (TEDE)**?

a. The sum of the deep dose equivalent and the committed effective dose equivalent.

b. The dose that your whole body receives from sources outside the body.

c. The sum of the external deep dose and the organ dose.

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

QUESTION B.7 [1.0 point]
Two inches of shielding reduce the gamma exposure in a beam of radiation from 400 mR/hr to 200 mR/hr. If you add an **additional four** inches of shielding what will be the new radiation level? (Assume all reading are the same distance from the source.)

a. 25 mR/hr

b. 50 mR/hr

c. 75 mr/hr

d. 100 mr/hr

QUESTION B.8 [1.0 point]
Your Reactor Operator license expires after _____ years.

a. 2

b. 4

c. 6

d. 8

QUESTION B.9 [1.0 point]
The Safety System channels required to be operable in all modes of operation are:

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

b. fuel element temperature scram and manual scram

c. manual scram and reactor high power scram

d. reactor high power scram, detector power supply scram, and fuel element temperature scram

QUESTION B.10 [1.0 point]
Which one of the following does NOT require the direct supervision of a licensed Senior Reactor Operator?

a. recovery from an unscheduled scram.

b. control rod movement for maintenance while the reactor is shutdown.

c. relocation of an in-core experiment with a worth of $0.90.

d. a licensed individual moving graphite reflectors within the core region.

QUESTION B.11 [1.0 point]
The capsule in a pneumatic transfer system fails to return from the reactor core at the proper time. The reactor operator must:

a. shutdown the reactor and attempt to dislodge the capsule using standard pneumatic system procedure.

b. reduce power and immediately inform the SRO.

c. perform a controlled reactor shutdown if the capsule cannot be returned within the next five (5) minutes.

d. immediately trip the reactor and turn off the Rabbit 1 Fan and Rabbit 1 Master.

QUESTION B.12 [1.0 point]
Which one of the following statements describes the basis for the Safety Limit?

a. Excessive gas pressure 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. High fuel temperature could result in clad melt.

QUESTION B.13 [1.0 point]
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 B.14 [1.0 point]
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 0.90% $\Delta k/k$ per second

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

QUESTION B.15 [1.0 point]
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 B.16 [1.0 point]
Which one of the following does NOT require NRC approval for changes?

a. Facility License

b. Requalification plan

c. Emergency Implementation Procedures

d. Emergency Plan

QUESTION B.17 [1.0 point]
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.

QUESTION B.18 [1.0 point]
The Emergency Planning Zone (EPZ) 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 C.1 [1.0 point]
The top grid plate in the reactor:

a. is bolted to the vertical aluminum angles of the suspension tower structure and supports the weight of the fuel.

b. prevents the control rods from dropping out of the core should their mechanical connection fail.

c. covers only a portion of the area so that experiments can be mounted adjacent to the core.

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

QUESTION C.2 [1.0 point]
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

QUESTION C.3 [1.0 point]
Which one of the following statements describes the moderating properties of Zirconium Hydride?

a. The probability that a neutron will return to the fuel element before being captured elsewhere is a function of the temperature of the hydride.

b. The ratio of hydrogen atoms to zirconium atoms affects the moderating effectiveness for slow neutrons.

c. The hydride mixture is very effective in slowing down neutrons with energies below 0.025 eV.

d. Elevation of the hydride temperature increases the probability that a thermal neutron will escape the fuel-moderator element before being captured.

QUESTION C.4 [1.0 point]
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.	Fuel temperature High	Fission Chamber Power High
b.	Manual Scram	Pulse Timer Scram
c.	Pulse Timer Scram	GIC Power High
d.	Keyswitch Off	Fuel Temperature High

QUESTION C.5 [1.0 point]
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

QUESTION C.6 [1.0 point]
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 C.7 [1.0 point]
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 C.8 [1.0 point]
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.

QUESTION C.9 [1.0 point]
The Wide Range power monitor uses a (an):

a. uncompensated ion chamber

b. compensated ion chamber

c. fission chamber

d. boron-trifluoride detector

QUESTION C.10 [1.0 point]
Which one of the following is true for the rod drive interlocks?

a. The rod drive interlock logic is fail safe on loss of power since power is not required for the motor controller digital inputs to perform the inhibit function.

b. The rod drive pushbuttons provide independent contacts for the RSS interlock functions and manual drive via DCC—X software with normally closed contacts for interlock functions and normally open contacts for inputs to DCC—X.

c. The interlock validation in RSS and the use of redundant software interlocks for the demand velocity signal provide a diverse control rod withdrawal interlock.

d. If more than one “up” pushbutton is pressed at one time, the logic blocks manual withdrawal of the last selected rod or rods and all rods in the automatic mode of control.

QUESTION C.11 [1.0 point]
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.

QUESTION C.12 [1.0 point]
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.

QUESTION C.13 [1.0 point]
Which one of the following is one of the several sources of water that are available for adding water to the reactor pool by 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 C.14 [1.0 point]
Reclaimed water from the Liquid Waste Evaporator System is transferred to the reactor makeup by the:

a. makeup pump

b. processed water pump

c. distillate pump

d. feed pump

QUESTION C.15 [1.0 point]
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

QUESTION C.16 [1.0 point]
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

QUESTION C.17 [1.0 point]
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 C.18 [1.0 point]
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 C.19 [1.0 point]
When in Auto Mode 2, 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 C.20 [1.0 point]
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.

***** END OF EXAMINATION*****

A.1 a, 2; b, 4; c, 1; d, 3
REF: Burn, R., *Introduction to Nuclear Reactor Operations,* © 1982, § 2.5, p. 2-36.

A.2 b
REF: Burn, R., Introduction to Nuclear Reactor Operations, © 1982, § 3.2.4, pp. 3-12.

A.3 b
REF: Burn, R., *Introduction to Nuclear Reactor Operations*, © 1988, §§ 8.1 —8.4, pp. 8-3 — 8-14.

A.4 a
REF: Burn, R., *Introduction to Nuclear Reactor Operations*, © 1982, § 3.2, pp. 3-13 — 3-18.

A.5 a
REF: Burn, R., *Introduction to Nuclear Reactor Operations,* © 1982, §§ 3.2.2 — 3.2.3.

A.6 b
REF: Burn, R., Introduction to Nuclear Reactor Operations, © 1982, § 6.2, pp. 6-1 — 6-4.

A.7 b
REF: PSBR Training Manual, Section 2.18 Neutron Source and Reactor Operation.

A.8 d
REF: Burn, R., *Introduction to Nuclear Reactor Operations,* © 1988, § 2.5.3 p. 2-45.

A.9 b
REF: SDM = $(1-k_{eff})/k_{eff}$ = (1-0.98)/0.98 = 0.02/0.99 = 0.02041 or 0.02041/.0075 = \$2.72, or a reactivity worth (ρ) of -\$2.72. Adding +\$1.00 reactivity will result in a SDM of \$2.72 - \$1.00 = \$1.72, or .0129081 ΔK/K
K_{eff} = 1/(1+SDM) = 1/(1 + 0.0129081) = 0.987

A.10 c
REF: $P = P_0\, e^{-T/\tau} = 10^{-5} \times e^{(-180sec/80sec)} = 10^{-5} \times e^{-2.25} = 0.1054 \times 10^{-5} = 1.054 \times 10^{-6}$

A.11 d
REF: The power of reactor A increases by a factor of 2, while the power of reactor B increases by a factor of 1.5. Since the periods are the same (rate of change is the same), power increase B takes a shorter time

A.12 b
REF: Burn, R., *Introduction to Nuclear Reactor Operations*, © 1982, § 2.4.5 p. 2-28.

A.13 b
REF: Burn, R., *Introduction to Nuclear Reactor Operations*, © 1982, § 2.5.1 p. 2-36.

A.14 c
REF: Burn, R., Introduction to Nuclear Reactor Operations, © 1982, § 6.4.1, pp. 6-5.

A.15 b
REF: Burn, R., *Introduction to Nuclear Reactor Operations*, © 1982, § 3.2.1, p. 3-4.
A.16 c
REF: Burn, R., *Introduction to Nuclear Reactor Operations*, © 1982, § 3.3.2, p. 3-18

A.17 a
REF: Burn, R., *Introduction to Nuclear Reactor Operations,* © 1988, § 4.7, p. 4-21

A.18 b
REF: Burn, R., *Introduction to Nuclear Reactor Operations,* © 1982, § 5.5, pp. 5-18 — 5-25.

A.19 b
REF: Burn, R., *Introduction to Nuclear Reactor Operations*, © 1982, § 3.2.4, p. 3-12.

B.1 d
REF: T.S. 3.6.2

B.2 a, 20; b, 1; c, 1; d, 10
REF: 10CFR20.100x

B.3 a, 2; b, 3; c, 3; d, 4
REF: 10 CFR 20.1003, Definitions

B.4 b
REF: 10CFR50.54(y)

B.5 c
REF: $\frac{DR_1}{X_2^2} = \frac{DR_2}{X_1^2} X_2^2 = \frac{DR_1}{DR_2} X$ $X_2^2 = \frac{2000}{5} \times 1^2 = 400ft^2 X_2 = 20f$

B.6
a
REF: 10 CFR 20.1003 *Definitions*

B.7 b
REF: Nuclear Power Plant Health Physics and Radiation Protection

B.8 c
REF: 10CFR55.55(a)

B.9 b
REF: T.S. 3.2.4

B.10 c
REF: AP-1

B.11 d
REF: SOP-9 C.2

B.12 a
REF: T.S. 2.1 - Basis

B.13 d
REF: SOP-9 A.4

B.14 b
REF: T.S. 3.7

B.15 c
REF: EP-1

B.16 c
REF: 10 CFR 50.54 (q); 10 CFR 50.59; 10 CFR 55.59

B.17 a
REF: PSBR Administrative Policy AP-10.

B.18 a
REF: PSBR Emergency Procedure EP-1, Page A-9

C.1 c
REF: PSBR Training Manual, Ch. 3 A-3.2

C.2 b
REF: SAR Section 4.4, figure 4-5

C.3 d
REF GA - 3886 (Rev. A) TRIGA Mark III Reactor Hazards Analysis, Feb. 1965.

C.4 c
REF: PSBR Training Manual, Section 4.20.7.2a

C.5 b
REF: PSBR Training Manual, Section 4.20.6.1b(d)v

C.6 d
REF: PSBR Training Manual, Section 4.20.1

C.7 d
REF: Penn State Training Manual, Pages 4-20, 28 and 29

C.8 d
REF: Penn State Training Manual, Page 4-20.

C.9 c
REF: PSBR Training Manual, Section 4.9

C.10 b
REF: PSBR Training Manual, Sect. 4.20.7.2c

C.11 c
REF: PSBR Training Manual, Sect. 4.20.6.1b(d)ii

C.12 b
REF: PSBR Training Manual, Sect. 4.22

C.13 b
REF: PSBR Training Manual, Sect. 3.8

C.14 b
REF: PSBR Training Manual, Sect. 3.12

C.15 d
REF: PSBR Training Manual, Page 3-13

C.16 a
REF: PSBR Training Manual, Sect. 4.15

C.17 d
REF: PSBR Training Manual, Page 3-7

C.18 c
REF: PSBR Training Manual, Sect. 5.4

C.19 b
REF: PSBR Training Manual Sect. 5.6 and 6.5.2

C.20 b
REF: PSBR Training Manual Sect. 3.14