January 10, 2001

Mr. Stephen Bilyj
Department of Nuclear Engineering
North Carolina State University
Campus Box 7909
2120 Burlington Engineering Labs
Raleigh, NC 27695-7909

SUBJECT: INITIAL EXAMINATION REPORT NO. 50-297/OL-10-01

Dear Mr. Bilyj:

During the week of December 4, 2000, the NRC administered initial examinations to employees of your facility who had applied for a license to operate your North Carolina 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 available electronically for public inspection in the NRC Public Document Room or from the Publicly Available Records (PARS) component of NRC's document system (ADAMS). ADAMS is accessible from the NRC Web site at (the Public Electronic Reading Room) http://www.nrc.gov/NRC/ADAMS/index.html. The NRC is forwarding the individual grades to you in a separate letter which will not be released publicly. Should you have any questions concerning this examination, please contact Mr. Warren Eresian at 301-415-1833 or internet e-mail wje@nrc.gov.

Sincerely,

/RA/

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. 50-297

Enclosures: 1. Initial Examination Report No. 50-297/OL-10-01
2. Examination and answer key

cc w/encl.:
Please see next page

cc:

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

REPORT NO.:	50-297/OL-00-01
FACILITY DOCKET NO.:	50-297
FACILITY LICENSE NO.:	R-120
FACILITY:	North Carolina State University
EXAMINATION DATES:	December 6-7, 2000
EXAMINER:	Warren Eresian, Chief Examiner
SUBMITTED BY:	***/RA/*** 12/ 22 /2000
	Warren Eresian, Chief Examiner Date

SUMMARY:

During the week of December 4, 2000, the NRC administered operator licensing examinations to one Senior Reactor Operator (Instant) candidate and three Reactor Operator candidates. All candidates passed the written examination and all candidates passed the operating test.

REPORT DETAILS

1. Examiner: Warren Eresian, Chief Examiner

2. Results:

	RO PASS/FAIL	SRO PASS/FAIL	TOTAL PASS/FAIL
Written	**3/0**	**1/0**	**4/0**
Operating Tests	**3/0**	**1/0**	**4/0**
Overall	**3/0**	**1/0**	**4/0**

3. Exit Meeting:

Mr. Stephen Bilyj, Reactor Operations Manager
Mr. Kerry Kincaid, Reactor Maintenance Manager
Warren Eresian, NRC Chief Examiner

The NRC thanked the facility staff for their cooperation during the examination. The facility provided comments on the written examination. As a result of their comments, the following question was deleted:

Category B

Question 06: Delete, no correct answer.

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

FACILITY: NC State University

REACTOR TYPE: PULSTAR

DATE ADMINISTERED: 12/06/00

REGION: 2

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	34	______	____	A. REACTOR THEORY, THERMODYNAMICS, AND FACILITY OPERATING CHARACTERISTICS
19	33	______	____	B. NORMAL AND EMERGENCY OPERATING PROCEDURES AND RADIOLOGICAL CONTROLS
19	33	______	____	C. FACILITY AND RADIATION MONITORING SYSTEMS
58	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. The point value for each question is indicated in parentheses after the question.

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

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

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

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

QUESTION: 001 (1.00)

A reactor is subcritical with a K_{eff} of 0.955. A positive reactivity of 650 pcm is inserted into the core. At this point, the reactor is:

a. subcritical.

b. exactly critical.

c. supercritical.

d. prompt critical.

QUESTION: 002 (1.00)

Which ONE of the following describes the term "prompt jump?"

a. The instantaneous change in the neutron population due to withdrawing a control rod.

b. A reactor which is critical on prompt neutrons only.

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

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

QUESTION: 003 (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 rod 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: 004 (1.00)

As a reactor continues to operate over time, for a constant power level, the 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)

Inelastic scattering can be described as a 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 absorbing a gamma ray.

QUESTION: 006 (1.00)

A reactor core has the following characteristics:

Excess reactivity = 4,000 pcm

Total control rod worth = 12,000 pcm

For this core, the actual shutdown margin (NOT the Tech. Spec. minimum shutdown margin) is:

a. 16,000 pcm.

b. 12,000 pcm.

c. 8,000 pcm.

d. 4,000 pcm.

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

QUESTION: 007 (1.00)

Two critical reactors at low power are identical except that Reactor 1 has a beta fraction of 720 pcm and Reactor 2 has a beta fraction of 600 pcm. An equal amount of positive reactivity is inserted into both reactors. Which ONE of the following will be the response of Reactor 2 compared to Reactor 1?

a. The resulting power level will be lower.

b. The resulting power level will be higher.

c. The resulting startup rate will be faster.

d. The resulting startup rate will be slower.

QUESTION: 008 (1.00)

Which ONE of the following describes the response of the subcritical reactor to <u>equal</u> insertions of positive reactivity as the reactor approaches critical? Each reactivity insertion causes:

a. a SMALLER increase in the neutron flux, resulting in a LONGER time to reach equilibrium.

b. a LARGER increase in the neutron flux, resulting in a LONGER time to reach equilibrium.

c. a SMALLER increase in the neutron flux, resulting in a SHORTER time to reach equilibrium.

d. a LARGER increase in the neutron flux, resulting in a SHORTER time to reach equilibrium.

QUESTION: 009 (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 factors describes an INCREASE in the number of neutrons during the cycle?

a. Thermal utilization factor.

b. Fast fission factor.

c. Thermal non-leakage probability.

d. Resonance escape probability.

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

QUESTION: 010 (1.00)

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

a. absorption/(production + leakage)

b. (production + leakage)/absorption

c. (absorption + leakage)/production

d. production/(absorption + leakage)

QUESTION: 011 (1.00)

For the same constant reactor startup rate, which ONE of the following transients requires the LONGEST time to occur? A power increase of:

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

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

c. 30% of rated power - going from 20% to 50% of rated power.

d. 50% of rated power - going from 50% to 100% of rated power.

QUESTION: 012 (1.00)

The resonance escape probability is the probability that a fission neutron will escape capture in resonances as it slows down to thermal energies. As the moderator temperature increases, the resonance escape probability:

a. increases, since the moderator becomes less dense.

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

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

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

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

QUESTION: 013 (1.00)

During the minutes following a reactor scram, reactor power decreases on a negative 80-second period (-1/3 DPM), corresponding to the half-life of the longest-lived delayed neutron precursors, which is approximately:

a. 20 seconds.

b. 40 seconds.

c. 55 seconds

d. 80 seconds.

QUESTION: 014 (1.00)

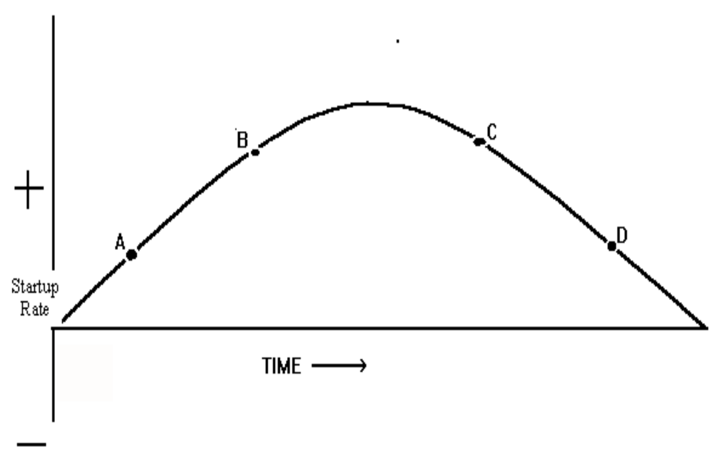
Shown below is a trace of startup rate as a function of time. Between points B and D, reactor power is:

a. continually increasing.

b. increasing, then decreasing.

c. continually decreasing.

d. constant.



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

QUESTION: 015 (1.00)

A 1/M curve is being generated as fuel is loaded into the core. After some fuel elements have been loaded, the count rate existing at that time is taken to be the new initial count rate, C_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. predicted criticality will occur earlier (i.e., with fewer elements loaded).

b. predicted criticality will occur later (i.e., with more elements loaded).

c. predicted criticality will occur with the same number of elements loaded as if the initial count rate had not been changed..

d. criticality will be completely unpredictable.

QUESTION: 016 (1.00)

A reactor pool contains 106, 000 gallons of water at 90 degrees F, and it heats up to 93 degrees F in two hours. Assuming no ambient losses, the calculated power level is:

a. 93 kW.

b. 259 kW.

c. 389 kW.

d. 777 kW.

QUESTION: 017 (1.00)

A reactor with an initial population of $1x10^8$ neutrons is operating with a K_{eff} = 1.001. Considering only the <u>increase</u> 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. 700.

b. 7,000.

c. 99,300.

d. 100,000.

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

QUESTION: 018 (1.00)

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

a. Removal of an experiment containing cadmium.

b. Insertion of a void into the core.

c. Pool water temperature increase at 90% power.

d. Buildup of samarium in the core.

QUESTION: 019 (1.00)

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

a. 40 to 50 hours after a startup to 100% power.

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

c. 10 to 12 hours after a power decrease from 100% to 50%.

d. 40 to 50 hours after a power increase from 50% to 100%.

QUESTION: 020 (1.00)

The reactor is operating in the automatic mode at 50% power. A problem in the secondary cooling system causes the primary coolant temperature to increase by 10 degrees F. Given that the moderator temperature coefficient is -4.0 pcm/deg. F and the differential rod worth of the regulating rod is 160 pcm/inch, the change in the position of the regulating rod will be:

a. two (2) inches in.

b. two (2) inches out.

c. one-quarter (0.25) inch in.

d. one-quarter (0.25) inch out.

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

QUESTION: 001 (1.00)

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

a. Pool water temperature = 112 degrees F.

b. Operation with a fueled experiment with the ventilation system in the confinement mode.

c. Reactivity worth of a single non-secured experiment = 0.4% ρk/k (400 pcm).

d. The Over-the-Pool monitor bypassed for 10 minutes.

QUESTION: 002 (1.00)

Which ONE of the following lists the personnel who may close out a RED tag-out?

a. Reactor Operators and Reactor Operator Assistants.

b. Reactor Operations Manager and Reactor Operators.

c. Senior Reactor Operators and Chief of Reactor Maintenance.

d. Reactor Operations Manager and Chief of Reactor Maintenance..

QUESTION: 003 (1.00)

A radiation survey of an area reveals a general radiation reading of 1 mrem/hr. There is, however, a small pipe which reads 10 mrem/hr at one (1) meter. Assuming that the pipe can be considered a point source, which ONE of the following defines the posting requirements for the area in accordance with 10CFR Part 20?

a. Restricted Area.

b. Radiation Area.

c. High Radiation Area.

d. Grave Danger, Very High Radiation Area.

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

QUESTION: 004 (2.00)

Match the 10CFR 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

QUESTION: 005 (1.00)

The Operations Boundary consists of:

a. the area within the Burlington Engineering Laboratory.

b. the area within the Pulstar Reactor Building and the South Wing.

c. the area within the Administration and Laboratory Building, and the Reactor Building.

d. the area within the Pulstar Reactor Building, Control Room and Primary Piping Vault.

QUESTION: 006 (1.00) DELETED

Reactor operations are being conducted around the clock over the weekend, during which time the Senior Reactor Operator (DSRO) becomes ill and is taken to a hospital. Only a Reactor Operator (RO) in the control room, a Reactor Operator Assistant and a Reactor Health Physicist remain in the facility. In accordance with the Technical Specifications, reactor operations:

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

b. must be discontinued because there is only one licensed person in the facility.

c. may continue until a replacement SRO can arrive at the facility within a reasonable time.

d. may continue since the RO can operate the facility with only a Reactor Health Physicist present in the facility.

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

QUESTION: 007 (1.00)

One of the immediate action steps following a reactor scram is the “ensure Reverse action of control rod position indicators.” Which ONE of the following is the action to be taken if the reverse action fails to occur?

a. Move the Ganged Insert switch to the “In’ position.

b. Initiate a Manual SCRAM.

c. Turn the Reactor Keyswitch off.

d. Inform the Designated Senior Reactor Operator.

QUESTION: 008 (1.00)

Which ONE of the following Emergency Classes is being described by the statement below?

“Events are in progress or have occurred, which involve actual or potential substantial degradation of the level of safety of the reactor.”

a. Notification of Unusual Events.

b. Alert.

c. Site Area Emergency.

d. General Emergency.

QUESTION: 009 (1.00)

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

a. 100 mrem/hr.

b. 60 mrem/hr.

c. 40 mrem/hr.

d. 160 mrem hr.

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

QUESTION: 010 (1.00)

While the reactor is operating, the Reactor Bay East Door and the Loading Dock Door may be open for:

a. up to one minute.

b. up to five minutes.

c. up to ten minutes.

d. up to thirty minutes.

QUESTION: 011 (1.00)

Which ONE of the following events does NOT require the direct presence (i.e., supervision) of a Senior Reactor Operator?

a. Movement of fuel within the reactor pool.

b. Recovery from a significant power reduction.

c. Reactor power calibration.

d. Control rod removal.

QUESTION: 012 (1.00)

Which ONE of the following events is considered an unanticipated abnormal reactivity change?

a. Actual critical position is 150 pcm lower than the estimated critical position.

b. Reactivity value of an experiment is 150 pcm higher than that which was anticipated.

c. Continuous withdrawal of a safety rod.

d. Continuous withdrawal of pulse rod.

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

QUESTION: 013 (1.00)

Two point sources have the same curie strength. Source A's gammas have an energy of 1 Mev, whereas Source B's gammas have an energy of 2 Mev. You obtain a reading from the same GM tube 10 feet from each source. Concerning the two readings, which ONE of the following statements is correct?

a. The reading from Source B is four times that of Source A.

b. The reading from Source B is twice that of Source A.

c. Both readings are the same.

d. The reading from Source B is half that of Source A.

QUESTION: 014 (2.00)

Match each of the Safety Limits for Natural Convection Flow in Column A with the correct value in Column B.

Column A	Column B
a. Reactor Thermal Power.	1. 117°F
	2. 1.4 MWt
b. Reactor Coolant Inlet Temperature.	3. 14 feet
	4. 250 kWt
c. Height of water above the top of the core.	5. 120°F
	6. 14 feet, 2 inches
	7. 123°F
	8. 1.3 MWt
	9. 14 feet, 4 inches

QUESTION: 015 (1.00)

In order to maintain an active reactor operator or senior reactor operator license, the license-holder must perform the functions of his/her position for at least:

a. four hours per calendar quarter.

b. three hours per calendar quarter.

c. one hour per month.

d. forty hours per year.

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

QUESTION: 016 (1.00)

An Emergency Action Level is:

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

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

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

d. a specific instrument reading or observation which may be used as a basis for emergency classification.

QUESTION: 017 (1.00)

The <u>minimum</u> number of personnel required during movement of fuel into and from the core is:

a. a DSRO and a licensed operator at the reactor console.

b. a DSRO at the reactor console and at least two Reactor Operator Assistants.

c. a DSRO, a licensed operator at the reactor console, and a fuel handler.

d. a licensed operator at the reactor console and a fuel handler.

QUESTION: 018 (1.00)

Which ONE of the following operations allows the Stack Gas and Particulate monitors to be bypassed?

a. Removal of experiments from the reactor pool.

b. Movement of fuel out of the core.

c. Initiation of confinement system.

d. Startup of the pneumatic blower system.

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

QUESTION: 001 (1.00)

Which ONE of the following events will occur due to a loss of the Reactor Air Supply while the reactor is operating at 100% power?

a. A Low Primary Flow condition will be sensed and the flapper valve will open, causing a Flapper Open scram.

b. An Abnormal Pool Level alarm will annunciate due to a high pool level indication.

c. A Low Primary Flow alarm will annunciate and a Low Primary Flow scram will result.

d. The shim rod will drift down into the core.

QUESTION: 002 (1.00)

Which ONE of the following radiation monitors, when in an ALARM condition, causes an evacuation?

a. VAMP.

b. Filter GM.

c. Auxiliary GM.

d. CAM.

QUESTION: 003 (1.00)

When the RANGE light on the area radiation monitors indicates solid red, this means that:

a. the instrument has failed.

b. the HIGH alarm has sounded and has been acknowledged, but the alarm condition is still present.

c. the rate of change of the reading has exceeded the hourly rate of change limit.

d. the reading is off-scale either high or low.

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

QUESTION: 004 (1.00)

Which ONE of the following describes a fuel pin?

	Cladding	Weight% U-235	Fuel Length
a.	Stainless Steel	6.0	15 inches
b.	Zircaloy	4.0	24 inches
c.	Zircaloy	6.0	15 inches
d.	Stainless Steel	4.0	24 inches

QUESTION: 005 (1.00)

Power is being supplied by the Auxiliary Generator and the Load Transfer Control switches have been operated so that the generator can supply the Control Room Distribution Panel, Confinement Fan No. 1 and Confinement Fan No. 2. When commercial power is restored:

a. Confinement Fan No. 1 instantly switches back to commercial power, while Confinement Fan No. 2 switches back after a one to two-minute delay, regardless of the positions of the Load Control Transfer switches.

b. the Control Room Distribution Panel instantly switches back to commercial power, while both Confinement Fans switch back after a one to two-minute delay, regardless of the positions of the Load Control Transfer switches.

c. the Load Transfer Control switches must be manually reset so that commercial power can be restored to the loads.

d. all loads are instantly switched back to commercial power, regardless of the positions of the Load Control Transfer switches.

QUESTION: 006 (1.00)

Which ONE set of equations below describes the operation of the installed neutron source?

a. Pu -> U + alpha
Be + alpha -> C + neutron

b. Pu -> Am + beta
Be + beta -> Li + neutron

c. Pu -> U + alpha
B + alpha -> N + neutron

d. Pu -> Am + beta
B + beta -> Be + neutron

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

QUESTION: 007 (1.00)

Temperatures in the primary coolant system are measured at five locations using a:

a. thermometer.

b. thermocouple.

c. bimetallic temperature detector.

d. resistance temperature detector.

QUESTION: 008 (1.00)

Primary coolant system flow rate is measured at an orifice installed:

a. prior to the suction of the primary coolant pump.

b. prior to the inlet of the heat exchanger.

c. after the discharge of the primary coolant pump.

d. after the outlet of the heat exchanger.

QUESTION: 009 (1.00)

When the Confinement Mode is initiated, the order for the flowpath for the discharged air is through the:

a. HEPA filter, charcoal absorber, confinement fan and stack.

b. confinement fan, HEPA filter, charcoal absorber and stack.

c. pre-filter, main filter, confinement fan, and stack.

d. HEPA filter, confinement fan, charcoal absorber and stack.

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

QUESTION: 010 (1.00)

Following an automatic reactor scram, the control rod motor will drive the magnet down because:

a. the down-limit light is activated.

b. the contact switch between the magnet and armature rod opens, signaling that they are no longer magnetically coupled.

c. the seating light is activated.

d. magnet current has been interrupted.

QUESTION: 011 (1.00)

Which ONE statement below is true when the Pneumatic Transfer System is operated in the Manual mode?

a. The sample holder will remain in the reactor indefinitely if no action is taken.

b. The “Emergency Return” will automatically initiate after 30 minutes if the sample holder does not return when the “Return” button is pressed.

c. The sample holder will automatically return after 20 minutes.

d. When the selector switch is set to “Manual” the pneumatic blower starts.

QUESTION: 012 (1.00)

The three-way pneumatic valve (S-5) controls cooling tower flow. If there is a loss of control air pressure:

a. maximum secondary cooling flow is diverted to the cooling tower.

b. the valve maintains its present position, maintaining pre-failure flow.

c. maximum secondary cooling flow is diverted back to the secondary pump suction.

d. the position of the valve becomes uncertain.

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

QUESTION: 013 (1.00)

The operation of the cooling tower fans is controlled by:

a. the temperature of secondary water in the cooling tower basin.

b. the temperature of primary water entering the heat exchanger.

c. the temperature of secondary water leaving the heat exchanger.

d. the outside air temperature.

QUESTION: 014 (1.00)

The flow rate through the Purification system is controlled by:

a. adjusting the speed of the centrifugal pump.

b. adjusting the position of a valve at the inlet to the demineralizer.

c. adjusting the position of a valve at the inlet to the pump.

d. adjusting the position of a valve at the outlet of the filter.

QUESTION: 015 (1.00)

Which ONE of the following is NOT an automatic primary coolant system SCRAM while operating in the Forced Convection mode?

a. Low primary flow, less than 475 gpm when power is greater than 200 kW.

b. Flapper open, power greater than 250 kW.

c. Low water level, 36 inches below normal.

d. High pool temperature, 114^{o}F.

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

QUESTION: 016 (1.00)

Which ONE of the following conditions will <u>prevent</u> the successful initiation of the Automatic Control system?

a. MODE switch in "Steady State".

b. No motion of GANG DRIVE switch.

c. The FC ABS DEV (Trip 4) is lit.

d. Regulating rod at 18.0 inches.

QUESTION: 017 (2.00)

Match the nuclear instrumentation actions listed in Column A with the detector types listed in Column B. Column B answers may be used once, more than once, or not at all.

	Column A		Column B
a.	Supplies input to Automatic Channel.	1.	Fission Chamber.
b.	Low count rate rod withdrawal inhibit.	2.	Uncompensated Ion Chamber.
c.	Supplies signal for Reverse drive.	3.	GM tube.
d.	Supplies input to safety power meter.	4.	Compensated Ion Chamber.

QUESTION: 018 (1.00)

When a fuel assembly is inserted into the core, misalignment is prevented by:

a. proper orientation of openings on the sides of the assembly.

b. proper orientation of the bail between the side plates at the top of the assembly.

c. proper orientation of two holes on the lower end fitting which mate with a pin on the grid plate.

d. proper orientation of the upper end fitting.

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

A. REACTOR THEORY, THERMODYNAMICS & FACILITY OPERATING CHARACTERISTICS

QUESTION: 001 (1.00)
A.
REFERENCE:
Pulstar Reactor Trainee Notebook, Section 1.4.1.
When k_{eff} = 0.955, ρ = -0.0471 delta k/k; 650 pcm = +0.00650 delta k/k.
-0.0471 + 0.0065 delta k/k = -0.0406 delta k/k, therefore reactor is subcritical.

QUESTION: 002 (1.00)
A.
REFERENCE:
Pulstar Reactor Trainee Notebook, Section 2.2.

QUESTION: 003 (1.00)
A.
REFERENCE:
Pulstar Reactor Trainee Notebook, Section 1.4.1.
Since negative reactivity is inserted, the value for thermal utilization must drop.

QUESTION: 004 (1.00)
C.
REFERENCE:
Pulstar Reactor Trainee Notebook, Section 3.4.
Power = $\Sigma_f \rho_{th}$ As Σ_f decreases due to fuel burnup, ρ_{th} must increase.

QUESTION: 005 (1.00)
A.
REFERENCE:
Pulstar Reactor Trainee Notebook, Section 1.1.

QUESTION: 006 (1.00)
C.
REFERENCE:
Pulstar Reactor Trainee Notebook, Section 3.13.

QUESTION: 007 (1.00)
C.
REFERENCE:
Pulstar Reactor Trainee Notebook, Section 2.3.

QUESTION: 008 (1.00)
B.
REFERENCE:
Pulstar Reactor Trainee Notebook, Section 1.5.3.

QUESTION: 009 (1.00)
B.
REFERENCE:
Pulstar Reactor Trainee Notebook, Section 1.4.1.

QUESTION: 010 (1.00)
D.
REFERENCE:
Pulstar Reactor Trainee Notebook, Section 1.5.2.

ANSWER: 011 (1.00)
A.
REFERENCE:
Pulstar Reactor Trainee Notebook, Section 2.5.
$P = P_o 10^{SUR\ t}$

ANSWER: 012 (1.00)
B.
REFERENCE:
Pulstar Reactor Trainee Notebook, Section 2.7.1.

ANSWER: 013 (1.00)
C.
REFERENCE:
Pulstar Reactor Trainee Notebook, Section 2.4.

ANSWER: 014 (1.00)
A.
REFERENCE:
Pulstar Reactor Trainee Notebook, Section 2.5.
Since the SUR is always positive, power must be increasing.

ANSWER: 015 (1.00)
C.
REFERENCE:
Pulstar Reactor Trainee Notebook, Section 1.5.4.

ANSWER: 016 (1.00)
C.
REFERENCE:
Pulstar Reactor Trainee Notebook, Section 3.7.
Power = mcρT/ρt , where: m=106,000 gallons x 8.34 lbs/gal = 884,040 lb; c=1 Btu/°F-lb; ρT/ρt = 1.5 degrees/hour. Power = 1,326,060 Btu/hour; 3413 Btu/hour = 1 kW. Power = 1,326,060/3413 = 389 kW

ANSWER: 017 (1.00)
C.
REFERENCE:
Pulstar Reactor Trainee Notebook, Section 2.2.
The increase = $1x10^8$x1.001 = 100,000 neutrons. Delayed neutrons = 0.007x100,000 = 700. Prompt = 99,300.

ANSWER: 018 (1.00)
A.
REFERENCE:
Insertion of a control rod inserts negative reactivity to balance the positive reactivity added when removing a neutron absorber. All other answers add negative reactivity.

ANSWER: 019 (1.00)
B.
REFERENCE:
Pulstar Reactor Trainee Notebook, Figure 2.11.

ANSWER: 020 (1.00)
D.
REFERENCE:
Pulstar Reactor Trainee Notebook, Section 2.7.1.
Since the coolant temperature increased, negative reactivity was added. Therefore, the rod must add positive reactivity, i.e. withdrawn. (10 deg. F)x(-4.0 pcm/deg. F) / (160 pcm/inch) = -0.25 inches.

B. NORMAL/EMERGENCY PROCEDURES & RADIOLOGICAL CONTROLS

ANSWER: 001 (1.00)
D.
REFERENCE:
Pulstar Technical Specifications, section 3.3.

ANSWER: 002 (1.00)
D.
REFERENCE:
Pulstar Operations Manual, Administrative Controls, section 2.9.3.

ANSWER: 003 (1.00)
C.
REFERENCE:
Pulstar Reactor Trainee Notebook, equation sheet.
10 mrem/hr at 1 meter (100 cm.) = 111.1 mrem/hr at 30 cm.

ANSWER: 004 (2.00)
A,4; B, 2; C, 2; D,1.
REFERENCE:
10 CFR 55

ANSWER: 005 (1.00)
D.
REFERENCE:
Pulstar Emergency Procedures, Emergency Procedure 1, Attachment 2.

ANSWER: 006 (1.00) DELETED

REFERENCE:
Pulstar Technical Specifications, section 6.1.2.

ANSWER: 007 (1.00)
A.
REFERENCE:
Pulstar Operations Manual, Reactor Operating Procedures, section 3.4.1.2.

ANSWER: 008 (1.00)
B.
REFERENCE:
Pulstar Emergency Plan, section 4.2.2.

ANSWER: 009 (1.00)
B.
REFERENCE:
With the window closed, only gamma radiation penetrates the window.

ANSWER: 010 (1.00)
B.
REFERENCE:
ARRR General Emergency Procedures.

ANSWER: 011 (1.00)
C.
REFERENCE:
Pulstar Technical Specifications, section 6.1.3.

ANSWER: 012 (1.00)
B.
REFERENCE:
Pulstar Operations Manual, Reactor Operating Procedures, section 3.4.4.

ANSWER: 013 (1.00)
C.
REFERENCE:
GM tubes cannot distinguish between gammas of different energy.

ANSWER: 014 (2.00)
A,2; B,5; C,3.
REFERENCE:
Pulstar Technical Specifications, section 2.1.2.

ANSWER: 015 (1.00)
A.
REFERENCE:
Pulstar Special Procedure 2.6, section 8.1.

ANSWER: 016 (1.00)
D.
REFERENCE:
Pulstar Emergency Procedures, Emergency Procedure 4.

ANSWER: 017 (1.00)
C.
REFERENCE:
Pulstar Special Procedures, Fuel Handling Procedures, sections 4.1, 4.2, 4.3.

ANSWER: 018 (1.00)
D.
REFERENCE:
Pulstar Technical Specifications, section 3.5.

C. FACILITY AND RADIATION MONITORING SYSTEMS

ANSWER: 001 (1.00)
C.
REFERENCE:
Pulstar Safety Analysis Report, section 7.3.1.

ANSWER: 002 (1.00)
C.
REFERENCE:
Pulstar Emergency Procedures, Emergency Procedure 1, Attachment 5.

ANSWER: 003 (1.00)
D.
REFERENCE:
Pulstar Operations Manual, section 7.2.2.1.

ANSWER: 004 (1.00)
B.
REFERENCE:
Pulstar Safety Analysis Report, Table 3-11.

ANSWER: 005 (1.00)
B.
REFERENCE:
Pulstar Safety Analysis Report, section 8.3.

ANSWER: 006 (1.00)
A.
REFERENCE:
Pulstar Safety Analysis Report, Table 3.11.

ANSWER: 007 (1.00)
D.
REFERENCE:
Pulstar Safety Analysis Report, section 4.2.5.

ANSWER: 008 (1.00)
D.
REFERENCE:
Pulstar Safety Analysis Report, Figure 4.1A.

ANSWER: 009 (1.00)
A.
REFERENCE:
Pulstar Safety Analysis Report, section 5.3.2.

ANSWER: 010 (1.00)
D.
REFERENCE:
Pulstar Operations Manual, section 4.4.3.

ANSWER: 011 (1.00)
A.
REFERENCE:
Pulstar Operations Manual, section 9.2.3.2.

ANSWER: 012 (1.00)
A.
REFERENCE:
Pulstar Safety Analysis Report, section 4.2.1.

ANSWER: 013 (1.00)
A.
REFERENCE:
Pulstar Operations Manual, section 5.2.3.3.

ANSWER: 014 (1.00)
D.
REFERENCE:
Pulstar Operations Manual, section 5.3.2.

ANSWER: 015 (1.00)
D.
REFERENCE:
Pulstar Operations Manual, section 5.1.4.7.

ANSWER: 016 (1.00)
C.
REFERENCE:
Pulstar Operations Manual, section 3.2.1.4.

ANSWER: 017 (2.00)
A,4; B,1; C,4; D,2.
REFERENCE:
Pulstar Safety Analysis Report, Figure 7-1.

ANSWER: 018 (1.00)
C.
REFERENCE:
Pulstar Safety Analysis Report, section 3.2.2.4.

A. REACTOR THEORY, THERMODYNAMICS AND 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______

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. 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 ______

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

EQUATION SHEET

$Q = m\, c_p\, \rho T$

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

$SUR = 26.06/\rho$

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

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

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

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

$\text{Doserate}_1 \times D_1^2 = \text{Doserate}_2 \times D_2^2$

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

$DR = 6CiE/D^2$

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

1 Curie = 3.7×10^{10} dps

1 gallon water = 8.34 pounds

1 Btu = 778 ft-lbf

°F = 9/5°C + 32

1 Mw = 3.41×10^6 BTU/hr

°C = 5/9 (°F - 32)