May 24, 2002

Mr. P. Michael Whaley
Nuclear Reactor Manager
112 Ward Hall
Kansas State University
Manhattan, KS 66506-2506

SUBJECT: INITIAL EXAMINATION REPORT NO. 50-188/OL-02-01, KANSAS STATE UNIVERSITY

Dear Mr. Whaley:

During the week of April 22, 2002, the NRC administered initial examinations to employees of your facility who had applied for a license to operate your Kansas 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 by Marvin Mendonca Acting for/

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

Docket No. 50-188

Enclosures: 1. Initial Examination Report No. 50-188/OL-02-01
2. Examination and answer key

cc w/encls:

Please see next page

cc:

Office of the Governor
State of Kansas
Topeka, KS 66612

Mayor of Manhattan
P.O. Box 748
Manhattan, KS 66502

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

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cc w/encls:
Please see next page

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AAdams, PM
Facility File (EBarnhill)

DISTRIBUTION w/o encls.:
RORP/R&TR r/f
WEresian
PMadden

ADAMS ACCESSION #: ML021300268 **TEMPLATE #: NRR-074**

OFFICE	**RORP:CE**	**IEHB:LA**	**RORP:SC**
NAME	**WEresian**	**EBarnhill**	**PMadden**
DATE	**05/ 13 /2002**	**05/ 21 /2002**	**05/ 24 /2002**

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

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

REPORT NO.:	50-188/OL-02-01
FACILITY DOCKET NO.:	50-188
FACILITY LICENSE NO.:	R-88
FACILITY:	Kansas State University
EXAMINATION DATES:	April 23-25, 2002
EXAMINER:	Warren Eresian, Chief Examiner

SUBMITTED BY: **/RA/** 05/ 14 /2002

Warren Eresian, Chief Examiner Date

SUMMARY:

During the week of April 22, 2002, the NRC administered operator licensing examinations to one Senior Reactor Operator (Instant) candidate, three Senior Reactor Operator (Upgrade) candidates, and three Reactor Operator candidates. All candidates passed the examinations.

ENCLOSURE 1

REPORT DETAILS

1. Examiner: Warren Eresian, Chief Examiner

2. Results:

	RO PASS/FAIL	SRO PASS/FAIL	TOTAL PASS/FAIL
Written	**3/0**	**1/0**	**4/0**
Operating Tests	**3/0**	**4/0**	**7/0**
Overall	**3/0**	**4/0**	**7/0**

3. Exit Meeting:

Mr. Michael Whaley, Reactor Supervisor
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 questions were modified:

Category A

Question 005: Two correct answers, B and D

Category B

Question 007: Two correct answers, C and D.

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

FACILITY: Kansas State University

REACTOR TYPE: TRIGA

DATE ADMINISTERED: 04/23/02

REGION: 3

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	36	______	____	A. REACTOR THEORY, THERMODYNAMICS, AND FACILITY OPERATING CHARACTERISTICS
20	36	______	____	B. NORMAL AND EMERGENCY OPERATING PROCEDURES AND RADIOLOGICAL CONTROLS
16	28	______	____	C. FACILITY AND RADIATION MONITORING SYSTEMS
56			______% 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)

Reactor power is increasing by a factor of 10 every minute. The reactor period is:

a. 65 seconds.

b. 52 seconds.

c. 26 seconds.

d. 13 seconds.

QUESTION: 002 (1.00)

A reactor is slightly supercritical, with the thermal utilization factor = 0.700. 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. 0.700

c. 0.702

d. 0.704

QUESTION: 003 (1.00)

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 the mass of the target nucleus increases.

d. decreases as the mass of the target nucleus increases.

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

QUESTION: 004 (1.00)

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

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

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

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

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

QUESTION: 005 (1.00)

During a reactor startup, the count rate is increasing linearly on a logarithmic scale, with no rod motion. This means that:

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

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

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

d. the reactor is supercritical.

QUESTION: 006 (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. criticality will occur with the same number of elements loaded as if there were no change in the initial count rate.

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

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

d. criticality will be completely unpredictable.

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

QUESTION: 007 (1.00)

As a reactor continues to operate over a period of months, for a constant power level, the average 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: 008 (1.00)

A reactor is operating at a constant power level of 250 kW. The fission rate of this reactor is approximately:

a. 0.78×10^{12} fissions/sec.

b. 1.56×10^{14} fissions/sec.

c. 0.78×10^{16} fissions/sec.

d. 3.90×10^{18} fissions/sec.

QUESTION: 009 (1.00)

Which ONE of the following statements correctly describes the influence of delayed neutrons during the neutron life cycle?

a. Delayed neutrons are more likely to cause fission because they thermalize more quickly than prompt neutrons.

b. Delayed neutrons take longer to thermalize because they are born at a higher average energy than prompt neutrons.

c. Delayed neutrons increase the average neutron generation time.

d. Delayed neutrons are produced some time after prompt neutrons and make up the majority of neutrons produced by fissions.

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

QUESTION: 010 (1.00)

The moderator-to-fuel ratio describes the relationship between the number of moderator atoms in a volume of core to the number of fuel atoms. A reactor which is:

a. undermoderated will have a positive moderator temperature coefficient.

b. undermoderated will have a negative moderator temperature coefficient.

c. overmoderated will have a constant moderator temperature coefficient.

d. overmoderated will have a negative moderator temperature coefficient.

QUESTION: 011 (1.00)

Which ONE statement below describes a positive fuel temperature coefficient?

a. When fuel temperature increases, positive reactivity is added.

b. When fuel temperature decreases, positive reactivity is added.

c. When fuel temperature increases, negative reactivity is added.

d. When fuel temperature increases, reactor power decreases.

QUESTION: 012 (1.00)

A reactor with an initial population of 1×10^8 neutrons is operating with $K_{eff} = 1.001$. 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 $\beta = 0.007$.

a. 700.

b. 7,000.

c. 99,300.

d. 100,000.

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

QUESTION: 013 (1.00)

Inelastic scattering can be described as a process whereby a neutron collides with a nucleus and:

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

b. reappears 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. reappears with a higher kinetic energy, with the nucleus absorbing a gamma ray.

QUESTION: 014 (1.00)

The Moderating Ratio measures the effectiveness of a moderator by combining the scattering cross section, the absorption cross section, and the average energy loss per collision. The Moderating Ratio is expressed as:

a. (absorption cross section)x(scattering cross section)/(average energy loss per collision).

b. (absorption cross section)x(average energy loss per collision)/(scattering cross section).

c. (scattering cross section)x(absorption cross section)x(average energy loss per collision).

d. (average energy loss per collision)x(scattering cross section)/(absorption cross section).

QUESTION: 015 (1.00)

Refer to the Regulating Rod Integral Rod Worth Curve, attached. The regulating rod is at position 625. An experiment with a reactivity worth of $0.60 is inserted into the reactor, and as a result the regulating rod moves into the core. The experiment has a reactivity worth of ______ and the regulating rod is at position______.

a. + $0.60; 375.

b. + $0.60; 400.

c. - $0.60; 375.

d. - $0.60; 400.

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

QUESTION: 016 (1.00)

Delayed neutron precursors decay by beta(-) decay. Which ONE reaction below is an example of beta(-) decay?

a. $_{35}Br^{87}$ -> $_{36}Kr^{87}$

b. $_{35}Br^{87}$ -> $_{36}Kr^{87}$

c. $_{35}Br^{87}$ -> $_{35}Kr^{88}$

d. $_{35}Br^{87}$ -> $_{35}Kr^{86}$

QUESTION: 017 (1.00)

A reactor is subcritical by 5% delta k/k with a count rate of 100 cps on the startup channel. Rods are withdrawn until the count rate is 1000 cps. Which ONE of the following is the condition of the reactor following the rod withdrawal?

a. Critical with k_{eff} = 1.000.

b. Subcritical with k_{eff} = 0.995.

c. Subcritical with k_{eff} = 0.950.

d. Supercritical with k_{eff} = 1.005.

QUESTION: 018 (1.00)

A reactor is operating at a constant power level with equilibrium xenon. Reactor power is then doubled. The equilibrium xenon level at the higher power level will be:

a. higher than its value at the lower power level, but not twice as high.

b. twice as high.

c. more than twice as high.

d. the same as at the lower power level.

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

QUESTION: 019 (1.00)

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

a. increased by 80 deg C.

b. decreased by 80 deg C.

c. increased by 8 deg C.

d. decreased by 8 deg C.

QUESTION: 020 (1.00)

Which ONE of the following statements correctly describes a characteristic of subcritical multiplication?

a. The number of neutrons gained per generation doubles for each succeeding generation.

b. A constant neutron population is achieved when the total number of neutrons produced in one generation is equal to the number of source neutrons added in the next generation.

c. For equal reactivity additions, it requires less time for the equilibrium neutron population to be reached.

d. When the indicated count rate doubles, the margin to criticality has been reduced by approximately one-half.

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

QUESTION: 001 (1.00)

The OPERATIONS BOUNDARY is defined as:

a. Room 110 of Ward Hall.

b. Ward Hall and adjacent fenced areas.

c. Facility Control Center.

d. Nuclear Engineering Departmental Office.

QUESTION: 002 (1.00)

In accordance with 10 CFR 20, the "Annual Limit on Intake (ALI)" refers to:

a. the amount of radioactive material taken into the body by inhalation or ingestion in one (1) year which would result in a committed effective dose equivalent of five (5) rems.

b. the concentration of a given radionuclide in air which, if breathed for a working year of 2000 hours, would result in a committed effective dose equivalent of 5 rems.

c. the dose equivalent to organs that will be received from an intake of radioactive material by an individual during the 50-year period following the intake.

d. limits on the release of effluents to an unrestricted environment.

QUESTION: 003 (1.00)

There has been a confirmed breach of cladding for multiple fuel elements. In accordance with the Emergency Plan, this event would be classified as a(n):

a. Unusual Event.

b. Alert.

c. Site Emergency.

d. General Emergency.

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

QUESTION: 004 (1.00)

Which ONE of the following conditions is permissible when the reactor is operating, or about to be operated?

a. The sum of the absolute reactivity worths of all experiments = $2.20.

b. A pulse reactivity insertion of $2.20.

c. A reactivity insertion rate of a standard control rod = $0.87 per second.

d. Operating in steady state mode with the linear power channel inoperable.

QUESTION: 005 (1.00)

In accordance with the Technical Specifications, which ONE of the following conditions is NOT permissible when the reactor is operating, or about to be operated?

a. Primary water temperature = 110° F.

b. Minimum shutdown margin = $0.87.

c. Maximum available reactivity above cold, clean condition = $2.20.

d. Pool water conductivity = 1.6 micromho/cm.

QUESTION: 006 (1.00)

"Protective Action Guides" are:

a. specific instrument readings, observations, dose rates, etc., which provide thresholds for establishing emergency classes.

b. projected dose equivalents to individuals in the general population which warrants protective actions following a nuclear incident.

c. dose equivalents that are projected to be received by individuals in a population group from a contaminating event if no protective actions were taken.

d. instructions that detail the implementation actions and methods required to achieve the objectives of the emergency plan.

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

QUESTION: 007 (1.00)

In accordance with Procedure No. 9, "Entrance to the Reactor Bay - Visitor Control," :

a. unescorted visitors may enter the reactor bay when the reactor is operating with the permission of a Senior Reactor Operator.

b. an escorted visitor may enter the reactor bay when the reactor is operating without dosimetry provided the escort has dosimetry.

c. an escorted visitor may enter the reactor bay when the reactor is operating with the permission of the Reactor Operator on duty at the console.

d. an escorted visiting group cannot enter the reactor bay unless the reactor is secured.

QUESTION: 008 (1.00)

In accordance with Procedure No. 16, "Reactor Shutdown," an intentional safety system scram is accomplished by:

a. actuating the manual scram bar.

b. manually interrupting current flow to the control rod drive magnets.

c. manually adjusting a scram setpoint.

d. removing the console key.

QUESTION: 009 (1.00)

In accordance with 10CFR20.1301, individual members of the public are limited to a TEDE in one year of:

a. 10 mrem.

b. 100 mrem.

c. 500 mrem.

d. 1.25 rem.

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

QUESTION: 010 (1.00)

Which ONE of the following statements is a condition for pulsing the KSU reactor?

a. In the Pulse mode, the reactor must be operated with a standard fuel TRIGA fuel element in the central thimble.

b. The fuel elements must be gauged after every pulse of magnitude greater than $1.00.

c. Pulsing operations must not be done from a subcritical configuration.

d. The peak fuel temperature of each pulse must be measured.

QUESTION: 011 (1.00)

A maintenance technician has completed an authorized modification to the control rod drive electrical system. Which ONE of the following staffing requirements applies to the subsequent startup?

a. A senior reactor operator may conduct the startup alone to verify operability prior to normal operations.

b. The maintenance technician may conduct the startup to evaluate proper response under direction of a senior reactor operator.

c. A senior reactor operator may conduct the startup if the senior health physicist is in the facility.

d. A reactor operator and a trainee may conduct the startup if the senior reactor operator is available in the facility or on call.

QUESTION: 012 (1.00)

What is the minimum exposure monitoring requirement for an escorted visiting group in the reactor bay?

a. 1 TLD badge per person.

b. 1 neutron-gamma sensitive pocket dosimeter for the tour guide.

c. 2 TLD badges for every 10 members of the group.

d. 2 pocket dosimeters for every 15 members of the group.

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

QUESTION: 013 (1.00)

Which ONE of the following statements is FALSE? The Reactor Manager may authorize temporary changes to a procedure provided that:

a. the Reactor Safeguards Committee approves the changes.

b. the changes do not alter the original intent of the procedure.

c. all licensed individuals are informed of the changes.

d. the changes are noted in the operations logbook.

QUESTION: 014 (1.00)

Select from Column II the Mode when the Scrams/Interlocks from Column I are effective. (Items in Column II may be used once, more than once or not at all. Only one answer may occupy an answer space in Column I). (Four answers required at 0.25 each)

COLUMN I (Scrams/Interlocks)	COLUMN II (Required Mode)
a. Safety Channel at 110% of Full Power	1. Pulse Mode
b. Fuel Temperature at 450°C	2. SS Mode
c. Ion Chamber Power Supply Failure	3. Pulse & SS Mode
d. Shim and regulating rod withdrawal with less than 2 CPS on the startup channel	

QUESTION: 015 (1.00)

Calculate the amount of reactivity by which the reactor is shutdown if the Pulse rod is stuck all the way out. Assume the following worths:

Shim= \$2.10; Regulating = \$1.05; Pulse = \$1.10; Excess reactivity = \$2.05.

a. \$0.95

b. \$1.10

c. \$2.20

d. \$4.25

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

QUESTION: 016 (1.00)

An irradiated sample having a half-life of 3 minutes provides a dose rate of 200 mrem/hr at 3 ft. Approximately how far from the sample must a Radiation Area sign be posted?

a. 6 ft.

b. 12 ft.

c. 18 ft.

d. 36 ft.

QUESTION: 017 (1.00)

Which ONE of the following would be an initiating condition for an ALERT?

a. On-site life-threatening release of toxic or flammable gases.

b. Tornado damage to facility.

c. Threatened compromise of security.

d. Attempted sabotage.

QUESTION: 018 (1.00)

The dose rate from a mixed beta-gamma point source is 100 mrem/hour at a distance of one (1) foot, and is 0.1 mrem/hour at a distance of twenty (20) feet. What percentage of the source consists of beta radiation?

a. 20%

b. 40%

c. 60%

d. 80%

QUESTION: 019 (1.00)

A small radioactive source is to be stored in the reactor facility. The source activity is estimated to be 25 curies and emits a 1.33 Mev gamma. Assuming no shielding is used, the dose rate from the source at a distance of 10 feet would be approximately:

a. 0.33 Rem/hour.

b. 2.0 Rem/hour.

c. 6.0 Rem/hour.

d. 20.0 Rem/hour.

QUESTION: 020 (1.00)

A foreign object is accidentally dropped into the reactor tank while the reactor is operating. The Reactor Supervisor is not immediately available. The reactor operator must:

a. direct another individual to try to remove the object by grappling hooks, vacuum line or other “fishing” tools.

b. immediately notify the Radiation Safety Officer.

c. declare an Unusual Event.

d. shut down the reactor.

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

QUESTION: 001 (1.00)

In the reactor cooling system, there is a pressure gauge on each side of the filter. The purpose of these gauges is to:

a. provide a differential pressure to measure flow through the deionizer.

b. provide a computer input for measuring system pressure.

c. measure primary pressure to ensure that it is always lower than secondary pressure.

d. measure the pressure drop across the filter to determine filter clogging.

QUESTION: 002 (1.00)

When the percent power channel is used for neutron detection, how is the gamma flux accounted for?

a. Pulse height discrimination is used to eliminate the gamma flux.

b. The gamma flux is proportional to neutron flux and is counted with the neutrons.

c. The gamma flux is canceled by creating an equal and opposite gamma current in the detector.

d. The gamma flux passes through the detector with no interaction because of detector design.

QUESTION: 003 (1.00)

The shim rod and the regulating rod are constructed of:

a. graphite with aluminum cladding.

b. boron and carbon with aluminum cladding.

c. boron and carbon with stainless steel cladding.

d. graphite and boron with aluminum cladding.

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

QUESTION: 004 (1.00)

Match the neutron measuring channel in Column A with the type of detector in Column B. Detectors in Column B may be used once, more than once, or not at all.

	Column A		Column B
a.	Log Wide Range Channel	1.	Compensated Ion Chamber
b.	Linear Multi-Range Channel	2.	Uncompensated Ion Chamber
c.	Percent Power Channel	3.	Fission Chamber
d.	Pulse Channel	4.	G-M Tube

QUESTION: 005 (1.00)

The central thimble is an aluminum tube extending from the top of the reactor tank and terminating:

a. below the bottom grid plate.

b. at the bottom grid plate.

c. at the midpoint of the core.

d. at the top grid plate.

QUESTION: 006 (1.00)

The outside air temperature is -15°F. The KSU TRIGA MKII reactor is operating at 100% power when the primary coolant temperature probe fails low. Which ONE of the following actions is performed by the secondary automatic control system if the temperature of the secondary cooling water is 62°F?

a. The cooling tower fan goes to slow speed and the secondary coolant flow bypasses the cooling tower.

b. The cooling tower fan goes to high speed and the secondary coolant flows to the cooling tower.

c. The cooling tower fan goes to slow speed and the secondary coolant flows to the cooling tower.

d. The cooling tower fan remains off and the secondary coolant flow bypasses the cooling tower.

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

QUESTION: 007 (1.00)

Actuation of the amber light on the control console associated with the pulse rod drive indicates that:

a. the solenoid valve has been de-energized.

b. the air supply for the pulse rod drive has dropped below approximately 45 psig.

c. the shock absorber is located at its highest position.

d. the variable timer has timed out.

QUESTION: 008 (1.00)

The continuous air monitor (CAM) is calibrated to detect the presence of:

a. noble gases from a leaking fuel element.

b. Ar-41.

c. N-16.

d. I-131.

QUESTION: 009 (1.00)

The flow rate in the primary loop is maintained by which ONE of the following methods?

a. A flow orifice in the primary piping.

b. Adjustment of the filter pressure drop.

c. Adjustment of primary pump speed.

d. Throttling the discharge valve of the primary pump.

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

QUESTION: 010 (1.00)

The reactor is operating in the pulse mode when a reactor scram occurs. The transient rod solenoid valve:

a. is energized by the scram circuitry, which opens the valve and removes air from the cylinder.

b. is de-energized by the scram circuitry, which closes the valve and removes air from the cylinder.

c. is energized by a timer, which closes the valve and removes air from the cylinder.

d. is de-energized by a timer, which opens the valve and removes air from the cylinder.

QUESTION: 011 (1.00)

Of all the automatic scrams available for the reactor, the only one which remains operable in the pulse mode is:

a. high fuel temperature.

b. short reactor period.

c. linear multi-range power.

d. percent power.

QUESTION: 012 (1.00)

When the shim control rod is withdrawn, the withdrawing force is provided by the:

a. pull rod.

b. push rod

c. draw tube.

d. worm gear.

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

QUESTION: 013 (1.00)

The current core for the KSU reactor consists of ____ rings, with up to a maximum of ____ fuel element locations.

a. 5; 86

b. 5; 91

c. 6; 91

d. 6; 88

QUESTION: 014 (1.00)

In the control rod drive system, separation of the magnet and armature is indicated by the CONTACT light, which extinguishes if the magnet and armature are not in contact. The contact light will be extinguished if:

a. the magnet DOWN microswitch is actuated AND the rod DOWN microswitch is actuated.

b. the magnet DOWN microswitch is unactuated AND the rod DOWN microswitch is actuated.

c. the magnet DOWN microswitch is actuated OR the rod DOWN microswitch is unactuated.

d. the magnet DOWN microswitch is unactuated OR the rod DOWN microswitch is actuated.

QUESTION: 015 (1.00)

The water monitor vessel contains:

a. a temperature probe, a pressure probe, and a GM tube.

b. a temperature probe, a conductivity probe, and a pressure probe.

c. a conductivity probe, a pressure probe, and a GM tube.

d. a conductivity probe, a temperature probe, and a GM tube.

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

QUESTION: 016 (1.00)

All primary power to the TRIGA instrumentation is supplied by a line conditioner. Upon a loss of building power:

a. the line conditioner continues to supply power for a period of one hour, after which the line conditioner ceases to supply power until building power is restored.

b. the line conditioner de-energizes, but automatically energizes again when building power is restored.

c. the line conditioner de-energizes, but must be manually reset when building power is restored.

d. the line conditioner will continue to supply power to the radiation monitoring equipment only. When building power is restored, it must be manually reset to supply the remaining instrumentation.

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

A. REACTOR THEORY, THERMODYNAMICS AND FACILITY OPERATING CHARACTERISTICS

ANSWER: 001 (1.00)
C.
REFERENCE:
DOE Fundamentals Handbook, Module 4, Reactor Kinetics, page 17.
Reactor Period = 26/Startup Rate

ANSWER: 002 (1.00)
A.
REFERENCE:
DOE Fundamentals Handbook, Module 3, Neutron Life Cycle, page 4.
In order to decrease K (return to critical), thermal utilization must decrease.

ANSWER: 003 (1.00)
B.
REFERENCE:
DOE Fundamentals Handbook, Module 2, Nuclear Cross Sections and Neutron Flux, page 9.

ANSWER: 004 (1.00)
C.
REFERENCE:
DOE Fundamentals Handbook, Module 2, Neutron Sources, page 2.

ANSWER: 005 (1.00)
B,D.
REFERENCE:
DOE Fundamentals Handbook, Module 4, Reactor Kinetics, page 14.

ANSWER: 006 (1.00)
A.
REFERENCE:
DOE Fundamentals Handbook, Module 4, Subcritical Multiplication, page 6.

ANSWER: 007 (1.00)
C.
REFERENCE:
DOE Fundamentals Handbook, Module 2, Reaction Rates, page 21.

ANSWER: 008 (1.00)
C.
REFERENCE:
DOE Fundamentals Handbook, Module 2, Reaction Rates, page 20.
250 kW = 1.562×10^{18} Mev/sec.
(1.562×10^{18} Mev/sec)/(200 Mev/fission) = 0.78×10^{16} fissions/sec.

ANSWER: 009 (1.00)
C.
REFERENCE:
DOE Fundamentals Handbook, Module 2, Prompt and Delayed Neutrons, page 29.

ANSWER: 010 (1.00)
B.
REFERENCE:
DOE Fundamentals Handbook, Module 3, Reactivity Coefficients, page 25.

ANSWER: 011 (1.00)
A.
REFERENCE:
DOE Fundamentals Handbook, Module 3, Reactivity Coefficients, page 26.

ANSWER: 012 (1.00)
C.
REFERENCE:
DOE Fundamentals Handbook, Module 2, Prompt and Delayed Neutrons, page 29.
Increase = $1.001x10^8 - 1x10^8 = 1x10^5$. Prompt neutron population = $0.993x1x10^5$ = 99,300.

ANSWER: 013 (1.00)
A.
REFERENCE:
DOE Fundamentals Handbook, Module 1, Neutron Interactions, page 45.

ANSWER: 014 (1.00)
D.
REFERENCE:
DOE Fundamentals Handbook, Module 2, Neutron Moderation, page 28.

ANSWER: 015 (1.00)
A.
REFERENCE:
DOE Fundamentals Handbook, Module 3, Control Rods, page 51.

ANSWER: 016 (1.00)
A.
REFERENCE:
DOE Fundamentals Handbook, Module 1, Modes of Radioactive Decay, page 24.

ANSWER: 017 (1.00)
B.
REFERENCE:
DOE Fundamentals Handbook, Module 4, Subcritical Multiplication, page 6.
$CR_1 (1-K_1) = CR_2 (1-K_2)$; $\rho = (K -1)/K$; $-0.05 = (K - 1)/K$; K = 0.952.
$100(1 - 0.952) = 1000(1 - K_2)$; $K_2 = 0.995$.

ANSWER: 018 (1.00)
A.
REFERENCE:
DOE Fundamentals Handbook, Module 3, Xenon, page 37.

ANSWER: 019 (1.00)
A.
REFERENCE:
DOE Fundamentals Handbook, Module 3, Reactivity, page 21.
Control rod inserts positive reactivity = 0.001delta k/k/inch x 10 inches = +0.01 delta k/k.
Fuel temperature inserts negative reactivity = $-1.25x10^{-4}$ delta k/k/deg.C x 80 deg.C = -0.01 delta k/k.

ANSWER: 020 (1.00)
D.
REFERENCE:
DOE Fundamentals Handbook, Module 4, Subcritical Multiplication, page 6.

B. NORMAL/EMERGENCY PROCEDURES & RADIOLOGICAL CONTROLS

ANSWER: 001 (1.00)
A.
REFERENCE:
Emergency Plan, section 1.1.

ANSWER: 002 (1.00)
A.
REFERENCE:
Radiation Protection Program, page A-2.

ANSWER: 003 (1.00)
B.
REFERENCE:
Emergency Plan, section 6.2.

ANSWER: 004 (1.00)
B
REFERENCE:
Technical Specifications, section E.4.

ANSWER: 005 (1.00)
B.
REFERENCE:
Technical Specifications, section E.5.

ANSWER: 006 (1.00)
B.
REFERENCE:
Emergency Plan, section 7.1.

ANSWER: 007 (1.00)
C,D.
REFERENCE:
Procedure No. 9.

ANSWER: 008 (1.00)
C.
REFERENCE:
Procedure No. 16.

ANSWER: 009 (1.00)
B.
REFERENCE:
Radiation Protection Program, page D-4.

ANSWER: 010 (1.00)
D.
REFERENCE:
Experiment 23.

ANSWER: 011 (1.00)
D.
REFERENCE:
Procedure No. 15.

ANSWER: 012 (1.00)
D.
REFERENCE:
Procedure No. 9.

ANSWER: 013 (1.00)
A.
REFERENCE:
Administrative Plan, section 5.0.

ANSWER: 014 (1.00)
A,2; B,1; C,3; D,2.
REFERENCE:
Technical Specifications, Tables I and II.

ANSWER: 015 (1.00)
B.
REFERENCE:
Shim rod + Regulating rod = $3.15. Excess reactivity - $3.15 = -$1.10.

ANSWER: 016 (1.00)
C.
REFERENCE:
Radiation Protection Program, page A-9.
Radiation area > 5 mrem/hour. 200 mrem at 3 feet -> 5 mrem at 18.3 feet.

ANSWER: 017 (1.00)
B.
REFERENCE:
Emergency Plan, section 6.2.

ANSWER: 018 (1.00)
C.
REFERENCE:
10CFR20.
At 20 feet, there is no beta radiation. Gamma at 20 feet = 0.1 mrem/hour, gamma at 1 foot = 40 mrem/hour.
Therefore beta at 1 foot = 60 mrem/hour = 60%.

ANSWER: 019 (1.00)
B.
REFERENCE:
Dose Rate = $6CiE/R^2$ = 6x25x1.33/100 = 2 Rem/hour.

ANSWER: 020 (1.00)
D.
REFERENCE:
Experiment No. 1.

C. FACILITY AND RADIATION MONITORING SYSTEMS

ANSWER: 001 (1.00)
D.
REFERENCE:
Training Manual, page A1-11.

ANSWER: 002 (1.00)
B.
REFERENCE:
Training Manual, page A1-15.

ANSWER: 003 (1.00)
B.
REFERENCE:
Training Manual, page A1-6.

ANSWER: 004 (1.00)
A,3; B,1; C,2; D,2.
REFERENCE:
Training Manual, page A1-14.

ANSWER: 005 (1.00)
A.
REFERENCE:
Training Manual, page A1-7.

ANSWER: 006 (1.00)
D.
REFERENCE:
Training Manual, page A1-11.

ANSWER: 007 (1.00)
B.
REFERENCE:
Training Manual, page A1-18.

ANSWER: 008 (1.00)
D.
REFERENCE:
Procedure No. 8.

ANSWER: 009 (1.00)
A.
REFERENCE:
Training Manual, page A1-10.

ANSWER: 010 (1.00)
D.
REFERENCE:
Training Manual, page A1-18.

ANSWER: 011 (1.00)
A.
REFERENCE:
Training Manual, page A1-16.

ANSWER: 012 (1.00)
C.
REFERENCE:
Training Manual, page A1-16.

ANSWER: 013 (1.00)
C.
REFERENCE:
Training Manual, page A1-4.

ANSWER: 014 (1.00)
B.
REFERENCE:
Training Manual, page A1-17.

ANSWER: 015 (1.00)
D.
REFERENCE:
Training Manual, page A1-10.

ANSWER: 016 (1.00)
C.
REFERENCE:
Training Manual, page A1-12.

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______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 ______

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

EQUATION SHEET

$Q = m\, c_p\, \Delta T$	$CR_1\,(1-K_1) = CR_2\,(1-K_2)$
$P = P_0\, 10^{SUR(t)}$	$P = P_0\, e^{(t/\tau)}$
$\tau = (\ell^*/\rho) + [(\beta-\rho)/\lambda_{eff}\rho]$	$\lambda_{eff} = 0.1$ seconds^{-1}
$DR_1 D_1^2 = DR_2 D_2^2$	$DR = Dro e^{-\lambda t}$
$DR = 6CiE/D^2$	$\rho = (K-1)/K$
1 Curie = 3.7×10^{10} dps	1 gallon water = 8.34 pounds
$^\circ F = 9/5\,^\circ C + 32$	1 Mw = 3.41×10^{6} BTU/hr
$^\circ C = 5/9\,(^\circ F - 32)$	1 Mev = 1.6×10^{-13} watt-sec