March 15, 2002

Dr. Kenan Ülnü
Ward Center for Nuclear Sciences
Cornell University
105 Ward Laboratory
Ithaca, NY 14853-7701

SUBJECT: INITIAL EXAMINATION REPORT NO. 50-157/OL-02-01

Dear Dr. Ülnü:

During the week of February 11, 2002, the NRC administered initial examinations to employees of your facility who had applied for a license to operate your Cornell 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 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/indesx.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 Warren Eresian at 301-415-1833 or Internet e-mail wje@nrc.gov.

Sincerely,

/RA/

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

Docket No. 50-157

Enclosures: 1. Initial Examination Report
No. 50-157/OL-02-01
2. Examination and answer key

cc w/encls: Please see next page

cc:

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cc w/encls: Please see next page
DISTRIBUTION:
Public RORP r/f PMadden
Facility File (EBarnhill) O6 D-17 WBeckner

ADAMS ACCESSION #: ML020580720 **TEMPLATE #: NRR-074**
***Please see previous concurrence**

OFFICE	RORP:CE		IEHB:LA		RORP:SC	
NAME	*WEresian		*EBarnhill		PMadden	
DATE	02/ 28 /2002		03/ 08 /2002		03/ 14 /2002	

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

REPORT NO.: 50-157/OL-02-01

FACILITY DOCKET NO.: 50-157

FACILITY LICENSE NO.: R-80

FACILITY: Cornell University

EXAMINATION DATES: February 12-13, 2002

SUBMITTED BY: ***/RA/*** 02/28/02
Warren Eresian, Chief Examiner Date

SUMMARY:

During the week of February 11, 2002, the NRC administered operator licensing examinations to two Reactor Operator (RO) initial candidates. Both candidates passed the examination.

REPORT DETAILS

1. Examiners:

   Warren Eresian, Chief Examiner

2. Results:

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

3. Exit Meeting:
   Warren Eresian, NRC
   Stephen LaFlamme, Director

   The NRC thanked the facility staff for their cooperation during the examinations. The facility staff presented their comments on the written examination.

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

FACILITY: Cornell University

REACTOR TYPE: TRIGA

DATE ADMINISTERED: 02/12/02

REGION: 1

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% is required to pass the examination.

Examination will be picked up one (1) hour after the examination starts.

CATEGORY VALUE	% OF TOTAL	CANDIDATE'S SCORE	% OF CATEGORY VALUE	CATEGORY
20	100	_____	____	A. REACTOR THEORY, THERMODYNAMICS, AND FACILITY OPERATING CHARACTERISTICS
20	100	_____	____	B. NORMAL/EMERGENCY PROCEDURES AND RADIOLOGICAL CONTROLS
20	100	_____	____	C. FACILITY AND RADIATION MONITORING SYSTEMS

CANDIDATE'S SCORE _____

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. Seven dollars ($7.00) of positive reactivity is inserted into the core ($\beta = 0.007$). 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 is true concerning the differences between prompt and delayed neutrons?

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

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

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

d. For small reactivity insertions, prompt neutrons are the dominating factor in determining the reactor period while delayed neutrons have little effect on the reactor period.

QUESTION: 003 (1.00)

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

a. Oxygen-16

b. Uranium-238

c. Hydrogen-1

d. Boron-10

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

QUESTION: 004 (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? Approximately 5 to 7 hours:

a. after a startup to 100% power.

b. after a shutdown from 100% power.

c. after a power decrease from 100% to 50% power.

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

QUESTION: 005 (1.00)

During a reactor startup, the count rate is increasing linearly with time, 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 critical and the count rate increase is due to the buildup of delayed neutron precursors.

QUESTION: 006 (1.00)

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

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

b. 15% of rated power - going from 10% to 25% 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.

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

QUESTION: 007 (1.00)

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

a. production/(absorption + leakage)

b. (production + leakage)/absorption

c. (absorption + leakage)/production

d. absorption/(production + leakage)

QUESTION: 008 (1.00)

For a beta effective = 0.0074, a reactivity insertion of 20 cents corresponds approximately to:

a. 0.0010 delta k/k.

b. 0.0015 delta k/k.

c. 0.0020 delta k/k.

d. 0.0074 delta k/k.

QUESTION: 009 (1.00)

During the minutes following a reactor scram, reactor power decreases on a negative 80 second period, corresponding to the half-life of the longest lived delayed neutron precursor, which is approximately:

a. 20 seconds.

b. 40 seconds.

c. 55 seconds.

d. 80 seconds.

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

QUESTION: 010 (1.00)

Which ONE of the following describes the characteristics of a good reflector?

a. High scattering cross-section and low absorption cross-section.

b. Low scattering cross-section and high absorption cross-section.

c. Low scattering cross-section and low absorption cross-section.

d. High scattering cross-section and high absorption cross-section.

QUESTION: 011 (1.00)

You enter the control room and observe that the neutron instrumentation indicates a steady neutron level with no rods in motion. Which ONE condition below CANNOT be true?

a. The reactor is critical.

b. The reactor is subcritical.

c. The reactor is supercritical.

d. The neutron source is out of the core.

QUESTION: 012 (1.00)

Which factor in the six-factor formula is represented by the ratio:

$$\frac{\text{number of neutrons that reach thermal energy}}{\text{number of neutrons that begin to slow down}}$$

a. Fast non-leakage probability.

b. Resonance escape probability.

c. Reproduction factor.

d. Thermal utilization factor.

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

QUESTION: 013 (1.00)

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

a. directly from the fission of Uranium-235.

b. directly from the fission of Uranium-238.

c. from the radioactive decay of Promethium.

d. from the radioactive decay of Iodine.

QUESTION: 014 (1.00)

The reactor is to be pulsed. The projected pulse will add TWICE as much reactivity as the last pulse performed. In relation to the last pulse, for the projected pulse:

a. peak power will be four times larger and the energy released will be four times larger.

b. peak power will be two times larger and the energy released will be four times larger.

c. peak power will be four times larger and the energy released will be two times larger.

d. peak power will be two times larger and the energy released will be two times larger.

QUESTION: 015 (1.00)

When the fuel temperature is suddenly increased, the neutron spectrum becomes “hardened,” which means that:

a. the clad strength increases to contain the higher hydrogen pressure resulting from the release of hydrogen gas from the ZrH.

b. thermal neutrons gain energy from the higher-energy hydrogen in the ZrH.

c. the erbium resonance peaks shift to higher energies.

d. it becomes harder for thermal neutrons to be absorbed in resonance peaks.

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

QUESTION: 016 (1.00)

Which ONE of the following describes the term prompt critical?

a. The instantaneous change in power level due to withdrawing a control rod.

b. A negative reactivity insertion which is greater than beta-effective.

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

d. A positive reactivity insertion which is less than beta-effective.

QUESTION: 017 (1.00)

The equations which describe the operation of an installed neutron source at the Cornell TRIGA are:

a. Am-241 -> alpha + Np-237
Be-9 + alpha -> C-12 + neutron

b. Am-241 -> alpha + Np-237
B-10 + alpha -> N-13 + neutron

c. Am-241 -> beta + Cm-241
Be-9 + beta -> Li-8 + neutron

d. Am-241 -> beta + Cm-241
B-10 + beta -> Be-9 + neutron

QUESTION: 018 (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. Resonance escape probability.

c. Thermal non-leakage probability.

d. Fast fission factor.

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

QUESTION: 019 (1.00)

The pool (bath) temperature coefficient of reactivity is -1.25×10^{-3} 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 pool temperature has:

a. increased by 8 deg C.

b. decreased by 8 deg C.

c. increased by 0.8 deg C.

d. decreased by 0.8 deg C.

QUESTION: 020 (1.00)

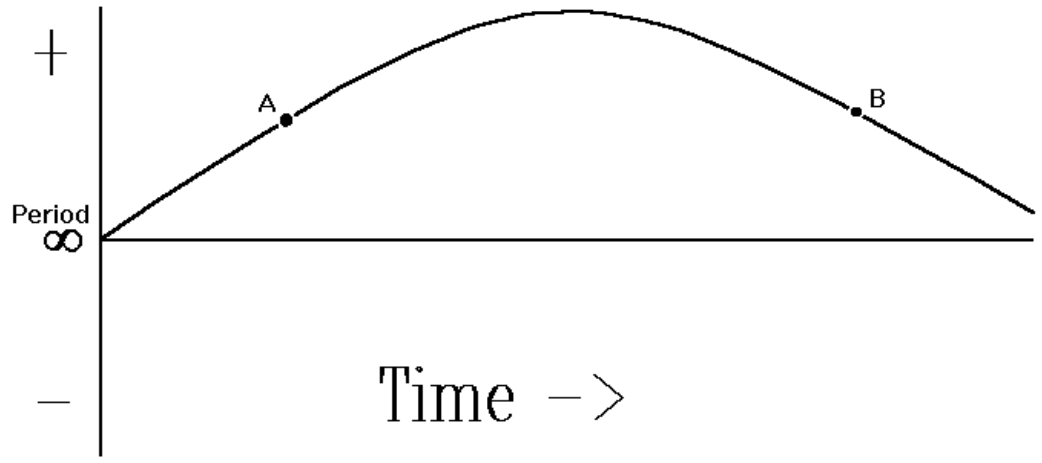
Shown below is a trace of reactor period as a function of time. Between points A and B, reactor power is:

a. continually increasing.

b. increasing, then decreasing.

c. continually decreasing.

d. constant.



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

QUESTION: 001 (1.00)

Which ONE statement below describes the basis for the Safety Limit applicable to fuel temperature for an stainless-steel-clad, high hydride fuel element?

a. High fuel temperature combined with lack of adequate cooling could result in fuel melt.

b. Pulsing the reactor at high fuel temperatures could result in loss of fuel element cladding integrity.

c. Excessive hydrogen gas pressure may result in loss of fuel element cladding integrity.

d. Phase transitions may result in fuel element cladding failure.

QUESTION: 002 (1.00)

Which ONE of the following defines an "Channel Test?"

a. The introduction of a an input signal into the channel to verify that it is operable.

b. A combination of sensors, electronic circuits and output devices which measure and display the value of a parameter.

c. The qualitative verification of acceptable performance by observation of channel behavior.

d. The adjustment of a channel such that its output corresponds with acceptable accuracy to known values of the parameter which the channel measures.

QUESTION: 003 (1.00)

Limits are placed on reactivity insertions during pulse operation in order to:

a. limit fuel temperature increases.

b. ensure that shutdown margin requirements can be met.

c. limit the peak power level to 500 kW.

d. ensure that excess reactivity limits can be met.

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

QUESTION: 004 (1.00)

Which ONE of the following activities must be performed under the direct supervision or presence of a senior licensed operator?

a. Measurement of Control Rod Drop Time.

b. Removal of Transient Rod Drive.

c. Testing of Containment Isolation Butterfly Valves.

d. Calibration of Radiation Monitoring Equipment.

QUESTION: 005 (1.00)

To maintain an active operator license, the functions of an operator must be actively performed for at least:

a. one hour per month.

b. four hours per calendar quarter.

c. six hours per calendar quarter.

d. sixteen hours per year.

QUESTION: 006 (1.00)

In accordance with the Technical Specifications, which ONE condition below is permissible during reactor operation?

a. Drop time of a standard control rod = 1 second.

b. Water temperature = 130 deg. F.

c. Reactivity worth of an individual experiment = $3.00.

d. Water level 19 feet above the bottom of the core.

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

QUESTION: 007 (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. The reading from Source B is half that of Source A.

d. Both readings are the same.

QUESTION: 008 (1.00)

The maximum licensed power level for the Cornell TRIGA is 500 kW. This means that:

a. at no time may reactor power exceed 500 kW.

b. the reactor must automatically scram when power exceeds 500 kW.

c. the steady state power level may not exceed 500 kW.

d. the steady state power level may not usually exceed 500 kW, but may be exceeded temporarily for a special experiment with permission from the Center Safety Committee.

QUESTION: 009 (1.00)

In accordance with the TRIGA Power Calibration procedure, after power level is determined:

a. the indicators on the power meters are adjusted to give the proper indication.

b. the high voltages to the neutron detectors are adjusted to give the proper indication.

c. the compensating voltages of the compensated ion chambers are adjusted to give the proper indication.

d. the positions of the neutron detectors are adjusted to give the proper indication.

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

QUESTION: 010 (1.00)

A radiation survey of an area reveals a general radiation reading of 1 mrem/hr. There is, however, a small section of pipe which reads 10 mrem/hr at one (1) meter. Which ONE of the following defines the posting requirements for the area in accordance with 10CFR20?

a. "CAUTION RADIATION AREA."

b. "CAUTION RADIOACTIVE MATERIAL."

c. "CAUTION HIGH RADIATION AREA."

d. "GRAVE DANGER, VERY HIGH RADIATION AREA."

QUESTION: 011 (1.00)

Two centimeters of lead placed in a beam of gamma rays reduce the radiation level from 400 mR/hr to 200 mR/hr. Which ONE of the following is the <u>total</u> thickness of lead that would reduce the gamma radiation level from 400 mR/hr to 50 mR/hr?

a. 3 cm.

b. 4 cm.

c. 6 cm.

d. 8 cm.

QUESTION: 012 (1.00)

In accordance with 10 CFR 20, the "Derived Air Concentration (DAC)" refers to:

a. the amount of radioactive material taken into the body by inhalation or ingestion in one year which would result in a committed effective dose equivalent of 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 Ar-41 from the exhaust plenum to an unrestricted environment.

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

QUESTION: 013 (1.00)

An event which causes or threatens to cause radiation hazards within Ward Laboratory would be classified as a(n):

a. personnel emergency.

b. emergency alert.

c. reactor emergency.

d. facility emergency.

QUESTION: 014 (1.00)

In the event of an emergency which requires evacuation, the primary assembly area is:

a. Ward Laboratory lobby.

b. Upson Hall first floor lounge.

c. Radiation Safety Office.

d. Emergency Control Center.

QUESTION: 015 (1.00)

A procedure change to an approved operating procedure may be made by the Responsible Person on Duty with the concurrence approval of the Reactor Supervisor ONLY if it is a change:

a. required for safe reactor shutdown.

b. required for safe operation of experiments and experiment facilities.

c. that does not change the original intent of the procedure.

d. that specifies corrective actions to be taken for specific foreseen malfunctions.

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

QUESTION: 016 (1.00)

In the event of a reportable occurrence, the reactor shall be shut down and reactor operation shall not be resumed until authorized by:

a. the NRC.

b. the Center Safety Committee.

c. the Reactor Supervisor.

d. the Center Director.

QUESTION: 017 (1.00)

"Releases of Ar-41 from the reactor bay exhaust plenum to an unrestricted environment shall not exceed 32 Ci/year." This is an example of a(n):

a. safety limit.

b. limiting safety system setting.

c. limiting condition for operation.

d. surveillance requirement.

QUESTION: 018 (2.00)

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

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

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

QUESTION: 019 (1.00)

There are a number of conditions which will initiate a scram. Of these, the scram signals required by the Technical Specifications are:

a. short reactor period, high power level, high fuel temperature.

b. high power level, manual scram, ion-chamber power supply failure.

c. high fuel temperature, high power level, manual scram.

d. high fuel temperature, ion-chamber power supply failure, short reactor period.

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

QUESTION: 001 (1.00)

Which ONE of the following is a control rod drive interlock?

a. Two rods cannot be moved at the same time unless power is below 1 kW in the steady state mode.

b. Control rods cannot be withdrawn unless the count rate is at least 60 counts per minute.

c. The transient rod cannot be withdrawn above 1 kW in the PULSE mode.

d. Control rods cannot be withdrawn unless the fission chamber is fully inserted.

QUESTION: 002 (1.00)

Pool water temperature is controlled automatically by a temperature controller which:

a. adjusts the speed of the pool water pump.

b. adjusts the position of the pool water pump discharge valve.

c. adjusts the position of a control valve in the chill water return line.

d. adjusts the position of the chill water pump discharge valve.

QUESTION: 003 (1.00)

A three-way solenoid valve controls the air supplied to the pneumatic cylinder of the transient rod. De-energizing the solenoid causes the valve to shift to:

a. open, admitting air to the cylinder.

b. close, admitting air to the cylinder.

c. open, removing air from the cylinder.

d. close, removing air from the cylinder.

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

QUESTION: 004 (1.00)

Upon receipt of a scram signal, the regulating rod:

a. magnet is de-energized, and the rod falls into the core.

b. remains where it is, and must be manually driven into the core.

c. automatically drives into the core.

d. magnet and drive both fall into the core.

QUESTION: 005 (1.00)

When the exhaust stack gas monitoring system alarm sounds, which ONE of the following occurs?

a. The reactor scrams.

b. The evacuation alarm sounds.

c. The ventilation system shuts down.

d. There are no automatic actions.

QUESTION: 006 (1.00)

Which ONE of the following is the purpose of the bottom grid plate in the reactor core?

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

b. Provides support for the weight of the fuel elements.

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

d. Provides support for the control rod drives.

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

QUESTION: 007 (1.00)

Primary system flow rates are measured by a(n):

a. rotometer.

b. flow orifice.

c. annubar flow element.

d. flow controller.

QUESTION: 008 (1.00)

For a control rod drive mechanism, in order to withdraw the rod, the armature is:

a. bolted to the draw tube.

b. threaded to accept the draw tube rack and pinion assembly.

c. connected to the draw tube with a connecting rod.

d. held by the draw tube using an electromagnet.

QUESTION: 009 (1.00)

The primary and secondary cooling systems are operating normally when the secondary (chill water) system pressure drops to 60 psi. As a result:

a. the chill water pump is secured, but the pool water pump continues to operate.

b. the pool water pump is secured, but the chill water pump continues to operate.

c. both the pool water and chill water pumps continue to operate.

d. both the pool water and chill water pumps are secured.

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

QUESTION: 010 (1.00)

Scramming of the transient rod is accomplished by:

a. a solenoid valve which redirects compressed air to the top of the rod, driving it into the core.

b. de-energizing the magnet which holds the rod to the drive.

c. actuating the worm gear which drives the rod into the core.

d. de-energizing a solenoid valve, which vents the compressed air holding the rod out of the core.

QUESTION: 011 (1.00)

Reactor period information is derived from:

a. the startup channel.

b. the log N channel.

c. power channel No. 1.

d. power channel No. 2.

QUESTION: 012 (1.00)

For a control rod, the magnet "UP" light is ON, the magnet "DOWN" light is OFF, and the "CONTACT" light is OFF. This indicates that:

a. the rod and drive are not in contact, the rod is full out and the drive is full in.

b. the rod and drive are both full out.

c. the rod and drive are both full in.

d. the rod and drive are not in contact, the drive is full out and the rod is full in.

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

QUESTION: 013 (1.00)

Radiation streaming from the beam ports not in use is prevented by:

a. lining the ports with cadmium to absorb leaking neutrons.

b. using a stepped inner concrete plug.

c. a wood plug and lead shutter.

d. beam stops and beam catchers.

QUESTION: 014 (1.00)

Which ONE of the following controls the amount of reactivity that is inserted by the transient rod during pulse operations?

a. The timer setting that vents the pneumatic piston.

b. The pressure of the air applied to the pneumatic piston.

c. The position of the cylinder.

d. The initial power level of the reactor prior to firing the pulse.

QUESTION: 015 (1.00)

Thermocouples in an instrumented TRIGA fuel element 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.

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

QUESTION: 016 (1.00)

The purpose of the NaI crystal near the suction line at the top of the pool is to:

a. detect the presence of fission products from a leaking fuel element.

b. detect the presence of Ar-41 in the coolant.

c. detect the presence of N-16 in the coolant.

d. detect the inleakage of chilled water.

QUESTION: 017 (1.00)

In the pool water cooling system, pool water conductivity is measured at:

a. the inlet to the pool water pump.

b. the inlet to the heat exchanger.

c. the outlet of the heat exchanger.

d. the outlet of the pool water pump.

QUESTION: 018 (1.00)

A high-hydride fuel element is:

a. clad with stainless steel, enriched to 8.5% U-235, and contains about 20 weight-percent uranium.

b. clad with aluminum, enriched to 20% U-235, and contains about 8.5 weight-percent uranium.

c. clad with stainless steel, enriched to 20% U-235, and contains about 8.5 weight-percent uranium.

d. clad with aluminum, enriched to 8.5% U-235, and contains about 20 weight-percent uranium.

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

QUESTION: 019 (1.00)

While operating the TRIGA reactor at 50 kW the operator pushes and immediately releases the MAGNET pushbutton for the regulating rod. Which ONE of the following is the response of the reactor control system?

a. All rods scram.

b. Only the regulating rod scrams.

c. The regulating rod drives inward.

d. The "ON" light goes out momentarily but the rod does not move.

QUESTION: 020 (1.00)

The in-core terminus of the pneumatic transfer system is located in:

a. the inner ring.

b. the outer ring.

c. the C-ring.

d. the D-ring.

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

A. REACTOR THEORY, THERMODYNAMICS AND FACILITY OPERATING CHARACTERISTICS

ANSWER: 001 (1.00)
A.
REFERENCE:
Reactor Operator Training Manual, Reactor Physics and Kinetics, Sections 6.2.1, 6.2.4.
Shutdown reactivity = (K-1)/K = -0.047 delta K/K. $7.00 added = 7(0.007) = +0.049 delta K/K.
-0.047 + 0.049 = + 0.002, i.e. supercritical.

ANSWER: 002 (1.00)
C.
REFERENCE:
Reactor Operator Training Manual, Reactor Physics and Kinetics, Sections 6.1.3, 6.2.2.

ANSWER: 003 (1.00)
B.
REFERENCE:
Reactor Operator Training Manual, Reactor Physics and Kinetics, Section 6.1.11.

ANSWER: 004 (1.00)
B.
REFERENCE:
Reactor Operator Training Manual, Reactor Physics and Kinetics, Section 6.3.7.

ANSWER: 005 (1.00)
B.
REFERENCE:
Reactor Operator Training Manual, Reactor Physics and Kinetics, Section 6.2.7.

ANSWER: 006 (1.00)
D.
REFERENCE:
Reactor Operator Training Manual, Reactor Physics and Kinetics, Section 6.2.5.

ANSWER: 007 (1.00)
D.
REFERENCE:
Reactor Operator Training Manual, Reactor Physics and Kinetics, Section 6.1.5.

ANSWER: 008 (1.00)
B.
REFERENCE:
Reactor Operator Training Manual, Reactor Physics and Kinetics, Section 6.2.4.
delta k/k = reactivity($) x beta = 0.20 x 0.0074 = 0.0015

ANSWER: 009 (1.00)
C.
REFERENCE:
Reactor Operator Training Manual, Reactor Physics and Kinetics, Section 6.2.5,

ANSWER: 010 (1.00)
A.
REFERENCE:
Reactor Operator Training Manual, Reactor Physics and Kinetics, Section 6.1.12.

ANSWER: 011 (1.00)
C.
REFERENCE:
Reactor Operator Training Manual, Reactor Physics and Kinetics, Section2 6.2.1, 6.2.7.

ANSWER: 012 (1.00)
B.
REFERENCE:
Reactor Operator Training Manual, Reactor Physics and Kinetics, Section 6.1.7.

ANSWER: 013 (1.00)
D.
REFERENCE:
Reactor Operator Training Manual, Reactor Physics and Kinetics, Section 6.3.7.

ANSWER: 014 (1.00)
C.
REFERENCE:
Reactor Operator Training Manual, Reactor Physics and Kinetics, Section 6.5.1.

ANSWER: 015 (1.00)
B.
REFERENCE:
Reactor Operator Training Manual, Reactor Physics and Kinetics, Section 6.6.4.

ANSWER: 016 (1.00)
C.
REFERENCE:
Reactor Operator Training Manual, Reactor Physics and Kinetics, Section 6.2.5.

ANSWER: 017 (1.00)
A.
REFERENCE:
Reactor Operator Training Manual, Reactor Physical Plant, Section 1.4.3.

ANSWER: 018 (1.00)
D.
REFERENCE:
Reactor Operator Training Manual, Reactor Physics and Kinetics, Section 6.1.6.

ANSWER: 019 (1.00)
A.
REFERENCE:
Reactor Operator Training Manual, Reactor Physics and Kinetics, Section 6.3.4.

ANSWER: 020 (1.00)
A.
REFERENCE:
Reactor Operator Training Manual, Reactor Physics and Kinetics, Section 6.2.5.

B. NORMAL/EMERGENCY PROCEDURES AND RADIOLOGICAL CONTROLS

ANSWER: 001
C.
REFERENCE
Technical Specifications, Section 2.1, pg. 4.

ANSWER: 002
A.
REFERENCE
Technical Specifications Definitions, Section 1.0, page 1.

ANSWER: 003
A.
REFERENCE
Technical Specifications, Section 3.3, pg. 7.

ANSWER: 004
B.
REFERENCE
OP 300.

ANSWER: 005
B.
REFERENCE
10 CFR 55.53

ANSWER: 006
B.
REFERENCE
Technical Specifications, Section 3.10, pg. 12.

ANSWER: 007
D.
REFERENCE
A GM tube cannot distinguish between energies.

ANSWER: 008
C.
REFERENCE
Technical Specifications, Section 3.2, pg. 7.

ANSWER: 009
A.
REFERENCE
OP 204

ANSWER: 010
C.
REFERENCE
10 CFR 20.1003, Definitions. Radiation level of 10 mrem/hr at 1 meter (100 cm) results in 111 mrem/hr at 30 cm.

ANSWER: 011
C.
REFERENCE
Each 2 cm. of lead reduces the radiation level by a factor of 2. 6 cm reduces it by a factor of 8.

ANSWER: 012
B.
REFERENCE
10 CFR 20.1003, Definitions.

ANSWER: 013
C.
REFERENCE
Emergency Plan, Section 4.0, pg. 9.

ANSWER: 014
A.
REFERENCE
Emergency Plan, Section 7.4.1, pg. 15.

ANSWER: 015
C.
REFERENCE
Technical Specifications, Section 6.3, pg. 22.

ANSWER: 016
B.
REFERENCE
Technical Specifications, Section 6.9, pg. 24.

ANSWER: 017
C.
REFERENCE
Technical Specifications, Section 3.6, pg. 9.

ANSWER: 018
A,4; B,2; C,2; D,1
REFERENCE
10 CFR 55

ANSWER: 019
C.
REFERENCE
Technical Specifications, Section 3.5, pg. 9.

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

C. FACILITY AND RADIATION MONITORING SYSTEMS

ANSWER: 001
B.
REFERENCE
SER, Table 7.1.

ANSWER: 002
C.
REFERENCE
OP 500

ANSWER: 003
D.
REFERENCE
SER, Section 4.7.1.

ANSWER: 004
A.
REFERENCE
SER, Section 7.3.

ANSWER: 005
C.
REFERENCE
OP 302

ANSWER: 006
B.
REFERENCE
SER, Section 4.3.

ANSWER: 007
C.
REFERENCE
OP 500

ANSWER: 008
D.
REFERENCE
SER, Section 4.7.1.

ANSWER: 009
C.
REFERENCE
SER, Section 5.2.

ANSWER: 010
D.
REFERENCE
SER, Section 4.7.1.

ANSWER: 011
B.
REFERENCE
SER, Figure 7.1.

ANSWER: 012
D.
REFERENCE
SER, Section 7.3.

ANSWER: 013
B.
REFERENCE
SER, Section 10.1.3.

ANSWER: 014
C.
REFERENCE
SER, Section 4.7.2.

ANSWER: 015
D.
REFERENCE
SER, Section 4.1.1.

ANSWER: 016
C.
REFERENCE
SER, Section 5.2.

ANSWER: 017
C.
REFERENCE
SER, Figure 5.1.

ANSWER: 018
C.
REFERENCE
SER, Section 4.1.1.

ANSWER: 019
B.
REFERENCE
SER, Section 4.7.1.

ANSWER: 020
B.
REFERENCE
SER, Section 10.1.2.

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

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 _____

B. NORMAL/EMERGENCY PROCEDURES AND RADIOLOGICAL CONTROLS

ANSWER SHEET

MULTIPLE CHOICE (Circle or X your choice)
If you change your answer, write your selection in the blank.

001 a b c d _____

002 a b c d _____

003 a b c d _____

004 a b c d _____

005 a b c d _____

006 a b c d _____

007 a b c d _____

008 a b c d _____

009 a b c d _____

010 a b c d _____

011 a b c d _____

012 a b c d _____

013 a b c d _____

014 a b c d _____

015 a b c d _____

016 a b c d _____

017 a b c d _____

018 a_____ b_____ c_____ d _____

019 a b c d _____

C. FACILITY AND RADIATION MONITORING SYSTEMS

ANSWER SHEET

MULTIPLE CHOICE (Circle or X your choice)

If you change your answer, write your selection in the blank.

001 a b c d _____

002 a b c d _____

003 a b c d _____

004 a b c d _____

005 a b c d _____

006 a b c d _____

007 a b c d _____

008 a b c d _____

009 a b c d _____

010 a b c d _____

011 a b c d _____

012 a b c d _____

013 a b c d _____

014 a b c d _____

015 a b c d _____

016 a b c d _____

017 a b c d _____

018 a b c d _____

019 a b c d _____

020 a b c d _____

EQUATION SHEET

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

$SUR = 26.06/\tau$

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

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

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

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

1 Curie = 3.7×10^{10} dps

1 Btu = 778 ft-lbf

1 Mw = 3.41×10^{6} BTU/hr

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

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

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

$DR_1 D_1^2 = DR_2 D_2^2$

$DR = 6CiE/D^2$

1 eV = 1.6×10^{-19} watt-sec.

1 gallon water = 8.34 pounds

$°F = 9/5\,°C + 32$

$°C = 5/9\,(°F - 32)$