May 10, 2001

Mr. Richard Myser, Associate Director
Nuclear Reactor Laboratory
Ohio State University
1298 Kinnear Rd.
Columbus, OH 43212-1154

SUBJECT: INITIAL EXAMINATION REPORT NO. 50-150/OL-01-01

Dear Mr. Myser:

During the week of April 16, 2001, the NRC administered an initial examination to an employee of your facility who had applied for a license to operate your Ohio State University reactor. The examination was conducted in accordance with NUREG-1478, "Non-Power Reactor Operator Licensing Examiner Standards," Revision 1. At the conclusion of the examination, the examination questions and preliminary findings were discussed with those members of your staff identified in the enclosed report.

In accordance with 10 CFR 2.790 of the Commission's regulations, a copy of this letter and the enclosures will be 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. 50-150

Enclosures: 1. Initial Examination Report No. 50-150/OL-01-01
2. Examination and answer key

cc w/encls:

Please see next page

Ohio State University Docket No. 50-150

cc:

Ohio Department of Health
ATTN: Radiological Health
Program Director
P.O. Box 118
Columbus, OH 43216

Ohio Environmental Protection Agency
Division of Planning
Environmental Assessment Section
P.O. Box 1049
Columbus, OH 43216

Dr. William Vernetson
Director of Nuclear Facilities
Department of Nuclear
Engineering Science
University of Florida
202 Nuclear Sciences Center
Gainesville, FL 32611

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**DISTRIBUTION:**

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| PUBLIC | REXB r/f | MMendonca |
| WEresian | LMarsh | JTappert |
| Facility File (EBarnhill, O6-D17) | | |

**ADAMS ACCESSION #: ML011210209** **TEMPLATE #: NRR-074**

***Please see previous concurrence**

| **OFFICE** | **DIPM:IOLB** | **REXB:CE** | **REXB:BC** |
|---|---|---|---|
| **NAME** | **EBarnhill** | ***WEresian** | **LMarsh** |
| **DATE** | **05/ 08 /2001** | **05/ 07 /2001** | **05/ 09 /2001** |

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

| | |
|---|---|
| REPORT NO.: | 50-150/OL-01-01 |
| FACILITY DOCKET NO.: | 50-150 |
| FACILITY LICENSE NO.: | R-75 |
| FACILITY: | Ohio State University |
| EXAMINATION DATES: | April 18-19, 2001 |
| EXAMINER: | Warren Eresian, Chief Examiner |
| SUBMITTED BY: | ***/RA/*** Warren Eresian, Chief Examiner — 04/30/2001 Date |

SUMMARY:

During the week of April 16, 2001, the NRC administered an operator licensing examination to one Senior Reactor Operator (Instant) candidate. The candidate passed the examination.

ENCLOSURE 1

# REPORT DETAILS

1. Examiner: Warren Eresian, Chief Examiner

2. Results:

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

3. Exit Meeting:

Richard Myser, Associate Director
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 deleted:

Category C

Question 004: Delete, no correct answer. Incorrect reference material.

Question 014: Delete, no correct answer. Incorrect reference material.

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

FACILITY: Ohio State University

REACTOR TYPE: Pool

DATE ADMINISTERED: 04/18/01

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 | 34 | ______ | ____ | A. REACTOR THEORY, THERMODYNAMICS, AND FACILITY OPERATING CHARACTERISTICS |
| 20 | 34 | ______ | ____ | B. NORMAL AND EMERGENCY OPERATING PROCEDURES AND RADIOLOGICAL CONTROLS |
| 18 | 32 | ______ | ____ | C. FACILITY AND RADIATION MONITORING SYSTEMS |
| 58 | ____ | ______ | ____ FINAL GRADE% | |

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

_________________________________________
Candidate's Signature

## 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)

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

a. $K_{eff}$ = production/(absorption + leakage).

b. $K_{eff}$ = (production + leakage)/absorption.

c. $K_{eff}$ = (absorption + leakage)/production.

d. $K_{eff}$ = absorption/(production + leakage).

QUESTION: 002 (1.00)

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.

QUESTION: 003 (1.00)

The term “buckling” in a reactor refers to:

a. the ratio of average neutron flux to maximum neutron flux.

b. the ratio of reflected neutron flux to average neutron flux.

c. the spatial curvature of neutron flux.

d. self-shielding of reactor fuel.

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

QUESTION: 004 (1.00)

Two reactors are identical except that Reactor 1 has a beta fraction of 0.0072 and Reactor 2 has a beta fraction of 0.0060. 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 is lower.

b. The resulting power level is higher.

c. The period of the power increase is shorter.

d. The period of the power increase is longer.

QUESTION: 005 (1.00)

<u>Inelastic scattering</u> 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)

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

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

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

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

d. A negative reactivity insertion which is less than $\beta_{eff}$.

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

QUESTION: 007 (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.

QUESTION: 008 (1.00)

A reactor with an initial population of $1x10^8$ neutrons is operating with $K_{eff}$ = 1.001. Considering only the increase in neutron population, how many neutrons (of the increase) will be prompt when the neutron population changes from the current generation to the next? Assume $\beta_{eff}$ = 0.007.

a. 700.

b. 7,000.

c. 99,300.

d. 100,000.

QUESTION: 009 (1.00)

Starting with a critical reactor at low power, a control rod is withdrawn from position X and reactor power starts to increase. Neglecting any temperature effects, in order to terminate the increase with the reactor again critical but at a higher power, the control rod must be:

a. inserted deeper than position X.

b. inserted, but not as far as position X.

c. inserted back to position X.

d. inserted, but exact position depends on power level.

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

QUESTION: 010 (1.00)

Which ONE of the following is the description of a thermal neutron?

a. A neutron which possesses thermal rather than kinetic energy.

b. The primary source of thermal energy increase in the reactor coolant during reactor operation.

c. A neutron that has been produced in a significant time (on the order of seconds) after its initiating fission took place.

d. A neutron that experiences no net change in kinetic energy after several collisions with atoms of the diffusing media.

QUESTION: 011 (1.00)

In a subcritical reactor with $K_{eff}$ = 0.861, +0.104 delta k/k reactivity is added. As a result, the new $K_{eff}$ is:

a. 0.899

b. 0.946

c. 0.989

d. 1.0574

QUESTION: 012 (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: 013 (1.00)

The moderator temperature coefficient of reactivity is $-1.25 \times 10^{-3}$ 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 power level. At this point, the moderator 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: 014 (1.00)

Which ONE statement below describes a negative fuel temperature coefficient?

a. When fuel temperature decreases, negative reactivity is added.

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

c. When fuel temperature decreases, reactor power decreases.

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

QUESTION: 015 (1.00)

Which ONE of the following elements will slow down fast neutrons most quickly, i.e. produces the greatest energy loss per collision?

a. Oxygen-16.

b. Uranium-238.

c. Hydrogen-1.

d. Boron-10.

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

QUESTION: 016 (1.00)

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

a. $_1H^2 + \rho \rightarrow {}_1H^1 + n$

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

c. $_{51}Sb^{123} + n \rightarrow {}_{51}Sb^{124} + \rho$

d. $_4Be^9 + \rho \rightarrow {}_6C^{12} + n$

QUESTION: 017 (1.00)

Which ONE of the following is responsible for the constant rate of power change several minutes after a reactor scram from full power?

a. The decay of the longest-lived delayed neutron precursors.

b. The decay of the shortest-lived delayed neutron precursors.

c. The mean average decay of the delayed neutron precursors.

d. The decay of fission product gammas producing photoneutrons.

QUESTION: 018 (1.00)

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

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

a. Fast non-leakage probability.

b. Resonance escape probability.

c. Reproduction factor.

d. Thermal utilization factor.

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

QUESTION: 019 (1.00)

For the same constant reactor period, 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. 15% of rated power - going from 10% to 25% of rated power.

d. 20% of rated power - going from 15% to 35% of rated power.

QUESTION: 020 (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.

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

QUESTION: 001 (2.00)

Match the Requalification Plan requirements 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: 002 (1.00)

In accordance with OM-16, “Power Calibration”, the two Safety Channels are adjusted to agree with the calculated power by:

a. mechanically adjusting the pointers on the meters to give the proper indication.

b. adjusting the compensating voltages to the ion chambers to give the proper indication.

c. adjusting the high voltages to the ion chambers to give the proper indication.

d. changing their positions to give the proper indication.

QUESTION: 003 (1.00)

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

a. A single moveable experiment having a reactivity worth of 0.7% delta k/k.

b. Exhaust fan shut down for one hour for repairs.

c. A depth of water of 15 feet in the reactor pool.

d. A shim/safety blade reactivity insertion rate of 0.015% delta k/k/second.

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

QUESTION: 004 (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 (point source) 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. "GRAVE DANGER, VERY HIGH RADIATION AREA."

d. "CAUTION HIGH RADIATION AREA."

QUESTION: 005 (1.00)

A tour group is visiting the reactor, and there are 14 adults in the group. How many pocket dosimeters must be worn by the group, including the escort?

a. 2.

b. 3.

c. 7.

d. 15.

QUESTION: 006 (1.00)

In accordance with the Technical Specifications, which ONE situation below is NOT permissible?

a. Operation at 100 kW with the secondary cooling pumps secured.

b. Excess reactivity = 2.6% delta k/k.

c. Moderator temperature coefficient = $+2x10^{-5}$ delta k/k/deg.C.

d. Pool water conductivity = 2.0 micromho/cm.

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

QUESTION: 007 (1.00)

A pre-start checklist was completed but no reactor operation took place. As a result:

a. the post-shutdown checkout need not be completed.

b. the post-shutdown checkout must be completed, but an area radiation survey need not be done.

c. the post-shutdown checkout must be completed in its entirety.

d. it is only required to remove the keyswitch in order to complete the checklist.

QUESTION: 008 (1.00)

An experiment is to be loaded into one of the experimental facilities. For which experimental facility listed below must the reactor be shut down when the experiment is loaded?

a. Auxiliary Irradiation Facility.

b. Graphite Isotope Irradiation Elements.

c. Central Irradiation Facility.

d. Dry Tubes.

QUESTION: 009 (1.00)

“Steady state power level shall not exceed 500 kW thermal.” This is an example of a :

a. safety limit.

b. limiting safety system setting.

c. limiting condition for operation.

d. surveillance requirement.

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

QUESTION: 010 (1.00)

Which ONE of the following precautions is <u>not true</u> regarding fuel element inspections?

a. All personnel shall wear a film badge and should wear a pocket dosimeter.

b. When the crane is no longer needed, power shall be turned off at the west breaker box.

c. The fuel handling tools shall remain locked when not being utilized for inspections.

d. Only two fuel elements shall be allowed in the facility which are not in storage or in the core lattice.

QUESTION: 011 (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 (1) year which would result in a committed effective dose equivalent of five (5) rems.

b. 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.

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

d. 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 five (5) rems.

QUESTION: 012 (1.00)

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

a. 40 mrem/hour.

b. 60 mrem/hour.

c. 100 mrem/hour.

d. 160 mrem/hour.

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

QUESTION: 013 (1.00)

The area radiation monitor at the pool top is out of service. As a result:

a. the reactor cannot be operated.

b. the reactor can continue to operate.

c. the reactor can continue to operate only if the alarm setpoints of the remaining area radiation monitors are lowered.

d. the reactor can continue to operate only if the monitor is replaced by a monitor with a read-out and capable of alarming.

QUESTION: 014 (1.00)

Emergency Procedure EP-03 describes responses to scram indications. The SRO on duty is required to be notified in all responses to scram indications <u>except</u>:

a. manual scrams.

b. switches not in proper position.

c. pool water level low.

d. low voltage on CICs.

QUESTION: 015 (1.00)

Two different gamma point sources have the same curie strength. The gammas from Source A have an energy of 1 Mev, and the gammas from Source B have an energy of 2 Mev. The dose rate from each source is measured at a distance of 10 feet using a G-M tube. Which ONE of the following statements is correct?

a. The dose rate of Source B is four times that of Source A.

b. The dose rate of Source B is two times that of Source A.

c. Both dose rates are the same.

d. The dose rate of Source B is half that of Source A.

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

QUESTION: 016 (1.00)

In order to maintain an active reactor 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. sixteen hours per year.

QUESTION: 017 (1.00)

The reactor has scrammed due to a building power failure. When building power has been restored, the reactor may be restarted:

a. after all instruments have warmed up for one hour.

b. as soon as a pre-start checklist has been completed.

c. without performing a pre-start checklist.

d. after all instruments have warmed up for one hour and a pre-start checklist performed.

QUESTION: 018 (1.00)

Two centimeters of lead placed in a beam of gamma rays reduces 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.

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

QUESTION: 019 (1.00)

Which ONE of the following activities requires the presence of a senior licensed operator?

a. Fuel element inspection.

b. Pu-Be source removal.

c. Reactor power calibration.

d. Rod drop time measurements.

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

QUESTION: 001 (1.00)

Which ONE of the following describes a standard fuel element?

a. 19.5% enriched uranium contained within stainless steel plates.

b. 37.5% enriched uranium contained within aluminum plates.

c. 19.5% enriched uranium contained within aluminum plates.

d. 37.5% enriched uranium contained within stainless steel plates.

QUESTION: 002 (1.00)

All positions in the core grid plate are occupied by some type of assembly. This is done so that:

a. there is an even weight distribution on the grid plate.

b. there is no uneven coolant flow distribution through the core.

c. the core is as symmetric as possible to maintain an even reactivity distribution.

d. a predictable control rod worth is maintained.

QUESTION: 003 (1.00)

Which ONE of the following statements is true regarding operation of the neutron source?

a. The neutron source may be moved at any time.

b. The neutron source cannot be moved out of its storage cask while simultaneously withdrawing any control rod.

c. The source is a 5-curie SbBe source providing about $1x10^7$ neutrons/second.

d. When the source is in its fully raised position, it is located near the top of the fuel elements.

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

QUESTION: 004  (1.00)  QUESTION DELETED

Secondary coolant flow to the secondary heat exchanger is controlled by a bypass control valve.  The position of the bypass control valve is determined by the:

a. temperature at the secondary side outlet of the primary heat exchanger.

b. primary loop inlet temperature.

c. primary loop outlet temperature.

d. temperature at the inlet of the secondary coolant pump.

QUESTION: 005  (1.00)

The aluminum shrouds which surround each control rod have holes in the lower sections.  The purpose of these holes is to:

a. provide viscous damping during reactor scrams.

b. provide a cooling water path through the shrouds.

c. provide points where a shroud lifting tool can be attached.

d. smooth out the thermal neutron flux distribution at the bottom of the core.

QUESTION: 006  (2.00)

Match the Area Radiation Monitor location listed in Column A with the correct detector listed in Column B.  Items listed in Column B may be used more than once or not at all.

| Column A | | Column B | |
|---|---|---|---|
| a. | Above reactor pool | 1. | Proportional counter |
| b. | Thermal column and beam ports | 2. | Ionization Chamber |
| c. | Primary coolant heat exchanger | 3. | GM detector |
| d. | Water processing system | 4. | Scintillation detector |

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

QUESTION: 007 (1.00)

The building evacuation system is activated by two switches. The switch located on the slow scram console in the control room only ______________________ while the switch located underneath the wall-mounted telephone in the control room only_____________________.

a. sounds the evacuation horn; turns off all ventilation fans exhausting to the outside of the building.

b. turns off all ventilation fans exhausting to the outside of the building; sounds the evacuation horn.

c. sounds the evacuation horn and turns off all ventilation fans exhausting to the outside of the building; sounds the evacuation horn.

d. sounds the evacuation horn; sounds the evacuation horn and turns off all ventilation fans exhausting to the outside of the building.

QUESTION: 008 (1.00)

Which ONE of the following will prevent the withdrawal of a control rod?

a. Startup source moving out of the core.

b. Movement of fission chamber into the core.

c. Movement of fission chamber out of the core.

d. Green light on in Control Rod Positioning System.

QUESTION: 009 (1.00)

For a control rod, the orange light is ON, the green light is OFF, and the white light is ON. These indicate 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: 010  (1.00)

When the building gaseous effluent monitor alarms, which ONE of the following occurs?

a. The reactor scrams.

b. The ventilation exhaust fan stops.

c. The building evacuation horn sounds.

d. No action occurs.

QUESTION: 011  (2.00)

Match the instrument channel listed in Column A with the correct detector listed in Column B.  Items listed in Column B may be used more than once or not at all.

| Column A | Column B |
|---|---|
| a. Logarithmic Power | 1. Proportional counter |
| b. Startup | 2. Fission chamber |
| c. Linear power | 3. GM detector |
| d. Power Level Safety | 4. Compensated Ion Chamber |
| | 5. Uncompensated Ion chamber |

QUESTION: 012   (1.00)

Input to the servo system is provided by the:

a. Logarithmic Power Channel.

b. Linear Power Channel.

c. Power Level Channel #1.

d. Power Level Channel #2.

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

QUESTION: 013 (1.00)

Which ONE of the following switch positions will prohibit a startup?

a. Effluent Monitor Compressor “On”.

b. Period Generator Switch Position “Off”.

c. Log N Amplifier Calibrate Switch “Test”.

d. Log Period Amplifier Calibrate Switch “Norm”.

QUESTION: 014 (1.00) QUESTION DELETED

When the City Water Control Valve is in the Auto mode, city water flow rate is controlled by:

a. primary loop outlet temperature.

b. secondary loop temperature.

c. city water inlet temperature.

d. city water outlet temperature.

QUESTION: 015 (1.00)

Water from the Makeup Water System is added to the reactor pool:

a. at the suction of the Water Process System pump.

b. at the inlet of the demineralizer in the Water Process System.

c. at the inlet of the ion exchange filters in the Water Process System.

d. at the outlet of the ion exchange filters in the Water Process System.

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

QUESTION: 016 (1.00)

Which ONE of the following scram functions results in ONLY a slow scram?

a. Reactor fast period.

b. Reactor overpower.

c. Low count rate.

d. Core inlet temperature below setpoint.

QUESTION: 017 (1.00)

The gamma rays incident upon the Startup Channel do not cause a pulse to be counted. Which ONE of the following describes the reason gamma pulses are not counted?

a. The Startup Channel detector has compensating voltage to subtract the gamma pulses from the signal.

b. The design of the detector allows gamma rays to pass through the detector with no interaction.

c. The detector uses a pulse height discriminator, which prevents the smaller gamma pulses from being counted.

d. The number of gamma rays is much smaller than the number of neutrons.

QUESTION: 018 (1.00)

An annunciator lamp switch flashes and an audible signal is emitted to alert the operator to a slow or fast scram condition. Acknowledging the condition will always:

a. silence the alarm and extinguish the light.

b. silence the alarm only if the condition has returned to normal.

c. silence the alarm.

d. extinguish the light.

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

## A. REACTOR THEORY, THERMODYNAMICS & FACILITY OPERATING CHARACTERISTICS

ANSWER: 001 (1.00)
A.
REFERENCE:
Glasstone & Sesonske, Nuclear Reactor Engineering, 3rd Edition, pg. 149.

ANSWER: 002 (1.00)
B.
REFERENCE:
Glasstone & Sesonske, Nuclear Reactor Engineering, 3rd Edition, pg. 264.

ANSWER: 003 (1.00)
C.
REFERENCE:
Glasstone & Sesonske, Nuclear Reactor Engineering, 3rd Edition, pg. 150.

ANSWER: 004 (1.00)
C.
REFERENCE:
$\rho = (\ell^*/\rho) + [(\beta-\rho)/\rho_{eff}\rho]$. The reactor with the smaller beta fraction will have the shortest period.
Glasstone & Sesonske, Nuclear Reactor Engineering, 3rd Edition, pg. 237.

ANSWER: 005 (1.00)
A.
REFERENCE:
Glasstone & Sesonske, Nuclear Reactor Engineering, 3rd Edition, pg. 70.

ANSWER: 006 (1.00)
A.
REFERENCE:
Glasstone & Sesonske, Nuclear Reactor Engineering, 3rd Edition, pg. 240.

ANSWER: 007 (1.00)
C.
REFERENCE:
Glasstone & Sesonske, Nuclear Reactor Engineering, 3rd Edition, pg. 236.

ANSWER: 008 (1.00)
C.
REFERENCE:
Glasstone & Sesonske, Nuclear Reactor Engineering, 3rd Edition, pg. 230.
Increase = $1.001 \times 10^8 - 1 \times 10^8 = 1 \times 10^5$. Prompt neutron population = $0.993 \times 1 \times 10^5$ = 99,300.

ANSWER: 009 (1.00)
C.
REFERENCE:
In the absence of any temperature effects, core reactivity returns to zero when the rods are returned to their original positions.

ANSWER: 010 (1.00)
D.
REFERENCE:
Glasstone & Sesonske, Nuclear Reactor Engineering, 3rd Edition, pg. 13.

ANSWER: 011 (1.00)
B.
REFERENCE:
Glasstone & Sesonske, Nuclear Reactor Engineering, 3rd Edition, pg. 231.
Initial reactivity = (K - 1)/K = (0.861 - 1)/0.861 = -0.1614 delta k/k.
Final reactivity = -0.1614 + 0.104 = -0.0574 delta k/k; k = 1/(1 + 0.574) = 0.946

ANSWER: 012 (1.00)
D.
REFERENCE:
Glasstone & Sesonske, Nuclear Reactor Engineering, 3rd Edition, pg. 188.

ANSWER: 013 (1.00)
A.
REFERENCE:
Glasstone & Sesonske, Nuclear Reactor Engineering, 3rd Edition, pg. 262.
Lamarsh, Introduction to Nuclear Engineering, 2nd. Edition, page 307.
Reactivity added by control rod = 0.001 delta k/k/inch x 10 inches = 0.01 delta k/k.
(0.01 delta k/k)/1.25x$10^{-3}$ delta k/k/deg.C = 8 deg. C. increase.

ANSWER: 014 (1.00)
D.
REFERENCE:
Glasstone & Sesonske, Nuclear Reactor Engineering, 3rd Edition, pg. 262.

ANSWER: 015 (1.00)
C.
REFERENCE:
Glasstone & Sesonske, Nuclear Reactor Engineering, 3rd Edition, pg. 164.

ANSWER: 016 (1.00)
A.
REFERENCE:
Glasstone & Sesonske, Nuclear Reactor Engineering, 3rd Edition, pg. 66.

ANSWER: 017 (1.00)
A.
REFERENCE:
Glasstone & Sesonske, Nuclear Reactor Engineering, 3rd Edition, pg. 120.

ANSWER: 018 (1.00)
B.
REFERENCE:
Glasstone & Sesonske, Nuclear Reactor Engineering, 3rd Edition, pg. 169.

ANSWER: 019 (1.00)
A.
REFERENCE:
Glasstone & Sesonske, Nuclear Reactor Engineering, 3rd Edition, pg. 234.

ANSWER: 020 (1.00)
C.
REFERENCE:
Glasstone & Sesonske, Nuclear Reactor Engineering, 3rd Edition, pg. 105.

B. NORMAL/EMERGENCY PROCEDURES & RADIOLOGICAL CONTROLS

ANSWER: 001 (2.00)
A, 4; B,2; C,1; D,1
REFERENCE:
AP-09

ANSWER: 002 (1.00)
D.
REFERENCE:
OM-16.

ANSWER: 003 (1.00)
D.
REFERENCE:
Technical Specifications, Section 3.2.2.

ANSWER: 004 (1.00)
D.
REFERENCE:
RS-09.
10 mrem/hr at 1 meter (100 centimeters) = 111 mrem/hr at 30 centimeters.

ANSWER: 005 (1.00)
A.
REFERENCE:
AP-02.

ANSWER: 006 (1.00)
C.
REFERENCE:
Technical Specifications, Section 3.1.1.

ANSWER: 007 (1.00)
B.
REFERENCE:
IM-04.

ANSWER: 008 (1.00)
B.
REFERENCE:
OM-03.

ANSWER: 009 (1.00)
A.
REFERENCE:
Technical Specifications, Section 2.2.

ANSWER: 010 (1.00)
D.
REFERENCE:
OM-07.

ANSWER: 011 (1.00)
D.
REFERENCE:
10 CFR 20.

ANSWER: 012 (1.00)
B.
REFERENCE:
With the window closed, no betas are measured. The gamma dose rate is 60 mrem/hour.

ANSWER: 013 (1.00)
D.
REFERENCE:
Technical Specifications, Section 3.6.1.

ANSWER: 014 (1.00)
B.
REFERENCE:
EP-03.

ANSWER: 015 (1.00)
C.
REFERENCE:
G-M tubes are not sensitive to energy.

ANSWER: 016 (1.00)
A.
REFERENCE:
AP-09.

ANSWER: 017 (1.00)
D.
REFERENCE:
IM-09.

ANSWER: 018 (1.00)
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: 019 (1.00)
A.
REFERENCE:
OM-07.

## C. FACILITY AND RADIATION MONITORING SYSTEMS

ANSWER: 001 (1.00)
C.
REFERENCE:
SAR page 27.

ANSWER: 002 (1.00)
B.
REFERENCE:
SAR page 27.

ANSWER: 003 (1.00)
A.
REFERENCE:
SAR pages 36,67.

ANSWER: 004 (1.00) QUESTION DELETED
D.
REFERENCE:
SAR page 52.

ANSWER: 005 (1.00)
B.
REFERENCE:
SAR page 36.

ANSWER: 006 (2.00)
A, 3; B, 3; C,3; D, 3.
REFERENCE:
SAR page 78.

ANSWER: 007 (1.00)
A.
REFERENCE:
SAR page 77.

ANSWER: 008 (1.00)
C.
REFERENCE:
SAR page 67.

ANSWER: 009 (1.00)
B.
REFERENCE:
SAR page 64.

ANSWER: 010 (1.00)
D.
REFERENCE:
EP-03.

ANSWER: 011 (2.00)
A,4; B,2; C,4; D,5.
REFERENCE:
SAR page 45.

ANSWER: 012 (1.00)
B.
REFERENCE:
SAR page 69.

ANSWER: 013 (1.00)
C.
REFERENCE:
Technical Specifications, Section 3.2.3.

ANSWER: 014 (1.00) QUESTION DELETED
B.
REFERENCE:
SAR page 54.

ANSWER: 015 (1.00)
D.
REFERENCE:
SAR Figure 3.16.

ANSWER: 016 (1.00)
C.
REFERENCE:
SAR Table 3.2.

ANSWER: 017 (1.00)
C.
REFERENCE:
SAR page 69.

ANSWER: 018 (1.00)
C.
REFERENCE:
SAR page 77.

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 & 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 ______

# EQUATION SHEET

$Q = m\ c_p\ \rho T$

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

$SUR = 26.06/\rho$

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

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

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

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

$DR_1 D_1^2 = DR_2 D_2^2$

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

$DR = 6CiE/D^2$

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

1 Curie = $3.7 \times 10^{10}$ dps

1 gallon water = 8.34 pounds

1 Btu = 778 ft-lbf

$°F = 9/5°C + 32$

1 Mw = $3.41 \times 10^6$ BTU/hr

$°C = 5/9\ (°F - 32)$