January 8, 2004

Dr. B. Don Russell, Deputy Director
Texas Engineering Experiment Station
Nuclear Science Center, Bldg. 1095
Texas A&M University
College Station, TX 77843-3575

SUBJECT: INITIAL EXAMINATION REPORT NO. 50-128/OL-04-01, TEXAS A&M UNIVERSITY

Dear Dr. Russell:

During the week of December 8, 2003, the NRC administered initial examinations to employees of your facility who had applied for a license to operate your Texas A&M 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 Daniel E. Hughes Acting for/***

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

Docket No. 50-128

Enclosures: 1. Initial Examination Report No. 50-128/OL-04-01
2. Examination and answer key

cc w/encl.: Please see next page

cc:

Mayor, City of College Station
P.O. Box Drawer 9960
College Station, TX 77840-3575

Governor's Budget and
Planning Office
P.O. Box 13561
Austin, TX 78711

Texas A&M University System
ATTN: Dr. Warren D. Reece, Director
Nuclear Science Center
Texas Engineering Experiment Station
F. E. Box 89, M/S 3575
College Station, TX 77843

Texas State Department of Health
Radiation Control Program Director
Bureau of Radiation Control
Dept. of Health
1100 West 49th Street
Austin, TX 78756-3189

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

January 4, 2004

Dr. B. Don Russell, Deputy Director
Texas Engineering Experiment Station
Nuclear Science Center, Bldg. 1095
Texas A&M University
College Station, TX 77843-3575

SUBJECT: INITIAL EXAMINATION REPORT NO. 50-128/OL-04-01, TEXAS A&M UNIVERSITY

Dear Dr. Russell:

During the week of December 8, 2003, the NRC administered initial examinations to employees of your facility who had applied for a license to operate your Texas A&M 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.

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Office of Nuclear Reactor Regulation

Docket No. 50-128

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cc w/encl.: Please see next page

**DISTRIBUTION w/encl.:**
PUBLIC
MMendonca, PM
Facility File (EBarnhill)

**DISTRIBUTION w/o encl.:**
RNRP\R&TR r/f
WEresian
PMadden

**ADAMS PACKAGE ACCESSION NO.: ML033650333**
**ADAMS REPORT ACCESSION No.: ML033650336** **TEMPLATE No.: NRR-074**

| OFFICE | RNRP:CE | | IROB:LA | | RNRP:SC | |
|---|---|---|---|---|---|---|
| NAME | WEresian | | EBarnhill/EHylton | | PMadden | |
| DATE | 01/ 05 /2004 | | 01/ 08 /2004 | | 01/ 08 /2004 | |

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

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

REPORT NO.: 50-128/OL-04-01

FACILITY DOCKET NO.: 50-128

FACILITY LICENSE NO.: R-83

FACILITY: Texas A&M University

EXAMINATION DATES: December 9-10, 2003

EXAMINER: Warren Eresian, Chief Examiner

SUBMITTED BY: ***/RA/*** 01/05/2004
Warren Eresian, Chief Examiner Date

SUMMARY:

During the week of December 8, 2003, the NRC administered operator licensing examinations to two Reactor Operator candidates. One candidate passed the examinations. One candidate passed the written examination but failed the operating test.

ENCLOSURE 1

REPORT DETAILS

1. Examiner: Warren Eresian, Chief Examiner

2. Results:

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

3. Exit Meeting:

Mr. Jim Remlinger, Manager of Operations
Warren Eresian, NRC Chief Examiner
Kevin Witt, NRC

The NRC thanked the facility staff for their cooperation during the examination. There were no comments on the written examination. No generic concerns were noted.

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

FACILITY: Texas A&M University

REACTOR TYPE: TRIGA

DATE ADMINISTERED: 12/09/03

REGION: 4

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 | 33.3 | _____ | ____ | A. REACTOR THEORY, THERMODYNAMICS, AND FACILITY OPERATING CHARACTERISTICS |
| 20 | 33.3 | _____ | ____ | B. NORMAL AND EMERGENCY OPERATING PROCEDURES AND RADIOLOGICAL CONTROLS |
| 20 | 33.3 | _____ | ____ | C. FACILITY AND RADIATION MONITORING SYSTEMS |
| 60 | | _____ | ____% 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)

| Given: | | |
|---|---|---|
| | Shutdown margin | $4.50 |
| | Control Rod 1 | $2.00 |
| | Control Rod 2 | $2.00 |
| | Control Rod 3 | $1.00 |

What is the actual excess reactivity (not the Tech. Spec. value) for this reactor?

a. $0.50

b. $1.50

c. $2.50

d. $5.00

QUESTION: 002 (1.00)

Which ONE of the following conditions would INCREASE the shutdown margin of a reactor?

a. Inserting an experiment which adds positive reactivity.

b. Lowering the moderator temperature, if the moderator temperature coefficient is negative.

c. Depletion of burnable poison.

d. Depletion of uranium fuel.

QUESTION: 003 (1.00)

When a reactor is scrammed, the xenon population starts to increase. This occurs primarily because:

a. delayed neutrons are continuing to be produced and cause fissions, resulting in xenon production.

b. the half-life for the decay of I-135 is shorter than the half-life for the decay of Xe-135.

c. Xe-135 is stable and does not decay.

d. the neutron population is so low that xenon burnout does not occur.

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

QUESTION: 004 (1.00)

A reactor is operating at criticality. Instantaneously, all of the delayed neutrons are suddenly removed from the reactor. The $K_{eff}$ of the reactor in this state would be approximately:

a. 1.007

b. 1.000

c. 0.993

d. 0.000

QUESTION: 005 (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

QUESTION: 006 (1.00)

Elastic Scattering is the process whereby a neutron collides with a nucleus and:

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

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

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

d. recoils with a higher kinetic energy, with the nucleus emitting a gamma ray.

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

QUESTION: 007 (1.00)

A reactor is subcritical with a $K_{eff}$ of 0.955. A positive reactivity of $5.00 is inserted into the core ($\beta$ = 0.007 delta k/k). At this point, the reactor is:

a. supercritical.

b. exactly critical.

c. prompt critical.

d. subcritical.

QUESTION: 008 (1.00)

A reactor is critical at 50% of rated power, with reactivity = zero. A control rod is withdrawn and the power increases to a higher steady-state value. The reactivity of the reactor at the higher power level is zero because:

a. the positive reactivity due to the fuel temperature decrease balances the negative reactivity due to the control rod withdrawal.

b. the negative reactivity due to the fuel temperature decrease equals the positive reactivity due to the control rod withdrawal.

c. the positive reactivity due to the fuel temperature increase balances the negative reactivity due to the control rod withdrawal.

d. the negative reactivity due to the fuel temperature increase equals the positive reactivity due to the control rod withdrawal.

QUESTION: 009 (1.00)

During fuel loading, which ONE of the following will have NO effect on the shape of the 1/M plot?

a. The order of fuel placement.

b. The source strength.

c. The location of the source in the core.

d. The location of the detector (or detectors) in the core.

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

QUESTION: 010 (1.00)

Which ONE of the following does NOT affect the Effective Multiplication Factor $K_{eff?}$

a. The moderator-to-fuel ratio.

b. The moderator temperature.

c. The physical dimensions of the core.

d. The strength of an installed neutron source.

QUESTION: 011 (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. 30% of rated power - going from 20% to 50% of rated power.

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

QUESTION: 012 (1.00)

Which ONE of the following is the principal source of energy (heat generation) in the reactor 15 minutes following a reactor shutdown from extended operation at full power?

a. Production of delayed neutrons.

b. Subcritical multiplication of neutrons.

c. Spontaneous fission of U-238.

d. Decay of fission products.

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

QUESTION: 013 (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 in the core.

QUESTION: 014 (1.00)

Which ONE of the following describes the response of the reactor to EQUAL amounts of reactivity insertion as the reactor approaches critical ($K_{eff}$ =1.0)?

a. The change in neutron population per reactivity insertion is smaller, and it requires a longer time to reach a new equilibrium count rate.

b. The change in neutron population per reactivity insertion is larger, and it requires a longer time to reach a new equilibrium count rate.

c. The change in neutron population per reactivity insertion is larger, and it takes an equal amount of time to reach a new equilibrium count rate.

d. The change in neutron population per reactivity insertion is smaller, and it requires a shorter time to reach a new equilibrium count rate.

QUESTION: 015 (1.00)

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

a. 93 kW.

b. 259 kW.

c. 389 kW.

d. 777 kW.

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

QUESTION: 016 (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 peak power will be:

a. about four times larger and the energy released will be about four times larger.

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

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

d. about two times larger and the energy released will be about two times larger.

QUESTION: 017 (1.00)

Which ONE of the following is the reason for operating with thermal neutrons rather than fast neutrons?

a. Probability of fission is increased since thermal neutrons are less likely to leak out of the core.

b. As neutron energy increases, neutron absorption in non-fuel materials increases exponentially.

c. The absorption cross-section of U-235 is much higher for thermal neutrons.

d. The fuel temperature coefficient becomes positive as neutron energy increases.

QUESTION: 018 (1.00)

The reactor is operating in the automatic mode at 50% power. A problem in the secondary cooling system causes the primary coolant temperature to increase by 5 degrees F. Given that the primary coolant temperature coefficient is $-7.0 \times 10^{-5}$ $\Delta$ k/k/deg. F and the differential rod worth of the regulating rod is
$8.75 \times 10^{-5}$ $\Delta$k/k/inch, the change in the position of the regulating rod will be:

a. eight (8) inches in.

b. eight (8) inches out.

c. four (4) inches in.

d. four (4) inches out.

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

QUESTION: 019 (2.00)

Given the following neutron life cycle for a critical reactor:

100 fast neutrons are produced from the previous generation and start to slow down. 20 neutrons are captured in resonance peaks, and 10 leak out of the core after they have reached thermal energy. The remaining neutrons are absorbed in fuel and other materials. Each fission produces 2.5 neutrons, and 85% of the neutrons absorbed in fuel result in fissions. For this reactor, the thermal utilization factor is _____and the resonance escape probability is _____:

a. 0.47; 0.70

b. 0.62; 0.90

c. 0.67; 0.80

d. 1.613; 0.80

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

QUESTION: 001 (1.00)

In accordance with SOP "Personnel Dosimetry," an Expected High Dose Individual is a person who:

a. may receive a dose greater than the annual limit.

b. may receive a dose greater than 10% of the annual limit.

c. will not be expected to exceed 10% of the annual limit.

d. has received an unknown amount of radiation resulting from an accident.

QUESTION: 002 (1.00)

In accordance with the Emergency Classification Guide, all alarms from the Facility Air Monitor System are classified as Operational Events with the exception of:

a. Stack Particulate Monitor.

b. Building Gas Monitor.

c. Fission Gas Monitor.

d. Stack Gas Monitor.

QUESTION: 003 (1.00)

Which ONE of the following does not require the direct supervision (i.e., presence) of an SRO?

a. Movement of the reactor bridge.

b. Initiation of a pulse.

c. Removal of a control rod.

d. Performance of a power calibration of the Linear Power Channel.

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

QUESTION: 004 (1.00)

Limiting Safety System Settings:

a. are limits on important process variables which are found to be necessary to reasonably protect the integrity of certain physical barriers which guard against the uncontrolled release of radioactivity.

b. are settings for automatic protective devices related to those variables having significant safety functions.

c. are combinations of sensors, interconnecting cables or lines, amplifiers, and output devices which are connected for the purpose of measuring the value of a variable.

d. are the lowest functional capability or performance levels of equipment required for safe operation of the facility.

QUESTION: 005 (1.00)

Operation of the reactor in the steady state mode means that:

a. the mode switch is in the steady state position.

b. reactor power is constant.

c. reactor power is constant, with power controlled by the servo system.

d. the mode switch is in the steady state position with power at 1 MW.

QUESTION: 006 (1.00)

You are standing ten (10) feet from a point source of radiation. When a ¼ inch sheet of lead is placed between you and the source, your exposure rate is halved. How many sheets of lead are required to reduce your exposure rate to 1% of its original value?

a. 2

b. 6

c. 7

d. 10

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

QUESTION: 007 (1.00)

The Design Basis Accident for the TA&M reactor is:

a. an accidental pulse at full power.

b. a loss of coolant accident (reactor pool is accidentally drained of water).

c. the loss of integrity of one fuel element cladding and the simultaneous loss of pool water.

d. the accidental insertion of an experiment with a positive reactivity worth of $1.00 while the reactor is critical.

QUESTION: 008 (1.00)

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

a. Steady state power level of 1.2 megawatts for purposes of testing.

b. A non-secured experiment worth $1.50.

c. A fuel element is known to be damaged, but has been moved to the edge of the core.

d. The Continuous Air Radiation Monitor and the Exhaust Gas Radiation Monitor are inoperable due to maintenance and have been replaced with gamma sensitive instruments with alarms.

QUESTION: 009 (1.00)

A power calibration (calorimetric) of the linear power channel has been performed. In order to make the front panel meter indication agree with the calculated power:

a. the compensating voltage of the linear channel CIC is adjusted.

b. the high voltage of the linear channel CIC is adjusted.

c. the position of the linear channel CIC is adjusted.

d. the full power gain adjust potentiometer is adjusted.

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

QUESTION: 010 (1.00)

In accordance with 10CFR20, 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. limits on the release of effluents to an unrestricted environment.

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

QUESTION: 011 (1.00)

The dose rate from a mixed beta-gamma 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: 012 (1.00)

"The total annual discharge of Argon-41 into the environment may not exceed 30 Ci per year unless permitted by the RSB." 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: 013 (2.00)

Select the MODE from Column II when the Safety Channels from Column I are required to be operable. Modes may be used once, more than once, or not at all.

| | Column I (Safety Channel) | Column II (Mode) |
|---|---|---|
| a. | Fuel Element Temperature | 1. Steady State only |
| b. | Preset timer | 2. Both modes |
| c. | Transient Rod Position | 3. Pulse only |
| d. | Log Power | |

QUESTION: 014 (1.00)

Argon-41 is produced by neutron absorption of argon-40. Argon-41 decays by:

a. a 1.3 Mev gamma with a half-life of 1.8 hours.

b. a 6.1 Mev gamma with a half-life of 7 seconds.

c. neutron emission with a half-life of 1.8 hours.

d. a 1.3 Mev beta with a half-life of 7 seconds.

QUESTION: 015 (1.00)

A system or component is defined as "operable" by Technical Specifications if:

a. a channel check has been performed.

b. it is capable of performing its intended function.

c. it has no outstanding testing requirements.

d. a functional test has been performed.

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

QUESTION: 016 (1.00)

Which ONE of the following conditions is NOT permissible when the reactor is operating, or about to be operated?

a. The reactivity worth of a single experiment = $1.00.

b. A control rod scram time = 1.5 seconds.

c. An excess reactivity = $2.20.

d. Steady state power level of 1.2 megawatts for purposes of testing.

QUESTION: 017 (1.00)

Limiting Safety System Settings used to prevent exceeding a Safety Limit:

a. must actuate automatically before the limit is exceeded.

b. can be exceeded during transients.

c. can be changed by the Reactor Safety Board.

d. apply only in the steady state mode of operation.

QUESTION: 018 (1.00)

A Limited Access Worker must receive _____and is issued a _____badge.

a. General Employee Training; green

b. Radiation Worker Training and General Employee Training; yellow

c. General Employee Training; orange

d. Radiation Worker Training and General Employee Training; blue

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

QUESTION: 019 (1.00)

The reactor was pulsed but the reactor was switched back to the steady state mode before the reactor operator logged the NVT and the pulse temperature values. The reactor operator should:

a. repeat the pulse.

b. look in the log book for a previous pulse of the same reactivity and use the NVT and pulse temperature values for that pulse.

c. shut down the reactor and record a statement in the Operations Log to document the event.

d. record the pulse temperature from the fuel element temperature recorder and correlate that value to the pulse power.

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

QUESTION: 001 (1.00)

What do the thermocouples in each of the instrumented fuel elements measure?

a. The temperature of the fuel cladding.

b. The temperature of the fuel reflector end pieces.

c. The temperature of the fuel's surface.

d. The temperature of the fuel's interior.

QUESTION: 002 (1.00)

Which ONE of the following lists the correct locations for the air handling system dampers?

a. Air inlet to all air handlers, exhaust stack, air inlet to central exhaust fan.

b. Air inlet to all air handlers, fresh air bypass to the exhaust fan, exhaust stack.

c. Fresh air bypass to the exhaust fan, air inlet to central exhaust fan, exhaust stack.

d. Air inlet to all air handlers, fresh air bypass to the exhaust fan, air inlet to central exhaust fan.

QUESTION: 003 (1.00)

Which set of measurements are chosen by the reactor console thermocouple selector?

a. Fuel temperature, irradiation cell temperature, heat exchanger primary outlet temperature.

b. Fuel temperature, pool water temperature, heat exchanger primary outlet temperature.

c. Fuel temperature, irradiation cell temperature, pool water temperature.

d. Pool water temperature, irradiation cell temperature, heat exchanger primary outlet temperature.

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

QUESTION: 004 (1.00)

Which ONE of the following situations will cause the reactor to automatically SCRAM?

a. Low safety detector voltage (<150 V).

b. High Radiation level at top of pool (>100 mrem/hr).

c. Low pool water level (<90% of normal level).

d. Low air pressure applied to the transient rod (<10 psi).

QUESTION: 005 (1.00)

What type of detector does the building particulate monitor use to measure radiation?

a. Gamma scintillator.

b. Geiger-Mueller.

c. Ionization chamber.

d. Beta scintillator.

QUESTION: 006 (1.00)

What automatic action is associated with a high radiation alarm signal from the Building Particulate Monitor?

a. The air handler fans continue to operate and all inlet dampers close.

b. The air handler fans cease operation and all inlet dampers remain open.

c. The air handler fans cease operation and all inlet dampers close.

d. The air handler fans continue to operate and all inlet dampers remain open.

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

QUESTION: 007 (1.00)

Which ONE of the following is provided by the wide range linear detector?

a. An indication of reactor period in steady state mode.

b. An indication of reactor power from shutdown to operating levels.

c. A signal for the reactor to SCRAM if the maximum pulse power level is exceeded.

d. A signal for the reactor to SCRAM if the maximum steady state power level is exceeded.

QUESTION: 008 (1.00)

What ONE of the following can cause the control rod jammed interlock?

a. Control rod drive going down and control rod going down at a slower rate.

b. Control rod drive going up and control rod going up at a slower rate.

c. Control rod drive going down and control rod not going down.

d. Control rod drive going up and control rod not going up.

QUESTION: 009 (1.00)

There is an annunciator light in the control room for which ONE of the following?

a. Opening a beam port door.

b. Absence of a shield plug from a beam port.

c. Presence of Ar-41 in the beam port.

d. Water leaking at a very slow rate into a beam port.

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

QUESTION: 010 (1.00)

What is the purpose of the exhaust duct in the lower irradiation cell?

a. To reduce humidity for experiment efficiency.

b. To minimize buildup of water if a leak develops in the irradiation window.

c. To minimize radiation exposure due to production of N-16.

d. To minimize radiation exposure due to production of Ar-41.

QUESTION: 011 (1.00)

What type of detector is used to measure the amount of radiation exposure at the top of the pool due to N-16?

a. Gamma scintillator.

b. Geiger-Mueller tube.

c. Ionization chamber.

d. Proportional counter.

QUESTION: 012 (1.00)

What prevents a fuel followed control rod from falling out of the core should it become detached from its mounting?

a. Bottom of pool is within 2 inches of grid plate.

b. Notch in control rod pole connected to reactor frame.

c. Safety plate assembly beneath the reactor grid plate.

d. Tapered section above absorber prevents passage through reactor frame.

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

QUESTION: 013 (1.00)

What prevents liquid radioactive waste from spilling uncontrollably into the environment if one of the liquid waste effluent tanks exceeds its capacity?

a. Pressure sealed caps.

b. Drain on the concrete pad leading to a sanitary sewer.

c. Electrical heater in tank accelerates evaporation.

d. Connection to other waste effluent tanks.

QUESTION: 014 (1.00)

Which ONE of the following actions will cause the operating reactor to automatically SCRAM?

a. Opening the cave door to BP4 when the reactor is against the radiography reflector.

b. Opening the irradiation cell door when the reactor is in the pool core position.

c. Opening the thermal column shield door with the reactor positioned at the centerline of BP 1 & 4.

d. Opening one of the beam port lead seal doors when the reactor is in the stall core position.

QUESTION: 015 (1.00)

For the Shim Safety Control Rod drives, which ONE of the following statements is correct?

a. An IN signal for one shim rod overrides an IN signal for the gang of shim rods.

b. An OUT signal for one shim rod overrides an IN signal for the gang of shim rods.

c. An IN signal for one shim rod overrides an OUT signal for the gang of shim rods.

d. An OUT signal for one shim rod overrides an OUT signal for the gang of shim rods.

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

QUESTION: 016 (1.00)

Why is the pneumatic system vented to the main exhaust stack?

a. Prevent exposure to N-16 due to buildup of water in the line.

b. Prevent exposure to $CO_2$, which is an asphyxiation hazard.

c. Prevent exposure to fission product gases due to a fuel cladding breach.

d. Prevent exposure to Ar-41 due to buildup of air in the line.

QUESTION: 017 (1.00)

Which ONE of the following is the purpose of the stainless steel liner that encircles the reactor pool?

a. Reduce radiation exposure to people.

b. Contain the water within the pool.

c. Prevent outside contaminants from getting into the pool.

d. Support the biological shield structure.

QUESTION: 018 (1.00)

For an emergency fill of the pool using the demineralizer system, what is the reason why the flow rate of 70 gpm should not be exceeded, as specified in SOP V-A?

a. Channels will be created in the demineralizer.

b. Resin will blow out of the demineralizer into the pool.

c. The demineralizer will become over pressurized.

d. The filter will blow upstream of the demineralizer into the demineralizer.

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

QUESTION: 019 (1.00)

More than 95% of the facility's Ar-41 is produced in the:

a. beam ports.

b. pneumatic system.

c. reactor pool.

d. reactor building atmosphere.

QUESTION: 020 (1.00)

During reactor operation, a leak develops in the primary to secondary heat exchanger. Which ONE of the following conditions correctly describes how the system will react?

a. Cooling tower basin level will increase due to leakage from the primary, pool level will decrease.

b. Cooling tower basin level will decrease due to leakage from the secondary, pool level will increase.

c. Cooling tower level will increase due to leakage from the primary, automatic level control will maintain level in the primary.

d. Pool level will increase due to leakage from the secondary, the automatic level control will maintain level in the secondary.

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

A. REACTOR THEORY, THERMODYNAMICS & FACILITY OPERATING CHARACTERISTICS

ANSWER: 001 (1.00)
A.
REFERENCE:
R. R. Burn, Introduction to Nuclear Reactor Operations, pg. 6-3.

ANSWER: 002 (1.00)
D.
REFERENCE:
Anything which adds negative reactivity increases the shutdown margin.

ANSWER: 003 (1.00)
B.
REFERENCE:
R. R. Burn, Introduction to Nuclear Reactor Operations, pg. 8-10.

ANSWER: 004 (1.00)
C.
REFERENCE:
R. R. Burn, Introduction to Nuclear Reactor Operations, pg. 4-1.

ANSWER: 005 (1.00)
C.
REFERENCE:
R. R. Burn, Introduction to Nuclear Reactor Operations, pg. 2-45.

ANSWER: 006 (1.00)
A.
REFERENCE:
R. R. Burn, Introduction to Nuclear Reactor Operations, pg. 2-28.

ANSWER: 007 (1.00)
D.
REFERENCE:
Lamarsh, Introduction to Nuclear Engineering, 2nd Edition, pg. 282.
$5.00 = 0.035 delta k/k. Reactor is initially subcritical by 0.045 delta k/k.

ANSWER: 008 (1.00)
D.
REFERENCE:
Since the fuel temperature must increase, negative reactivity is added.

ANSWER: 009 (1.00)
B.
REFERENCE:
R. R. Burn, Introduction to Nuclear Reactor Operations, pg. 5-18.

ANSWER: 010 (1.00)
D.
REFERENCE:
R. R. Burn, Introduction to Nuclear Reactor Operations, pg. 3-18.

ANSWER: 011 (1.00)
A.
REFERENCE:
R. R. Burn, Introduction to Nuclear Reactor Operations, pg. 4-4. Largest value of $P/P_o = e^{t/T}$.

ANSWER: 012 (1.00)
D.
REFERENCE:
R. R. Burn, Introduction to Nuclear Reactor Operations, pg. 4-23.

ANSWER: 013 (1.00)
C.
REFERENCE:
R. R. Burn, Introduction to Nuclear Reactor Operations, pg. 3-21.

ANSWER: 014 (1.00)
B.
REFERENCE:
R. R. Burn, Introduction to Nuclear Reactor Operations, pg. 5-7.

ANSWER: 015 (1.00)
C.
REFERENCE:
Power = $mc\Delta T/\Delta t$, where: m=106,000 gallons x 8.34 lbs/gal = 884,040 lb; c=1 Btu/°F-lb; $\Delta T/\Delta t$ = 1.5 degrees/hour. Power = 1,326,060 Btu/hour; 3413 Btu/hour = 1 kW. Power = 1,326,060/3413 = 389 kW

ANSWER: 016 (1.00)
C.
REFERENCE:
TA&M SAR, Figure 3-21.

ANSWER: 017 (1.00)
C.
REFERENCE:
R. R. Burn, Introduction to Nuclear Reactor Operations, pg. 2-39.

ANSWER: 018 (1.00)
D.
REFERENCE:
R. R. Burn, Introduction to Nuclear Reactor Operations, pg. 8-10.
Since the coolant temperature increased, negative reactivity was added. Therefore, the rod must add positive reactivity, i.e. withdrawn. $7x5x10^{-5}/8.75x10^{-5}$ = 4 inches.

ANSWER: 019 (2.00)
C.
REFERENCE:
R. R. Burn, Introduction to Nuclear Reactor Operations, pg. 3-15.
A total of 70 thermal neutrons (100-20-10) are absorbed in fuel plus other materials. Since the reactor is critical, there were 40 fissions (40x2.5 = 100). Since 85% of absorptions result in fission, there were 40/0.85 = 47 neutrons absorbed in fuel. The thermal utilization = 47/70 = 0.67. Resonance escape probability is 80/100 = 0.80

B. NORMAL/EMERGENCY PROCEDURES & RADIOLOGICAL CONTROLS

ANSWER: 001 (1.00)
B.
REFERENCE:
SOP Personnel Dosimetry.

ANSWER: 002 (1.00)
C.
REFERENCE:
Emergency Classification Guide, pg. 2.

ANSWER: 003 (1.00)
D.
REFERENCE:
SOP Power Calibration.

ANSWER: 004 (1.00)
B.
REFERENCE:
TA&M Technical Specifications, Section 1.13.

ANSWER: 005 (1.00)
A.
REFERENCE:
TA&M Technical Specifications, Section 1.41.

ANSWER: 006 (1.00)
C.
REFERENCE:
Each sheet of lead reduces the exposure rate by half. First sheet - 50%; second sheet - 25%; third sheet - 12.5%, etc.

ANSWER: 007 (1.00)
C.
REFERENCE:
SAR Chapter XI.

ANSWER: 008 (1.00)
A.
REFERENCE:
TA&M Technical Specifications, Section 3.1.1.

ANSWER: 009 (1.00)
D.
REFERENCE:
SOP Power Calibration.

ANSWER: 010 (1.00)
A.
REFERENCE:
20CFR20.

ANSWER: 011 (1.00)
C.
REFERENCE:
At twenty feet, the dose rate consists only of gamma radiation. The gamma dose rate at one foot is:
$DR_1 d_1^2 = DR_2 d_2^2$ ; $(DR_1)(1) = (0.1)(400)$ ; $DR_1 = 40$ mrem/hour.
The beta dose rate at one foot is 60 mrem/hour = 60%.

ANSWER: 012 (1.00)
C.
REFERENCE:
TA&M Technical Specifications, Section 3.7.

ANSWER: 013 (2.00)
A,2; B,3; C,1; D,2
REFERENCE:
TA&M Technical Specifications, Table 1.

ANSWER: 014 (1.00)
A.
REFERENCE:
Chart of the Nuclides

ANSWER: 015 (1.00)
B.
REFERENCE:
TA&M Technical Specifications, Section 1.18.

ANSWER: 016 (1.00)
B.
REFERENCE:
TA&M Technical Specifications, Section 3.2.3.

ANSWER: 017 (1.00)
A.
REFERENCE:
TA&M Technical Specifications, Section 2.2.

ANSWER: 018 (1.00)
C.
REFERENCE:
SOP NSC Access Control.

ANSWER: 019 (1.00)
D.
REFERENCE:
SOP Pulsing Operation.

C. FACILITY AND RADIATION MONITORING SYSTEMS

ANSWER: 001 (1.00)
D.
REFERENCE:
SAR, page 4-5

ANSWER: 002 (1.00)
B.
REFERENCE:
SAR, page 6-2

ANSWER: 003 (1.00)
C.
REFERENCE:
SAR, page 7-4

ANSWER: 004 (1.00)
A.
REFERENCE:
SAR, page 7-4

ANSWER: 005 (1.00)
D.
REFERENCE:
SOP VII-B-6-a

ANSWER: 006 (1.00)
D.
REFERENCE:
SAR, page 6-2; SOP VII-B-10

ANSWER: 007 (1.00)
B.
REFERENCE:
SAR, page 7-2

ANSWER: 008 (1.00)
C.
REFERENCE:
SAR, page 7-12

ANSWER: 009 (1.00)
A.
REFERENCE:
SAR, page 10-3

ANSWER: 010 (1.00)
D.
REFERENCE:
SAR, page 10-7; SOP IV-E-1

ANSWER: 011 (1.00)
B.
REFERENCE:
SOP VII-B-7

ANSWER: 012 (1.00)
C.
REFERENCE:
SAR, page 4-8

ANSWER: 013 (1.00)
D.
REFERENCE:
NRC Inspection Report No. 50-128/2003-201

ANSWER: 014 (1.00)
A.
REFERENCE:
SAR, page 10-7; SOP IV-F-3

ANSWER: 015 (1.00)
C.
REFERENCE:
SAR, page 7-9

ANSWER: 016 (1.00)
D.
REFERENCE:
SOP IV-C-2; Experiment Authorization #24

ANSWER: 017 (1.00)
B.
REFERENCE:
SAR, page 4-9

ANSWER: 018 (1.00)
A.
REFERENCE:
SOP V-A

ANSWER: 019 (1.00)
C.
REFERENCE:
SAR, page 11-1

ANSWER: 020 (1.00)
A.
REFERENCE:
SAR, page 5-4

A. REACTOR THEORY, THERMODYNAMICS AND FACILITY OPERATING CHARACTERISTICS

ANSWER SHEET

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

001 a b c d _____

002 a b c d _____

003 a b c d _____

004 a b c d _____

005 a b c d _____

006 a b c d _____

007 a b c d _____

008 a b c d _____

009 a b c d _____

010 a b c d _____

011 a b c d _____

012 a b c d _____

013 a b c d _____

014 a b c d _____

015 a b c d _____

016 a b c d _____

017 a b c d _____

018 a b c d _____

019 a b c d _____

(***** 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 _____

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

C. FACILITY AND RADIATION MONITORING SYSTEMS

ANSWER SHEET

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

| | | | | |
|---|---|---|---|---|
| 001 | a | b | c | d _____ |
| 002 | a | b | c | d _____ |
| 003 | a | b | c | d _____ |
| 004 | a | b | c | d _____ |
| 005 | a | b | c | d _____ |
| 006 | a | b | c | d _____ |
| 007 | a | b | c | d _____ |
| 008 | a | b | c | d _____ |
| 009 | a | b | c | d _____ |
| 010 | a | b | c | d _____ |
| 011 | a | b | c | d _____ |
| 012 | a | b | c | d _____ |
| 013 | a | b | c | d _____ |
| 014 | a | b | c | d _____ |
| 015 | a | b | c | d _____ |
| 016 | a | b | c | d _____ |
| 017 | a | b | c | d _____ |
| 018 | a | b | c | d _____ |
| 019 | a | b | c | d _____ |
| 020 | a | b | c | d _____ |

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

# EQUATION SHEET

$Q = m\ c_p\ \Delta T$

$CR_1\ (1\text{-}K_1) = CR_2\ (1\text{-}K_2)$

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

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

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

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

$DR_1D_1^2 = DR_2D_2^2$

$DR = DR_oe^{-\lambda t}$

$DR = 6CiE/D^2$

$\rho = (K\ \text{-}1)/K$

$1\ \text{Curie} = 3.7\text{x}10^{10}\ \text{dps}$

1 gallon water = 8.34 pounds

$^\circ F = 9/5\,^\circ C + 32$

$1\ \text{Mw} = 3.41\text{x}10^6\ \text{BTU/hr}$

$^\circ C = 5/9\ (^\circ F - 32)$

$1\ \text{Mev} = 1.6\text{x}10^{-13}\ \text{watt-sec}$