May 20, 2003

Dr. William Vernetson, Director
Nuclear Facilities
102 Nuclear Reactor Bldg.
Department of Nuclear Engineering Sciences
University of Florida
Gainesville, FL 32611-8300

SUBJECT: INITIAL EXAMINATION REPORT NO. 50-083/OL-03-01, UNIVERSITY OF FLORIDA

Dear Dr. Vernetson:

During the week of April 14, 2003, the NRC administered operator licensing examinations at your University of Florida 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 Patrick Isaac at 301-415-1019 or via Internet e-mail at pxi@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. 50-83

Enclosures:
1. Initial Examination Report No. 50-083/OL-03-01
2. Facility Comments and NRC Resolution
3. Examination and answer key

cc w/enclosures:
Please see next page

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**ADAMS EXAMINATION PACKAGE NO.: ML031350636**
**ADAMS EXAMINATION REPORT ACCESSION NO.: ML031350644**

**TEMPLATE #:NRR-074**

| OFFICE | RORP:CE | | IEHB:LA | E | RORP:SC | |
|---|---|---|---|---|---|---|
| NAME | PIsaac:rdr | | EBarnhill | | PMadden | |
| DATE | 05/ 15 /2003 | | 05/ 20 /2003 | | 05/ 20 /2003 | |

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

| | |
|---|---|
| REPORT NO.: | 50-083/OL-03-01 |
| FACILITY DOCKET NO.: | 50-083 |
| FACILITY LICENSE NO.: | R-56 |
| FACILITY: | University of Florida |
| EXAMINATION DATES: | 04/14/2003 - 04/15/2003 |
| SUBMITTED BY: | ***/RA/*** 05/13/2003<br>Patrick Isaac, Chief Examiner Date |

SUMMARY:

During the week of April 14, 2003, NRC administered operator licensing examinations to two Senior Reactor Operator (SROI) candidates. Both candidates passed the examinations.

## REPORT DETAILS

1. Examiners:
   Patrick J. Isaac, Chief Examiner

2. Results:

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

3. Exit Meeting:
   Mr. Aaron D Vierbicky, Senior Reactor Operator
   Patrick Isaac, Chief Examiner

   Mr. Vierbicky suggested some changes to the written examination answer key. These suggestions and the NRC’s resolution to them are addressed in Enclosure 2. There were no generic concerns raised by the examiners.

## FACILITY COMMENTS AND NRC RESOLUTION

Facility Comment C-7:

Question C.7 asks the result of depressing all four control blades switches simultaneously to shutdown the reactor while in automatic mode. The question does not specify which control blade switches are depressed. If the control blade clutch current switches are depressed all four blades will insert, and the reactor will shutdown, therefore answer D is correct. If the control blade down switches are depressed then the three safety blades insert, and the regulating blade withdraws, therefore answer C is correct. Because the question does not specify which control blade switches are depressed, and depressing either the down or current switches will shutdown the reactor under manual operating conditions we are requesting both answers C and D are counted as correct.

NRC Resolution C-7:

Comment accepted. The answer key will be modified to accept both options c and d as correct.

Facility Comment C-8:

Question C.8 asks which control blade drive systems do NOT have a withdrawal interlock light on their calibrate and test switches. No control blade drive system has either an interlock light or calibrate, or trip test switch associated with it. Safety Channel 1, and Safety Channel 2 both have calibrate and trip test control switches which when out of the operate or off position (except for Safety Channel 2 Trip Test) will prevent all control blade drives from operating; however, the Safety 1 Trip test control switch will not light up the “INTLK” warning light on the SCRAM annunciator panel. The correct answer to this question would be all of them. The question is confusing and the answers are not applicable to what we perceive to be the point of the question. We request that this question be deleted from the examination.

NRC Resolution C-8:

Comment accepted. Question C-8 will be deleted from the examination.

Facility Comment B-1:

Question B.1 asks which of the following meets the conditions for monitoring removal of an experiment from the reactor. The correct answer is D; however due to the fact that the radiation control qualification is a required qualification for all UFTR RO and SRO trainees, answers A and B would also be correct. We are not asking for any action to be taken on this question.

NRC Resolution B-1:

No change to the answer key is required.

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

FACILITY: University of Florida

REACTOR TYPE: Argonaut

DATE ADMINISTERED: 2003/04/14

CANDIDATE: ______________________

INSTRUCTIONS TO CANDIDATE:
Answers are to be written on the answer sheet provided. Attach all answer sheets to the examination. Point values 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 |
|---|---|---|---|---|---|
| 20.00 | 33.3 | ______ | ____ | A. | REACTOR THEORY, THERMODYNAMICS AND FACILITY OPERATING CHARACTERISTICS |
| 20.00 | 33.3 | ______ | ____ | B. | NORMAL AND EMERGENCY OPERATING PROCEDURES AND RADIOLOGICAL CONTROLS |
| 20.00 | 33.3 | ______ | ____ | C. | FACILITY AND RADIATION MONITORING SYSTEMS |
| 60.00 | | ______ FINAL GRADE | ____% | | TOTALS |

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

______________________________
Candidate's Signature

ENCLOSURE 3

QUESTION A.1 [1.0 point]
Core excess reactivity changes with …

a. fuel element burnup

b. control rod height

c. neutron energy level

d. reactor power level

QUESTION A.2 [1.0 point]
You enter the control room and note that all nuclear instrumentation show a steady neutron level, and no rods are in motion. Which ONE of the following conditions CANNOT be true?

a. The reactor is critical.

b. The reactor is subcritical.

c. The reactor is supercritical.

d. The neutron source has been removed from the core.

QUESTION A.3 [1.0 point]
The delayed neutron precursor (β) for $U^{235}$ is 0.0065. However, when calculating reactor parameters you use $\beta_{eff}$ with a value of ~0.0070. Why is $\beta_{eff}$ larger than β?

a. Delayed neutrons are born at higher energies than prompt neutrons resulting in a greater worth for the neutrons.

b. Delayed neutrons are born at lower energies than prompt neutrons resulting in less leakage during slowdown to thermal energies.

c. The fuel also contains $U^{238}$ which has a relatively large β for fast fission.

d. $U^{238}$ in the core becomes $Pu^{239}$ (by neutron absorption), which has a higher β for fission.

QUESTION A.4 [1.0 point]
The difference between a moderator and a reflector is that a reflector …

a. increases the fast non-leakage factor and a moderator increases the thermal utilization factor.

b. increases the neutron production factor and a moderator increases the fast fission factor.

c. increases the neutron production factor and a moderator decreases the thermal utilization factor.

d. decreases the fast non-leakage factor and a moderator increases the thermal utilization factor.

QUESTION A.5 [1.0 point]
Which of the following atoms will cause a neutron to lose the most energy during an elastic scattering reaction?

a. $O^{16}$

b. $C^{12}$

c. $U^{235}$

d. $H^{1}$

QUESTION A.6 [1.0 point]
Which ONE of the following is the MAJOR source of energy released during fission? Kinetic Energy of the…

a. prompt gamma rays.

b. capture gammas.

c. Beta particles.

d. fission fragments.

QUESTION A.7 [1.0 point]
Which ONE of the following describes the **MAJOR** contributor to the production and depletion of Xenon respectively in a **STEADY-STATE OPERATING** reactor?

| | Production | Depletion |
|---|---|---|
| a. | Radioactive decay of Iodine | Radioactive Decay |
| b. | Radioactive decay of Iodine | Neutron Absorption |
| c. | Directly from fission | Radioactive Decay |
| d. | Directly from fission | Neutron Absorption |

QUESTION A.8 [1.0 point]
Which ONE of the following is an example of neutron decay?

a. ${}_{35}Br^{87} \rightarrow {}_{33}As^{83}$

b. ${}_{35}Br^{87} \rightarrow {}_{35}Br^{86}$

c. ${}_{35}Br^{87} \rightarrow {}_{34}Se^{86}$

d. ${}_{35}Br^{87} \rightarrow {}_{36}Kr^{87}$

QUESTION A.9 [1.0 point]
Which ONE of the following is the reason for the -80 second period following a reactor scram?

a. The ability of $U^{235}$ to fission source neutrons.

b. The half-life to the longest-lived group of delayed neutron precursors.

c. The amount of negative reactivity added on a scram is greater than the shutdown margin.

d. The Doppler effect, which adds positive reactivity due to the temperature decrease following a scram.

QUESTION A.10 [1.0 point]
Which ONE of the following explains the response of a SUBCRITICAL reactor to equal insertions of positive reactivity as the reactor approaches criticality?

a. Each insertion causes a **SMALLER** increase in the neutron flux resulting in a **LONGER** time to stabilize.

b. Each insertion causes a **LARGER** increase in the neutron flux resulting in a **LONGER** time to stabilize.

c. Each insertion causes a **SMALLER** increase in the neutron flux resulting in a **SHORTER** time to stabilize.

d. Each insertion causes a **LARGER** increase in the neutron flux resulting in a **SHORTER** time to stabilize.

QUESTION A.11 [1.0 point]
$K_{eff}$ for the reactor is 0.85. If you place an experiment worth +17.6% into the core, what is the new $K_{eff}$ ?

a. 0.995

b. 0.9995

c. 1.005

d. 1.05

QUESTION A.12 [1.0 point]
Which ONE of the following is the reason for an installed neutron source within the core? A startup without an installed neutron source …

a. is impossible as there would be no neutrons available to start up the reactor.

b. would be very slow due to the long time to build up neutron population from so low a level.

c. could result in a very short period due to the reactor going critical before neutron population built up high enough to be read on nuclear instrumentation.

d. can be compensated for by adjusting the compensating voltage on the source range detector.

QUESTION A.13 [1.0 point]
Several processes occur that may increase or decrease the available number of neutrons. SELECT from the following the six-factor formula term that 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. Reproduction factor.

QUESTION A.14 [1.0 point]
The term "prompt jump" refers to:

a. the instantaneous change in power due to raising 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 $\beta_{eff}$.

QUESTION A.15 [1.0 point]
By definition, an exactly critical reactor can be made prompt critical by adding positive reactivity equal to …

a. the shutdown margin

b. the $K_{excess}$ margin

c. the $\beta_{eff}$ value

d. 1.0 %ΔK/K.

QUESTION A.16 [1.0 point]
The number of neutrons passing through a one square centimeter of target material per second is the definition of which one of the following?

a. Neutron Population (np)

b. Neutron Impact Potential (nip)

c. Neutron Flux (nv)

d. Neutron Density (nd)

QUESTION A.17 [1.0 point]
Reactor power doubles in 42 seconds. Based on the period associated with this transient, how long will it take for reactor power to increase by a factor of 10?

a. 80 seconds

b. 110 seconds

c. 140 seconds

d. 170 seconds

QUESTION A.18 [1.0 point]
A thin foil target of 10% copper and 90% aluminum is in a thermal neutron beam. Given $\sigma_a$ Cu = 3.79 barns, $\sigma_a$ Al = 0.23 barns, $\sigma_s$ Cu = 7.90 barns, and $\sigma_s$ Al =1.49 barns, which ONE of the following reactions has the highest probability of occurring? A neutron …

a. scattering reaction with aluminum

b. scattering reaction with copper

c. absorption in aluminum

d. absorption in copper

QUESTION A.19 [1.0 point]
Regulating rod worth for a reactor is 0.001 ΔK/K/inch. Moderator temperature **INCREASES** by 9°F, and the regulating rod moves 4½ inches inward to compensate. The moderator temperature coefficient $\alpha_{Tmod}$ is …

a. $+5 \times 10^{-4}$ ΔK/K/°F

b. $-5 \times 10^{-4}$ ΔK/K/°F

c. $+2 \times 10^{-5}$ ΔK/K/°F

d. $-2 \times 10^{-5}$ ΔK/K/°F

QUESTION A.20 [1.0 point]
$K_{eff}$ is $K_\infty$ times …

a. the fast fission factor (ε)

b. the total non-leakage probability ($\mathscr{L}_f \times \mathscr{L}_{th}$)

c. the reproduction factor (η)

d. the resonance escape probability (p)

QUESTION B.1 [1.0 point]
Which of the following meets the conditions for monitoring removal of an experiment from the reactor?

a. Any two UFTR licensed staff members.

b. One Class A and one Class B reactor operator.

c. Two Radiation Control Representatives.

d. A licensed UFTR staff member and any radiation control qualified person.

QUESTION B.2 [1.0 point]
Which classes of experiments MUST be approved by the Reactor Manager AND the Radiation Control Officer?

a. All classes

b. II and III and IV

c. III and IV

d. IV only

QUESTION B.3 [2.0 points, ½ point each]
Identify each of the following as either a Safety Limit (SL), Limiting Safety System Setting (LSSS) or a Limiting Condition for Operation (LCO).

a. The reactor shall not be started unless the reactor control system is operable.

b. The primary coolant flow rate shall be monitored at the return line.

c. The primary coolant outlet temperature from any fuel box shall not exceed 200°F.

d. The total reactivity worth of all experiments shall not exceed 2.3% $\Delta k/k$.

QUESTION B.4 [1.0 point]
Select the condition that REQUIRES the reactor to be shutdown.

a. Graphite becomes wetted during operation.

b. Stack monitor level reaches 2000 cps at 100 kW.

c. Primary coolant temperature exceeds 120°F. on the well water supply.

d. Adjustments to auxiliary portable shielding are necessary.

QUESTION B.5 [1.0 point]
Which ONE of the following is the definition of a ***CHANNEL TEST***?

a. the combination of sensor, line, amplifier, and output devices which are connected for the purpose of measuring the value of a parameter

b. an adjustment of the channel such that it output corresponds with acceptable accuracy to known values of the parameter which the channel measures. Calibration shall encompass the entire channel, Including equipment actuation, alarm, or 'trip and shall be deemed to include a channel test

c. a qualitative verification of acceptable performance by observation of channel behavior.' This verification, where possible, shall Include comparison of the channel with other Independent channels or systems measuring the same variable.

d. the Introduction of a signal Into the channel for verification that It Is operable.

QUESTION B.6 [1.0 point]
Which of the following is a violation of UFTR Safety Limits?

a. A power excursion from 100 kW to a peak of 525 kW resulting in a FULL Trip.

b. Average primary coolant outlet temperature from one fuel box at 160°F.

c. Primary coolant flow rate of 15 gpm with power at 10 kW.

d. Primary coolant core level at 1 inch above the fuel.

QUESTION B.7 [1.0 point]
**Two** inches of shielding reduce the gamma exposure in a beam of radiation from 400 mR/hr to 100 mR/hr. If you add an **additional** **four** inches of shielding what will be the new radiation level? (Assume all reading are the same distance from the source.)

a. 6.25 mR/hr

b. 12.5 mR/hr

c. 25 mr/hr

d. 100 mr/hr

QUESTION B.8 [2.0 points, ½ point each]
10 CFR 55 contains requirements associated with your operator or senior operator license. Match each of the requirements listed in column A with it's appropriate time period in column B. (Note: Periods from column B may be used more than once or not at all.)

| **Column A (Requirements)** | **Column B (Years)** |
|---|---|
| a. License Expires | 1 |
| b. Pass a Requalification Written Examination | 2 |
| c. Pass a Requalification Operating Test | 4 |
| d. Medical Examination Required | 6 |

QUESTION B.9 [2.0 points, ½ each]
Identify each of the radioisotopes in column A with its PRIMARY source (irradiation of air, irradiation of water, or is a fission product).

a. ${}_{1}H^{3}$

b. ${}_{18}Ar^{41}$

c. ${}_{7}N^{16}$

d. ${}_{54}Xe^{135}$

QUESTION B.10[1.0 point]
The CURIE content of a radioactive source is a measure of

a. the number of radioactive atoms in the source.

b. the amount of energy emitted per unit time by the source

c. the amount of damage to soft body tissue per unit time.

d. the number of nuclear disintegrations per unit time.

QUESTION B.11[2.0 points, ½ each]
Match the Condition listed in column A with the corresponding reactivity limit in column B.

| ***Column A*** | ***Column B*** |
|---|---|
| a. Maximum core excess reactivity | 0.06% ΔK/K |
| b. Absolute reactivity worth of any single experiment | 0.6% ΔK/K |
| c. Maximum worth of an ***Unsecured Experiment*** | 2.0% ΔK/K |
| d. Maximum reactivity insertion rate per second for a single control blade | 2.3% ΔK/K |

QUESTION B.12[1.0 point]
The reactor has been running at full power. Which of the following must be satisfied for personnel to enter the Primary Equipment Pit?

a. The pit area is not contaminated.

b. There is no evidence of a primary coolant leak.

c. The reactor has been shutdown for 15 minutes.

d. All control blades are fully inserted.

QUESTION B.13[1.0 point]
10CFR50.54(x) states: “A licensee may take reasonable action that departs from a license condition or a technical specification (contained in a license issued under this part) in an emergency when this action is immediately needed to protect the public health and safety and no action consistent with license conditions and technical specifications that can provide adequate or equivalent protection is immediately apparent.” 10CFR50.54(y) state that the minimum level of management which may authorize this action is …

a. any Reactor Operator licensed at facility

b. any Senior Reactor Operator licensed at facility

c. Facility Manager (or equivalent name at facility).

d. NRC Manager

QUESTION B.14[1.0 point]
A radiation survey instrument was used to measure an irradiated experiment. The results were 0.1 mrem/hr, read 10 minutes following removal from the core. If the half life of the sample is 1 minute. What was the dose rate, at the time the sample was initially removed from the core?

a. 10 rem/hr

b. 1 rem/hr

c. 100mrem/hr

d. 10 mrem/hr

QUESTION B.15[1.0 point]
Consider two point sources, each having the ***SAME*** curie strength. Source A's gammas have an energy of 1.0 MeV, while Source B's gammas have an energy of 2.0 MeV. Using a **Geiger-Müller** detector the reading from source B will be … *(Ignore detector efficiency)*

a. four times that of source A.

b. twice that of source A.

c. the same.

d. half that of source A.

QUESTION B.16[1.0 point]
Which ONE of the following is an abnormal occurrence?

D. During a fuel inspection, a deep scratch is noted on a fuel plate with swipes taken and a spectrum analysis showing no significant presence of fission products.

E. During the quarterly calibration check, the reactor manager discovers that the limiting safety system setting on the primary coolant flow rate had been set to 34 gpm during the previous quarterly check.

F. A small graphite matrix is inserted into the CVP on a string and is suspended 2 feet above the core centerline. The string breaks dropping the sample into the core and putting the reactor on a 120 second positive period for which the operator immediately compensates.

G. While performing a four hour irradiation, the RO notices that the NORTH and EAST area monitors are no longer operating. He decides to complete the final 10 minutes of the irradiation with an extra ion chamber set up monitoring radiation levels. The reactor is then promptly shut down and secured.

QUESTION (C.1) [1.0]
The reactor vent system must be IMMEDIATELY secured if:

a. the stack monitor indicates less than 10 counts per second.

b. the stack monitor recorder is inoperable.

c. air flow is less than 400 cfm.

d. the absolute filter is dirty.

QUESTION (C.2) [1.0]
Which of the following will cause a FULL Trip?

a. Manual scram bar trip.

b. Loss of power to control console.

c. Core water level less than 42.5 inches.

d. Loss of power to the ventilation system.

QUESTION (C.3) [1.0]
Which ONE of the following does NOT open the Dump valve?

a. console key to off with one control blade at 150 units.

b. loss of power to the dump valve.

c. nuclear instrumentation trip with 2 control blades fully out.

d. loss of high voltage power supply 2 when at full power.

QUESTION (C.4) [1.0]
Which of the following is the most accurate neutron instrumentation channel for reactor control?

a. Safety Channel 1

b. Safety Channel 2

c. Wide range logarithmic

d. Linear Channel

QUESTION (C.5) [1.0]
Which of the following reactor control system features will remain functional while the Regulating Blade is being operated by the Auto Flux Control System?

a. Multiple safety blade interlock.

b. Ten second period interlock.

c. Regulating blade updrive limit switch.

d. Regulating blade down drive control.

QUESTION (C.6) [1.0]
Select the secondary coolant flow that must be maintained from the well system or the city water system when the reactor is greater than 1 kW.

| | Well system | City Water system |
|---|---|---|
| a. | 8 gpm | 60 gpm |
| b. | 18 gpm | 30 gpm |
| c. | 30 gpm | 18 gpm |
| d. | 60 gpm | 8 gpm |

QUESTION (C.7) [1.0]
The following conditions exist:

- -- The reactor is in the Automatic Flux Control Mode.
- -- Reactor power is 100 kW.
- -- All four control blade switches are pushed simultaneously to shut down the reactor.

Which of the following will be the result?

a. Three safety blades do NOT move, the regulating blade inserts.

b. Three safety blades insert, the regulating blade does NOT move.

c. Three safety blades insert, the regulating blade withdraws.

d. All control blades insert.

QUESTION (C.8) [1.0] *DELETED*
Which of the following control blade control blade drive systems does NOT have a withdrawal interlock (INTLK) light on all trip test and calibrate switches?

a. Safety 1

b. Safety 2

c. Safety 3

d. Regulating

QUESTION (C.9) [1.0]
Which of the following will automatically actuate the evacuation alarm?

a. Two area radiation monitors alarm high.

b. An air particulate monitor has an alarm condition.

c. Rupture disk pressure exceeds 7 psid.

d. The dump valve opens.

QUESTION (C.10) [2.0 points, ½ each]
Match the event in Column A with the resulting automatic action in Column B.

NOTE: Items in Column B may be used more than once or not at all.

| Column A (EVENT) | Column B (AUTOMATIC ACTION) |
|---|---|
| a. PC Pump On | 1. Cell air conditioner secures |
| b. Dump Valve Opens | 2. Primary coolant pump secures |
| c. Dilute Fan Off | 3. Demineralizer pump secures |
| d. PC Pit Alarm | 4. Core vent fan secures |
| | 5. No action |

QUESTION (C.11) [1.0]
Which of the following describes why the regulating blade has a higher clutch current than the safety blades?

a. The clutches for safety blades must release quicker.

b. It has different gearing with more torque to overcome.

c. To assure no slippage in automatic flux control.

d. It is heavier than the safety blades.

QUESTION (C.12) [2.0 points, ½ each]
For each nuclear instrumentation channel listed, select the method of discriminating the gamma component of the signal.

NOTE: Items in Column B may be used more than once or not at all.

| Column A (CHANNEL) | Column B (METHOD) |
|---|---|
| a. Safety 1 | 1. Intrinsic |
| b. Safety 2 | 2. Active Gamma Compensation |
| c. Linear N Recorder | 3. Pulse Height Discrimination |
| d. Log N Recorder | 4. Photomultiplication |
| | 5. None |

QUESTION (C.13) [1.0]
Which of the following has BOTH emergency diesel and emergency battery as backup power supplies?

a. Auxiliary alarm console

b. Control console

c. Evacuation alarm

d. Radiation monitoring system

QUESTION (C.14) [1.0]
When the control blades are NOT inserted, select the MAXIMUM load that may be lifted over the control blade drive units with the 3-ton bridge crane.

a. 500 lb

b. 1000 lb

c. 2000 lb

d. 3000 lb

QUESTION (C.15) [2.0 points, ½ each]
For each location listed in column A, select the MAXIMUM expected radiation exposure rate from column B when at 100 kW.

NOTE: Items in Column B may be used more than once or not at all.

| Column A (LOCATION) | Column B (RATE) |
|---|---|
| a. Directly outside any emergency exit | 1. 0.4 mR/h |
| b. Over shield tank, NO shield block | 2. 1.5 mR/h |
| c. Over shield tank, WITH shield block | 3. 10 mR/h |
| d. Shield tank corner at core level | 4. 20 mR/h |
| | 5. 30 mR/h |
| | 6. 50 mR/h |
| | 7. 100 mR/h |
| | 8. 150 mR/h |

QUESTION (C.16) [1.0]
Which of the following will NOT directly (by interlock) cause an automatic trip of the UFTR?

a. Loss of power to the dilution fan.

b. Actuation of the rupture disk.

c. Initiation of the evacuation alarm.

d. Less than 30 gpm primary cooling flow.

QUESTION (C.17) [1.0]

The following conditions exist:

- -- Power is 50 kW and is being raised in the automatic mode.
- -- The period has decreased to less than 30 seconds.

Select expected response of the control blades.

a. A rod-drop trip will occur if period reaches 10 seconds.

b. The safety blades will stop all movement due to the inhibit interlock.

c. The regulating blade will drive down until the period is greater than 30 seconds.

d. The Automatic Flux Control system will shift to manual.

(***** End of Examinations *****)

A.1 a
REF: Burn, R., *Introduction of Nuclear Reactor Operations*, © 1988, §

A.2 c
REF: Burn, R., *Introduction of Nuclear Reactor Operations*, © 1988, §

A.3 b
REF: Burn, R., *Introduction of Nuclear Reactor Operations*, © 1988, §

A.4 a
REF: Burn, R., *Introduction of Nuclear Reactor Operations*, © 1988, §

A.5 d
REF: Burn, R., *Introduction of Nuclear Reactor Operations*, © 1988, §

A.6 d
REF: Burn, R., *Introduction of Nuclear Reactor Operations*, © 1988, §

A.7 b
REF: Burn, R., *Introduction of Nuclear Reactor Operations*, © 1988, §

A.8 b
REF: Burn, R., *Introduction of Nuclear Reactor Operations*, © 1988, §

A.9 b
REF: Burn, R., *Introduction of Nuclear Reactor Operations*, © 1988, §

A.10 b
REF: Burn, R., *Introduction of Nuclear Reactor Operations*, © 1988, §

A.11 b
REF: Burn, R., *Introduction of Nuclear Reactor Operations*, © 1988, §

A.12 c
REF: Burn, R., *Introduction of Nuclear Reactor Operations*, © 1988, §

A.13 d
REF: Burn, R., *Introduction of Nuclear Reactor Operations*, © 1988, §

A.14 a
REF: Burn, R., *Introduction of Nuclear Reactor Operations*, © 1988, §

A.15 c
REF: Burn, R., *Introduction of Nuclear Reactor Operations*, © 1988, §

A.16 c
REF: Burn, R., *Introduction of Nuclear Reactor Operations*, © 1988, §

A.17 c
$P = P_0 e^{t/\tau}$ 1st find **τ**. **τ** = time/(ln(2)) = 42/0.693 = 60.6 sec. Time = 60.6 × ln(10) = 139.5 sec
REF: Burn, R., *Introduction of Nuclear Reactor Operations*, © 1988, §

A.18 a

0.1 × 3.79 = .379 0.9 × 0.23 = 0.207 0.1 × 7.9 = 0.79 0.9 × 1.49 = 1.34

REF: Burn, R., *Introduction of Nuclear Reactor Operations*, © 1988, §

A.19 a

0.001 ΔK/K/~~inch~~ × 4.5 ~~inch~~ ÷ 9°F = 0.001 ÷ 2 = 0.0005 = $5 \times 10^{-4}$ ΔK/K/°F

REF: Burn, R., *Introduction of Nuclear Reactor Operations*, © 1988, §

A.20 b

REF: Burn, R., *Introduction of Nuclear Reactor Operations*, © 1988, §

(*** End of Section A ***)

B.1 d
REF: SOP-A.5, 7.4.4

B.2 b
REF: TS pg 13

B.3 a, LCO; b, LSSS; c, SL; d, LCO
REF: T.S.

B.4 a
REF: SOP-E.2, § 4.7.2

B.5 d
REF: Technical Specification Definitions

B.6 c
REF: TS Section 2.1

B.7 a
REF: Nuclear Power Plant Health Physics and Radiation Protection, Research Reactor Version©1988, § 1.2.3 "Half-Thickness and Tenth-Thickness" $(½)^6 = {}^{1}/_{64} = {}^{400}/_{64}$ = 50/8 = 25/4 = 6.26

B.8 a, 6; b, 2; c, 1; d, 2
REF: 10CFR55

B.9 a, water; b, air; c, water; d, fission product
REF: Typical NRC Question (Chart of the Nuclides

B.10 d
REF: Standard Health Physics Definition.

B.11 a, 2.3% ΔK/K; b, 0.6% ΔK/K; c, 0.6% ΔK/K; d, 0.06% ΔK/K
REF: Technical Specifications 3.1 and 3.5

B.12 c
REF: SOP-D.3, sect 4.0

B.13 b
REF: 10CFR50.54(y)

B.14 c
REF: Ten half-lives implies that dose was reduced by (½)10 = 1/1024 ≈ 1/1000. Initially, the reading would be about 1000 times larger 0.1 mrem × 1000 = 100 mrem.

B.15 c
REF: Typical NRC Question

B.16 d
REF: UFTR Requal Exam

(*** End of Section B ***)

C.1 b
REF: UFTR TS 3.3.1.(1) and pg 11, 3.4.2. table 3.3

C.2 b
REF: UFTR specifications for reactor safety system trips. TS table 3.1

C.3 a
REF: UFTR SAR

C.4 d
REF: TS 9. 3.2.4. Bases

C.5 a
REF: Requal exam bank I & C pg 7, ques 27 & 29, Fig 1-5 & 7-1

C.6 d
REF: UFTR I&C Lecture notes, pg 3, TS LSSS

C.7 c, d
REF: UFTR I&C requal exam ques # 15,

C.8 a *DELETED*
REF: UFTR Design and Operating Characteristics requal exam pg 8, #53

C.9 a
REF: TS pg 15

C.10 a-3 b-2 c-4 d-5
REF: UFTR requal exam for I & C pg 3 of 5, #7

C.11 c
REF: UFTR requal exam solution set, pg 7, ques #46 for design and operating characteristics.

C.12 a-5 b-5 c-2 d-3
REF: UFTR requal exam for I & C pg 2, #7, pg 3, # 12, pg 4&5

C.13 d
REF: Lecture notes, pg 17,18, I & C requal exam, pg 6, ques, 29 & 30

C.14 a
REF: TS pg 22, sect 5.2

C.15 a-2 b-8 c-5 d-4
REF: Design and operating characteristics, pgs 7 & 8

C.16 b
REF: Reactor protection system lecture notes, table 3.1,

C.17 c
REF: TS pg 7, 3.2.1.5.e

(*** End of Examinations ***)

## Section A ℞ Theory, Thermo & Fac. Operating Characteristics

A N S W E R   S H E E T

Multiple Choice (Circle or X your choice)

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

MULTIPLE CHOICE

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

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

## Section 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 ___

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

## Section C  Plant and Rad 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  1  2  3  4  5  ___

b  1  2  3  4  5  ___

c  1  2  3  4  5  ___

d  1  2  3  4  5  ___

011  a  b  c  d  ____

012  a  1  2  3  4  5  ___

b  1  2  3  4  5  ___

c  1  2  3  4  5  ___

d  1  2  3  4  5  ___

013  a  b  c  d  ___

014  a  b  c  d  ___

015  a  1  2  3  4  5  6  7  8  ___

b  1  2  3  4  5  6  7  8  ___

c  1  2  3  4  5  6  7  8  ___

d  1  2  3  4  5  6  7  8  ___

016  a  b  c  d  ___

017  a  b  c  d  ___

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

EQUATION SHEET

$$\dot{Q} = \dot{m}c_p \Delta T = \dot{m} \Delta H = UA \Delta T$$

$$\ell^* = 1 \ x \ 10^{-5} \ seconds$$

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

$$SUR = 26.06\left[\frac{\lambda_{eff}\rho}{\beta - \rho}\right]$$

$$M = \frac{1}{1 - K_{eff}} = \frac{CR_1}{CR_2}$$

$$SDM = \frac{(1 - K_{eff})}{K_{eff}}$$

$$\tau = \frac{\ell^*}{\rho - \bar{\beta}}$$

$$\rho = \frac{\Delta K_{eff}}{k_{eff}}$$

$$T_{½} = \frac{0.693}{\lambda}$$

$$DR = DR_0 \ e^{-\lambda t}$$

$$DR = \frac{6CiE(n)}{R^2}$$

DR — mRem, Ci — curies,
E — Mev, R — feet

$$P_{max} = \frac{(\rho - \beta)^2}{2\alpha(k)\ell}$$

$$SCR = \frac{S}{1 - K_{eff}}$$

$$CR_1(1 - K_{eff_1}) = CR_2(1 - K_{eff_2})$$

$$M = \frac{1 - K_{eff_0}}{1 - K_{eff_1}}$$

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

$$P = P_0 \ e^{\frac{t}{\tau}}$$

$$P = \frac{\beta(1 - \rho)}{\beta - \rho} \ P_0$$

$$\tau = \frac{\ell^*}{\rho} + \left[\frac{\bar{\beta} - \rho}{\lambda_{eff}\rho}\right]$$

$$\rho = \frac{(K_{eff} - 1)}{K_{eff}}$$

$$DR_1 d_1^2 = DR_2 d_2^2$$

$$\frac{(\rho_2 - \beta)^2}{Peak_2} = \frac{(\rho_1 - \beta)^2}{Peak_1}$$

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| | |
|---|---|
| 1 Curie = 3.7 x 1010 dis/sec | 1 kg = 2.21 lbm |
| 1 Horsepower = 2.54 x 103 BTU/hr | 1 Mw = 3.41 x 106 BTU/hr |
| 1 BTU = 778 ft-lbf | °F = 9/5 °C + 32 |
| 1 gal (H2O) ≈ 8 lbm | °C = 5/9 (°F - 32) |