July 28, 2009

Dr. John G. Williams
Director, Nuclear Reactor Laboratory
University of Arizona
P.O. Box 210020
Tucson, AZ 85721-0020

SUBJECT: INITIAL EXAMINATION REPORT NO. 50-113/OL-09-01,
UNIVERSITY OF ARIZONA

Dear Dr. Williams:

During the week of June 8, 2009, the NRC administered operator licensing examinations at your University of Arizona Reactor. The examinations were conducted according to NUREG-1478, "Operator Licensing Examiner Standards for Research and Test Reactors," Revision 2. Examination questions and preliminary findings were discussed with those members of your staff identified in the enclosed report at the conclusion of the examination.

In accordance with Title 10 of the Code of Federal Regulations Section 2.390, 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 Agencywide Documents Access and Management System (ADAMS). ADAMS is accessible from the NRC Web site at http://www.nrc.gov/reading-rm/adams.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. Phillip T. Young at (301) 415-4094 or via internet e-mail Phillip.Young @nrc.gov.

Sincerely,

/RA/

Johnny H. Eads, Jr., Chief
Research and Test Reactors Branch B
Division of Policy and Rulemaking
Office of Nuclear Reactor Regulation

Docket No. 50-113

Enclosures: 1. Initial Examination Report No. 50-113/OL-09-01
2. Written examination with facility comments incorporated

cc without enclosures:
Please see next page

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DISTRIBUTION w/ encls.:

PUBLIC	PRTB r/f	RidsNRRDPRPRTA
RidsNRRDPRPRTB	Facility File (CRevelle) O7 E13	

ADAMS ACCESSION #: ML091760870 TEMPLATE #:NRR-074

OFFICE	PRTB:CE		IOLB:LA		PRTB:SC	
NAME	PYoung:		CRevelle		JEads	
DATE	07/07/2009		07/23/2009		07/28/2009	

OFFICIAL RECORD COPY

University of Arizona Docket No. 50-113

cc:

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

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

REPORT NO.: 50-113/OL-09-01

FACILITY DOCKET NO.: 50-113

FACILITY LICENSE NO.: R-52

FACILITY: University of Arizona Reactor

EXAMINATION DATES: June 9 & 10, 2009

SUBMITTED BY: _____ _____
Phillip T. Young, Chief Examiner Date

SUMMARY:

During the week of June 8, 2009, the NRC administered operator licensing examinations to two Reactor Operator (RO) candidate's. All candidates passed all portions of the examination.

REPORT DETAILS

1. Examiners: Phillip T. Young, Chief Examiner, NRC

2. Results:

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

3. Exit Meeting:

The NRC examiner thanked the facility staff for their cooperation during the examination and for their comments on the written examination. The examiner discussed his observations on the pneumatic transfer experiment system and applicant knowledge of the thermal power heat balance process.

ENCLOSURE 1

UNIVERSITY OF ARIZONA

Operator License Examination

Written Exam with Answer Key

June 9, 2009

ENCLOSURE 2

FACILITY COMMENTS

Comment:
Question A.009, 'a' is correct. In fact it is more correct than answer 'd', because this effect is significantly larger (pp 21-22 SAR). Also the wording in answer 'd' is incorrect, because Doppler decreases the resonance escape probability. (SAR says increase in resonance capture probability).

RESOLUTION:
Accepted 'a' as the correct answer. Since 'd' is incorrect as worded, did not change 'd'.

Comment:
Question B.008, 'b' is correct. 'a' is wrong (UARR procedure 108 and Tech Specs 6.2.b.2.

RESOLUTION:
Accepted 'b' as the correct answer.

Comment:
Question C.015, as written a and c are correct. Insert NOT and b and d are correct. Please delete the question.

RESOLUTION:
Question C.015, is deleted from the examination.

Question A.001 [1.0 point] {1.0}
The term "Prompt Critical" refers to:

a. a reactivity insertion which is less than β_{eff}
b. the instantaneous jump in power due to a rod withdrawal
c. a reactor which is supercritical using only prompt neutrons
d. a reactor which is critical using both prompt and delayed neutrons

Answer: A.001 c.
Reference: Lamarsh, Introduction to Nuclear Engineering, 1975, Page 250

Question A.002 [1.0 point] {2.0}
Which ONE of the following describes the difference between reflectors and moderators?

a. Reflectors decrease core leakage while moderators thermalize neutrons.
b. Reflectors thermalize neutrons while moderators decrease core leakage.
c. Reflectors shield against neutrons while moderators decrease core leakage.
d. Reflectors decrease thermal leakage while moderators decrease fast leakage.

Answer: A.002 a.
Reference: Lamarsh, Introduction to Nuclear Engineering, 1975, Pages 57, 214

Question A.003 [1.0 point] {3.0}
What is the K_{eff} for a reactor shutdown by 0.0455 $\Delta K/K$?

a. 0.957
b. 0.855
c. 0.786
d. 0.0455

Answer: A.003 a.
Reference: Standard EQB question.

$$\rho = \frac{K_{eff}^{-1}}{K_{eff}} \qquad \rho K_{eff} = K_{eff}^{-1}$$

$$K_{eff} = \frac{1}{1-\rho} \qquad K_{eff} = \frac{1}{1-(-0.455)} \qquad K_{eff} = 0.9565$$

Question A.004 [1.0 point] {4.0}
Which ONE of the following reactions describes the operation of the neutron source?

a. Am^{241} -> α + Np^{237} -> α + Be^{9} → C^{12} + neutron

b. Am^{241} -> α + Np^{237} -> α + Be^{10} →N^{13} + neutron

c. Am^{241} -> β + Np^{237} -> β + Be^{9} → Li^{8} + neutron

d. Am^{241} -> β + Np^{237} -> β + Be^{10} →Be^{9} + neutron

Answer: A.004 a.
Reference: Standard EQB question.

Question A.005 [1.0 point] {5.0}
Which change to the core will most strongly affect the Thermal Utilization Factor?

a. Going from High Enrichment fuel to Low Enrichment fuel.

b. Removal of moderator. (Thermal expansion)

c. Build up of fission products in the fuel.

d. Removal of a control rod

Answer: A.005 d.
Reference: Intro to Nuc Eng, John R. Lamarsh © 1983, § 7.4, p. 317.

Question A.006 [1.0 point] {6.0}
You are performing a reactor startup and are just critical. If you were to continue the startup by pulling out the regulating rod adding $0.30 worth of reactivity to the reactor, what would be the resulting reactor period? Assume λ_{eff} is 0.125 sec.

a. ≈ 60 seconds
b. ≈ 30 seconds
c. ≈ 20 seconds
d. ≈ 10 seconds

Answer: A.006 c.
Reference: Intro to Nuc Eng, John R. Lamarsh © 1983, §4.4, equation 4.15.
Given \$1.00 = β ====> ρ = 0.3(β) Assume λ_{eff} = 0.125

$$T = \frac{\beta_{eff} - \rho}{\lambda_{eff}\rho} = \frac{\beta_{eff} - 0.3(\beta_{eff})}{\lambda_{eff}0.3(\beta_{eff})} = \frac{0.7(\beta_{eff})}{\lambda_{eff}0.3(\beta_{eff})}$$

$$T = \frac{0.7}{0.125 \times 0.3} = 23$$

Question A.007 [1.0 point] {7.0}
The reactor has been run for a short period of time at 100 Kwatt before being shutdown (Equilibrium Xenon conditions). An experiment worth +30¢ is REMOVED from the reactor. When the reactor is restarted two days later POOL temperature is 5ºF COOLER. What will be the difference in the rod height when the reactor is returned to 100 Kwatt (equilibrium Xenon conditions)?

a. 30¢ more rods must be withdrawn
b. 30¢ less rods must be withdrawn
c. 3¢ more rods must be withdrawn
d. 3¢ less rods must be withdrawn

Answer: A.007 a.
Reference: Intro to Nuc Eng, John R. Lamarsh © 1983, § 7.2 and 7.3, pp. 304 & 313,
also Safety Analysis Report, p. 22.
$\rho_{Control\ Rod}$ = 30¢, α_{Tbath} ≈ 0 ΔK/K/ºC. 30¢ = 30¢

Question A.008 [1.0 point] {8.0}
Control rods are being withdrawn for startup prior to the reactor being critical. The operator allows the neutron population to stabilize between each rod withdrawal. Assuming equal amounts of reactivity are added for each rod withdrawal, which ONE statement below correctly describes the expected time for the neutron population to stabilize as criticality is approached.

a. Time to stabilize will decrease for each withdrawal because increased neutron flux.

b. Time to stabilize will be the same for each withdrawal because source strength is constant.

c. Time to stabilize will be the same for each withdrawal because equal amounts of reactivity are being added.

d. Time to stabilize will increase for each withdrawal because source strength is constant but larger changes in flux occur.

Answer: A.008 d.
Reference: Standard reactor theory.

Question A.009 [1.0 point] {9.0}
Which ONE statement describes why the TRIGA fuel has a prompt and very negative temperature coefficient of reactivity?

a. Neutrons are de-thermalized by the excited hydrogen atoms in the fuel.

b. Fuel temperature increases at a greater rate than does a power increase.

c. There is a large amount of self-shielding, resulting in less neutron absorption by the inner fuel.

d. Neutrons penetrate deeper into the fuel, resulting in an increase in the resonance escape probability.

Answer: A.009 ~~d.~~ a. Answer changed per facility comment.
Reference: UARR Safety Analysis Report, Page 20

Question A.010 [1.0 point] {10.0}
For U-235, the thermal fission cross-section is 582 barns, and the capture cross-section is 99 barns. When a thermal neutron is absorbed by U-235, the probability that fission will occur is:

a. 0.146
b. 0.170
c. 0.830
d. 0.855

Answer: A.010 d.
Reference: Lamarsh, Introduction to Nuclear Engineering, 2nd Edition, Page 73
Probability = fission xsection/total xsection = 582/681 = 0.855

Question A.011 [1.0 point] {11.0}
Given:

ρ_{excess} = \$2.50
Control Rod 1 Worth = \$2.00
Control Rod 2 Worth = \$2.00
Control Rod 3 Worth = \$1.00

What is the actual (NOT Tech. Spec. minimum) shutdown margin for this core?

a. \$0.50
b. \$2.50
c. \$5.00
d. \$7.50

Answer: A.011 b.
Reference: Rod Worth = SDM + ρ_{ex} SDM = 5.00 - 2.50 = \$2.50

Question A.012 [1.0 point] {12.0}
If equal amounts of positive or negative reactivity are added to an exactly critical reactor, which ONE of the following describes the result on the absolute value of stable reactor period?

a. Positive period and negative period will be of equal value.
b. The positive period value will be greater than the negative period value.
c. The negative period value will be greater than the positive period value.
d. Positive and negative periods will only be of equal value until the reactivity added exceeds ONE dollar.

Answer: A.012 c.
Reference: Lamarsh, Introduction to Nuclear Engineering, 2nd Edition, Page 285

Question A.013 [1.0 point] {13.0}
The major contributor to the production of Xenon-135 in a reactor operating at full power is:

a. direct from the fission of Uranium-235.
b. direct from the fission of Uranium-238.
c. from the radioactive decay of Iodine.
d. from the radioactive decay of Promethium.

Answer: A.013 c.
Reference: Lamarsh, Introduction to Nuclear Engineering, 2nd Edition, Page 318

Question A.014 [1.0 point] {14.0}
The fuel temperature coefficient of reactivity is -1.25×10^{-4} $\Delta K/K/^{\circ}C$. When a control rod with an average rod worth of 0.1 % $\Delta K/K$/inch is withdrawn 10 inches, reactor power increases and becomes stable at a higher level. At this point, the fuel temperature has:

a. increased by 80º C
b. decreased by 80º C
c. increased by 8º C
d. decreased by 8º C

Answer: A.014 a.
Reference: Lamarsh, Introduction to Nuclear Engineering, 2nd Edition, Page 306
Reactivity added by control rod = +(0.001 $\Delta k/k$/inch)(10 inches) = 0.01 $\Delta k/k$.
Fuel temperature change = -Reactivity added by rod / fuel temperature coefficient
Fuel temperature change = (-0.01 $\Delta k/k$) / (-1.25×10^{-4} $\Delta k/k/^{\circ}C$) = 80°C.

Question A.015 [1.0 point] {15.0}
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.

Answer: A.015 c.
Reference: All other conditions allow for a steady neutron population.

Question B.001 (1.0 point) {1.0}
What level of unisolable leakage from the pool requires declaration of an Unusual Event?

a. 1 centimeter/week

b. 1 meter/hour

c. 10 gallons/week

d. 100 gallons/hour

Answer: B.001 d.
Reference: UARR 114 Procedure for Responding to suspected Primary Coolant Leaks § 3,

Question B.002 (1.0 point) {2.0}
In accordance with the Technical Specifications, which ONE condition below is permissible?

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

b. bulk temperature of coolant water = 45ºC

c. experiments containing 2 millicuries of I^{131}

d. reactivity inserted by the pulse rod = $3.00

Answer: B.002 b.
Reference: UARR Technical Specifications, Sections 3.1, 3.7

Question B.003 (1.0 point) {3.0}
In accordance with the Technical Specifications, a SAFETY LIMIT is:

a. the actuating level for an automatic protective device related to those variables having significant safety functions.

b. a system which is designed to initiate automatic reactor protection or to provide information for initiation of manual protective action.

c. an administratively established constraint on equipment and operational characteristics which shall be adhered to during operation of the reactor.

d. a limit on an important process variable which is found to be necessary to reasonably protect the integrity of physical barriers which guard against the uncontrolled release of radioactivity.

Answer: B.003 d.
Reference: UARR Technical Specifications, Section 1.0

Question B.004 (1.0 point) {4.0}
Operator "A" works a standard forty (40) hour work week. His duties require him to work in a radiation area for (4) hours a day. The dose rate in the area is 10 mR/hour. Which one of the following is the MAXIMUM number of days Operator "A" may perform his duties without exceeding 10CFR20 limits?

a. 12 days
b. 25 days
c. 31 days
d. 125 days

Answer: B.004 d.
Reference: 10CFR20.1201(a)(1)
5000 mr x 1 hr x day = 125 days { 10 mr 4 hr}

Question B.005 (1.0 point) {5.0}
Temporary changes to procedures which do not alter their original intent may be made with the approval of:

a. the Reactor Laboratory Director
b. Reactor Supervisor
c. a Senior Reactor Operator
d. the Reactor Committee

Answer: B.005 a.
Reference: UARR Technical Specifications, Section 6.3.1

Question B.006 (1.0 point) {6.0}
Which ONE of the following records need not be retained indefinitely?

a. off-site environmental monitoring surveys
b. radiation exposures for all personnel
c. fuel inventories and transfers
d. reportable occurrences

Answer: B.006 d.
Reference: UARR Technical Specifications, Section 6.6

Question B.007 (1.0 point) {7.0}
Control rod reactivity worth must be determined:

a. annually
b. semiannually
c. following an unplanned scram
d. after the disassembly and reassembly of control rod drives or removal of control elements

Answer: B.007 a.
Reference: UARR Technical Specifications, Section 4.2

Question B.008 (1.0 point) {8.0}
Changes in the electronics of the console or the control rod drive system, other than the replacing of circuit elements with identical or equivalent parts, must be reviewed and approved by:

a. the Reactor Laboratory Director
b. the Reactor Committee
c. the Reactor Supervisor
d. a Senior Reactor Operator

Answer: B.008 ~~a.~~ b. Answer changed per facility comment.
Reference: UARR Procedure 108

Question B.009 (1.0 point) {9.0}
The reactor may be operated with the Ventilation system inoperable, provided that:

a. the reactor is not pulsed
b. the power level does not exceed 10 kW
c. the Ventilation system will be operable within five (5) days
d. no experiment with a reactivity worth greater than $1.00 is in place

Answer: B.009 b.
Reference: UARR Technical Specifications, Section 3.6

Question B.010 (1.0 point) {10.0}
In accordance with the Technical Specifications, which ONE situation below is NOT permissible?

a. a bulk temperature of coolant water of 45ºC
b. an unsecured experiment with a reactivity worth of $0.50
c. a depth of water in the reactor pool of 13 feet above the top of the core
d. a conductivity of the coolant water, averaged over thirty days, of 4 µmhos/cm

Answer: B.010 c.
Reference: UARR Technical Specifications, Section 3.1

Question B.011 (1.0 point) {11.0}
If a minor fire or explosion which is non-specific to the reactor occurs in NRL, the operator must immediately:

a. stop all rod withdrawal and notify the Senior Reactor Operator
b. determine the cause, then notify the Senior Reactor Operator
c. secure the reactor and notify the Senior Reactor Operator
d. declare an emergency

Answer: B.011 c.
Reference: UARR Procedure 101

Question B.012 (1.0 point) {12.0}
How would an accessible area be posted if the radiation level in the area is 65 mR/hr?

a. CAUTION- RADIATION AREA
b. CAUTION- RESTRICTED AREA
c. CAUTION- HIGH RADIATION AREA
d. CAUTION- RADIOACTIVE MATERIALS AREA

Answer: B.012 a.
Reference: 10 CFR 20.202

Question B.013 (1.0 point) {13.0}
Which ONE of the following requires the direct supervision of a licensed Senior Reactor Operator?

a. an unlicenced individual moving fuel
b. a reactor operator trainee during a normal startup
c. a student operating the reactor as part of a course
d. an individual operating the reactor who is licensed at another, very different, research reactor facility

Answer: B.013 a.
Reference: UARR Procedure 100

Question B.014 (1.0 point) {14.0}
When performing the "Preliminary Checklist", UARR-151, which one of the below conditions must be reported to the Senior Operator and requires his authorization to continue with the checkout?

a. The CAM flow meter reads 33 ℓpm.
b. The Stack Filter gauge reads 1.3 inches.
c. In "Calibrate" the Right Safety channel reads 103.
d. A background check of the GM area monitor reads 150 cpm.

Answer: B.014 c.
Reference: UARR 151 pgs. 1 - 2

Question B.015 (1.0 point) {15.0}
The Limiting Safety Systems Setting (LSSS) in the Pulse mode is:

a. $2.50
b. 400ºC
c. 1000ºC
d. 1100 MW

Answer: B.015 d.
Reference: T.S. 2.3 SAR pg. 28

Question C.001 {1.0}
How is gamma radiation compensated for in the Log Power Channel?

a. The detector is positioned in toward and out away from the core to compensate for gammas.

b. A compensating current equal and opposite to the signal due to gammas is sent to the detector.

c. The output of the detector is put through a discriminator circuit which passes only pulses caused by neutron interactions.

d. Lead shielding around the detector decreases the signal due to gammas low enough such that compensation is not required.

Answer: C.001 c.
Reference: Univ. of Arizona Training Material Chapter C.

Question C.002 {2.0}
The maximum reactivity insertion during pulse mode operation is:

a. $1.00

b. $2.50

c. $3.00

d. $5.00

Answer: C.002 b.
Reference: UARR Safety Analysis Report, Page 29

Question C.003 {3.0}
When operating in the AUTOMATIC mode:

a. only the shim rod can be moved manually.

b. the transient rod cannot be moved manually.

c. both shim and transient rods can be moved manually.

d. neither the shim nor the transient rod can be moved manually.

Answer: C.003 c.
Reference: UARR Safety Analysis Report, Page 47

Question C.004 {4.0}
The Fast Irradiation Facility operates by positioning samples in:

a. areas of low thermal neutron flux
b. areas of high thermal neutron flux
c. the region of maximum neutron flux
d. a coated tube which absorbs thermal neutrons

Answer: C.004 d
Reference: UARR Safety Analysis Report, Page 35

Question C.005 {5.0}
Which ONE of the following elements would most likely be found in the reactor pool when a fuel element leak is present?

a. Iodine-135
b. Xenon-135
c Argon-41
d. Uranium-235

Answer: C.005 a.
Reference: UARR Safety Analysis Report, Page 58

Question C.006 {6.0}
You have just brought the reactor critical at a power level of 1 watt. What effect would you observe on the reactor if you were to remove the neutron source from the core?

a. Reactor power would increase slightly.
b. Reactor power would decrease slightly.
c. Reactor power would remain the same.
d. Reactor power would decrease by a large margin (source levels).

Answer C.006 d.
Reference: Glasstone & Seonske, Nuclear Engineering.

Question C.007 {7.0}
For a standard control rod, the UP light is ON, the DOWN light is OFF, and the CONT light is OFF. This indicates that:

a. the rod and drive are both full up
b. the rod and drive are both full down
c. the rod and drive are in contact, the rod is full up and the drive is full down
d. the rod and drive are not in contact, the drive is full up and the rod is full down

Answer: C.007 d.
Reference: UARR Safety Analysis Report, Page 42

Question C.008 {8.0}
Pool water conductivity is measured by a probe located:

a. at the outlet of the purification pump.
b. at the outlet of the demineralizer.
c. at the inlet to the filter.
d. in the reactor pool.

Answer: C.008 d.
Reference: UARR Safety Analysis Report, Page 25

Question C.009 {9.0}
Cooling of the reactor core is accomplished by:

a. natural convection of the pool water.
b. forced convection of the pool water.
c. a freon refrigeration system.
d. cooling coils in the tank.

Answer: C.009 a.
Reference: UARR Safety Analysis Report, Page 22

Question C.010 {10.0}
Which one of the following is the normal location of the fuel element that contains the fuel temperature thermocouples?

a. D-ring
b. C-ring
c. B-ring
d. A-ring

Answer: C.010 c.
Reference: UARR TRIGA Reactor Description pg. 6

Question C.011 {11.0}
Certain core positions have larger (1.505 inch) holes in the bottom grid plate, as compared to the normal (0.25 inch) holes. Which one of the following is the reason for the larger holes in these positions?

a. To accommodate insertion of "odd shaped" specimens.
b. To accommodate insertion of the pneumatic transfer tube.
c. To accommodate insertion of fuel follower type control rods.
d. To accommodate insertion of the Fast Neutron Irradiation Facility.

Answer: C.011 c.
Reference: UARR TRIGA Reactor description, Core

Question C.012 {12.0}
Assuming the reactor pool is at the maximum allowable water depth when a water pipe from the pool develops a leak. Which one of the following is the MAXIMUM number of centimeters by which the pool level would decrease?

a. 12 cm
b. 32 cm
c. 52 cm
d. 72 cm

Answer: C.012 b.
Reference: TRIGA Reactor Description, T-20, Water System, pg 4.
Max allowable water depth = 596 cm Siphon break = -544 cm/52 cm

Question C.013 {13.0}
Which one of the following is the capacity of the cooling system?

a. 250 kW
b. 100 kW
c. 25 kW
d. 10 kW

Answer: C.013 c.
Reference: TRIGA Reactor Description, T-20 pg. 5

Question C.014 {14.0}
The neutron absorber in the UARR's control rods is:

a. Zirconium hydride
b. Graphite powder
c. Aluminum oxide
d. Boron carbide

Answer: C.014 d.
REFERENCE: SAR pg. 16

Question C.015 {15.0} Question deleted per facility comment.
~~Which one of the following will result in an automatic reactor scram signal?~~

~~a. Loss of HVPS to the Fission Chamber.~~
~~b. Bulk water temperature monitor exceeds 120℃.~~
~~c. Right Safety Channel switched to "zero" position.~~
~~d. 120% peak power on the Left Safety Channel in Pulse mode.~~

~~Answer: C.015 c.~~
~~Reference: TRIGA Rx Description, Reactor Console, T-63, Fig. 6.2~~