June 22, 2010

Mr. Terence Tehan, Director
Rhode Island Atomic Energy Commission
Rhode Island Nuclear Science Center
16 Reactor Road
Narragansett, RI 02882-1165

SUBJECT: INITIAL EXAMINATION REPORT NO. 50-193/OL-10-01, RHODE ISLAND ATOMIC ENERGY COMMISSION

Dear Dr. Tehan:

During the week of June 7, 2010, the Nuclear Regulatory Commission (NRC) administered operator licensing examinations at your Rhode Island Atomic Energy Commission 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. John T. Nguyen at (301) 415-4007 or via internet e-mail John.Nguyen@nrc.gov.

Sincerely,

/RA/

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

Docket No. 50-193

Enclosures:
1. Initial Examination Report No. 50-193/OL-10-01
2. Written examination

cc w/out encls:
See next page

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ADAMS Accession No: **ML101620303**

OFFICE	PRTB:CE		IOLB:LA	E	PRTB:BC
NAME	JNguyen		CRevelle		JEads
DATE	06/21/2010		06/22/2010		06/22/2010

OFFICIAL RECORD COPY

cc:

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

REPORT NO.: 50-193/OL-10-01

FACILITY DOCKET NO.: 50-193

FACILITY LICENSE NO.: R-95

FACILITY: RHODE ISLAND ATOMIC ENERGY COMMISSION

EXAMINATION DATES: June 7, 2010

SUBMITTED BY: ________/RA/____________ _06/21/2010_
John T. Nguyen, Chief Examiner Date

SUMMARY:

During the week of June 7, 2010, the NRC administered operator licensing examinations to two operator licensing candidates, one for senior reactor operator upgrade and one reactor operators. The candidates passed all portions of the operating examination.

REPORT DETAILS

1. Examiners: John T. Nguyen, Chief Examiner, NRC

2. Results:

	RO PASS/FAIL	SRO PASS/FAIL	TOTAL PASS/FAIL
Written	1/0	0/0	1/0
Operating Tests	1/0	1/0	2/0
Overall	1/0	1/0	2/0

3. Exit Meeting:
John T. Nguyen, Chief Examiner, NRC
Jeff Davis, Reactor Supervisor

The NRC examiner thanked the facility staff for their cooperation during the examination. The examiner reported no generic weaknesses.

RHODE ISLAND
ATOMIC ENERGY COMMISSION

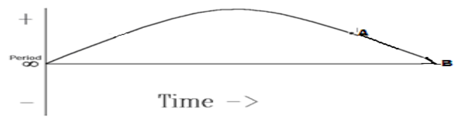
Operator Licensing Examination

Written Exam with Answer Key

June 7, 2010

ENCLOSURE 2

QUESTION A.01 [1.0 point]
Shown below is a trace of reactor period as a function of time. Between points A and B reactor power is:



a. continually increasing.

b. continually decreasing.

c. increasing, then decreasing.

d. increasing, then constant.

QUESTION A.02 [1.0 point] **"0.00312 Δk/k" is replaced for "$0.40" during the administrative of the examination.**

Which **ONE** of the following will be the resulting stable reactor period when a ~~$0.40~~ 0.00312 Δk/k reactivity insertion is made into an exactly critical reactor core? Given $\beta = 0.0078$

a. 15 seconds

b. 30 seconds

c. 38 seconds

d. 50 seconds

QUESTION A.03 [1.0 point]
Which **ONE** of the following is the **MOST** affected factor in the six factor formula when a poison in the control rods is changed from BORON (B) to CADMIUM (Cd)?

a. Fast fission factor.

b. Reproduction factor.

c. Thermal utilization factor.

d. Fast non leakage probability.

QUESTION A.04 [1.0 point]
Which **ONE** of the following power manipulations would take the longest time to complete assuming the same period is maintained?

a. 2 Kilowatts: from 2 kW to 4 kW

b. 2.5 Kilowatts: from 4 kW to 6.5 kW

c. 3 Kilowatts: from 6.5 kW to 9.5 kW

d. 3.5 Kilowatts: from 9.5 kW to 13 kW

QUESTION A.05 [1.0 point]
Which **ONE** of the following statements details the effect of fuel temperature on core operating characteristics? As fuel temperature increases:

a. Doppler peaks will become higher.

b. density of U-235 in fuel increases.

c. void volume in the moderator increases.

d. density of the moderator increases.

QUESTION A.06 [1 point]
Which **ONE** of the following best describes the alpha decay of a nuclide?

a. The atomic mass number increases by 2, and the number of protons increase by 2.

b. The atomic mass number decreases by 2, and the number of protons decrease by 2.

c. The atomic mass number decreases by 4, and the number of protons decrease by 2.

d. The atomic mass number increases by 4, and the number of protons increase by 2.

QUESTION A.07 [1.0 point]
Which **ONE** of the following describes the difference between reflectors and moderators?

a. Reflectors decrease core leakage while moderators thermalize neutrons

b. Reflectors shield against neutrons while moderators decrease core leakage

c. Reflectors decrease thermal leakage while moderators decrease fast leakage

d. Reflectors thermalize neutrons while moderators decrease core leakage

QUESTION A.08 [1.0 point]
Which **ONE** of the following is the correct amount of reactivity added if the multiplication factor, k, is increase from 0.800 to 0.950?

a. 0.150

b. 0.158

c. 0.188

d. 0.197

QUESTION A.09 [1.0 point]
Delayed neutrons are produced by:

a. decay of O-16.

b. Photoelectric Effect.

c. decay of fission fragments.

d. directly from the fission process.

QUESTION A.10 [1.0 point]
A reactor is **SHUTDOWN** by 8.6 % Δk/k. When a control rod with a worth of -3.1 % Δk/k is removed from the core, a rate of 1000 counts per second (cps) is measured. What was the previous count rate (cps)?

a. 660

b. 760

c. 860

d. 1160

QUESTION A.11 [1.0 point]
The reactor is exactly critical with β_{eff} = 0.0078. Which **ONE** of the following is the **MINIMUM** reactivity that must be added to produce prompt criticality?

a. Reactivity equals $1.10.

b. Reactivity equals to the β_{eff}.

c. Reactivity when K_{eff} equals 1.0078.

d. Reactivity when the stable reactor period equals 3 seconds.

QUESTION A.12 [1.0 point]
Excess reactivity is the amount of reactivity:

a. associated with sample's worth.

b. needed to achieve prompt critical.

c. needed to keep a reactor shutdown when a SHIM blade is fully up.

d. available above cold criticality with all of the shim blades withdrawn from the point where the reactor is exactly critical.

QUESTION A.13 [1.0 point]
Given the following worth: ρ_{excess} = 0.60% Δk/k, SHIM blade 1 = 0.30% Δk/k
SHIM blade 2 = 0.45 % Δk/k, SHIM blade 3 = 0.50% Δk/k
REG blade = 0.10 % Δk/k

Calculate the ***TECHNICAL SPECIFICATION LIMIT*** of Shutdown Margin for this core.

a. 0.15% Δ k/k

b. 0.65% Δ k/k

c. 1.25% Δ k/k

d. 1.75% Δk/k

QUESTION A.14 [1.0 point]
Which **ONE** of the following describes the term **PROMPT JUMP**?

a. A reactor is critical at 80-second period.

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

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

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

QUESTION A.15 [1.0 point]
The effective target area, in cm^2, presented by a single nucleus to an incident neutron beam is defined as:

a. a neutron flux.

b. a mean free path.

c. a microscopic cross section.

d. a macroscopic cross section.

QUESTION A.16 [1.0 point]
Which **ONE** of the following **DOES NOT** describe the production and depletion of Xenon in an operating reactor?

a. Xe-135 is lost by alpha decay.

b. Xe-135 is lost by neutron absorption.

c. Xe-135 is formed by fission and I-135 decay.

d. I-135 is formed by fission and lost by beta decay to Xe-135.

QUESTION A.17 [1.0 point]
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 period will only be equal value until the reactivity added exceeds one dollar.

QUESTION A.18 [1.0 point]
The **RESONANCE ESCAPE PROBABILITY** is defined as a ratio of:

a. the number of thermal neutrons absorbed in fuel over the number of thermal neutrons absorbed in fuel and core materials.

b. the number of fast neutrons produced by fission in a generation over the number of total neutrons produced by fission in the previous generation.

c. the number of fast neutrons produced by U-238 over the number of thermal neutrons absorbed in fuel.

d. the number of neutrons that reach thermal energy over the number of fast neutrons that start to slow down.

QUESTION A.19 [1.0 point]
During the fuel loading of the core, the **INITIAL** value of 1/M is:

a. 0

b. 1

c. 10

d. infinitive

QUESTION A.20 [1.0 point]
Which **ONE** of the following conditions will **INCREASE** the shutdown margin of a reactor?

a. Lowering moderator temperature (Assume negative temperature coefficient).

b. Insertion of a positive reactivity worth experiment.

c. Burnout of a burnable poison.

d. Fuel depletion.

***************** End of Section A ********************************

QUESTION B.01 [1.0 point]
Which **ONE** of the following conditions is a violation of Technical Specifications?

a. The primary coolant pH is 5.0 averaged over a week.

b. The height of water above the top of the core is 23.8 ft at 1 MW.

c. Bulk pool temperature at 110 kW in Natural Convection Flow is 121°F (48.9°C).

d. The intake and exhaust ventilation valves are open during 2 MW.

QUESTION B.02 [1.0 point]
Which **ONE** of the following types of experiments shall **NOT** be irradiated at RINSC?

a. The experiment contains Cryogenic liquid.

b. The experiment contains explosive materials.

c. The unsecured experiment has a reactivity worth of 0.07 %Δk/k.

d. The sum of all experiments in the reactor and experimental facilities has a reactivity worth of 0.55 %Δk/k.

QUESTION B.03 [2.0 points, 0.5 each]
Match the type of radiation in column A with their quality factor in column B. Items in column B can be used once, more than once or not at all.

Column A		Column B	
a.	Beta	1.	1
b.	Gamma	2.	5
c.	Alpha particles	3.	10
d.	Neutrons of unknown energy	4.	20

QUESTION B.04 [1.0 point]
A radioactive source reads 160 Rem/hr on contact. Four hours later, the same source reads 40 Rem/hr. How long is the time for the source to decay from a reading of 160 Rem/hr to 10 Rem/hr?

a. 6.0 hours

b. 8.0 hours

c. 9.0 hours

d. 10.0 hours

QUESTION B.05 [1.0 point]
The secondary circulating pump fails while the reactor is at 100% power with all rods in manual control. Assume that all systems operate normally and no operator action is taken. Which one of the following is the expected outcome?

a. Low flow alarm on the secondary coolant system. Reactor power stays at 100%.

b. Primary coolant inlet temperature increases to the scram setpoint and the reactor scrams.

c. Primary coolant outlet temperature goes up to alarm setpoint and scrams the reactor at the scram setpoint.

d. Pool inlet temperature increases. Reactor power decreases due to the negative temperature coefficient. An equilibrium is reached and reactor power stays at around 95%.

QUESTION B.06 [1.0 point]
Given that the following emergency conditions occur at the RINSC reactor facility:

(1) Earthquake occurs
(2) Particulate monitor alarm
(3) Projected dose at the site boundary exceed 400 mRem TEDE accumulated in 24 hours.

Which **ONE** of the following is the appropriate Emergency Classification?

a. Notification of Unusual Event.

b. Alert.

c. Site Area Emergency.

d. General Emergency.

QUESTION B.07 [1.0 point]
Exposing a check source to the particulate detector to verify whether it is operable is considered to be:

a. a channel test.

b. a channel check.

c. a channel calibration.

d. a channel verification.

QUESTION B.08 [1.0 point]
A radioactive material is **DECAYING** at a rate of 20% per hour. Determine its half-life?

a. 1.5 hours.

b. 2.0 hours.

c. 3.0 hours.

d. 5.0 hours.

QUESTION B.09 [1.0 point]
During a reactor startup, the senior reactor operator calculates that the maximum excess reactivity for reference core conditions is 4.76 % Δk/k. For this excess reactivity, which **ONE** of the following is the best action?

a. Increase power to 1 MW and verify the excess reactivity again.

b. Continue to operate because the excess reactivity is within TS limit.

c. Shutdown the reactor; report the result to supervisor including the NRC due to excess being above TS limit.

d Continue operation, but report the result to the supervisor since the excess reactivity is about exceeding TS limit.

QUESTION B.10 [1.0 point]
An area in which radiation levels could result in an individual receiving a dose equivalent in excess of 120 mRem/hr is defined as:

a. Radiation area.

b. Restricted Area.

c. High Radiation Area.

d. Very High Radiation Area.

QUESTION B.11 [1.0 point]
The parameters used to evaluate the RINSC Safety Limits are:

a. reactor power level, coolant flow rate, water tank level, and reactor outlet water temperature.

b. reactivity, reactor power level, water tank level, and reactor inlet water temperature.

c. reactivity, reactor power level, coolant flow rate, and water tank level.

d. reactor power level, coolant flow rate, water tank level, and reactor inlet water temperature.

QUESTION B.12 [1.0 point]
Minor modifications to the original procedures which do not effect reactor safety or change their original intent may be made by…

a. the Reactor Operator on his/her own and such changes shall be documented, and reviewed by the NRSC Subcommittee.

b. the Senior Reactor Operator on his/her own and such changes shall be documented and reviewed by the NRSC Subcommittee.

c. the Associate Director/Reactor Director and such changes shall be documented and reviewed by the NRSC Subcommittee.

d. the Radiation Safety Officer and such changes shall be documented and reviewed by the NRSC Subcommittee.

QUESTION B.13 [1.0 point]
A two curie source, with a 1.8 Mev gamma, is to be stored in the reactor building. How far from the source should a **HIGH RADIATION AREA** sign be posted?

a. 4 feet.

b. 15 feet.

c. 22 feet.

d. 66 feet.

QUESTION B.14 [1.0 point]
Select the list that gives the order of types of radiation from the **LEAST** penetrating to the **MOST** penetrating (i.e. travels the further in air).

a. neutron, gamma, beta, alpha.

b. alpha, beta, neutron, gamma.

c. beta, alpha, gamma, neutron.

d. alpha, neutron, beta, gamma.

QUESTION B.15 [1.0 point]
In a **LESS STRESSFUL EMERGENCY**, actions require personnel to protect facility or to control fires, a planned emergency exposure to the whole body could be allowed up to ____ to save a life.

a. 25 rem

b. 50 rem

c. 75 rem

d. 100 rem

QUESTION B.16 [1.0]
Which one of the following does **NOT** require NRC approval for changes?

a. Technical Specifications

b. Requalification plan

c. SOP

d. Emergency Plan

QUESTION B.17 [2 points, 0.5 each]
Match the 10CFR55 requirements for maintaining an active operator license in column A with the corresponding time period from column B. Items in column B can be used once, more than once or not at all.

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

QUESTION B.18 [1.0 point]
The drop-time of each of the four shim blades shall be measured:

a. monthly.

b. quarterly.

c. semi-annually.

d. annually.

QUESTION B.19 [1.0 point]
The radiation from an unshielded Co-60 source is 500 mrem/hr. What thickness of lead shielding will be needed to lower the radiation level to 5 mrem/hr? The HVL (half-value-layer) for lead is 6.5 mm.

a. 26 mm.

b. 33 mm.

c. 38 mm.

d. 44 mm.

QUESTION B.20 [1.0 point]
According to the RINSC Emergency Plan, which **ONE** of the following is the definition of the OPERATION BOUNDARY for the reactor facility?

a. The reactor control room.

b. The reactor bay area.

c. The reactor building and basement area.

d. Entire Narragansett Bay campus.

****************************** End of Section B ********************************

QUESTION C.01 [1.0]
While operating in the Natural Convection Mode which **ONE** of the following will result in a reactor scram?

a. Log N Period = 3 sec

b. Coolant Inlet Temperature = 118°F

c. No flow in Thermal Column

d. Pool Level is 25.5 ft above the core.

QUESTION C.02 [1.0]
Which **ONE** of the following is the actual design feature which prevents siphoning of primary water on a failure of the primary piping?

a. The Emergency Fill system will automatically maintain tank level.

b. 2 inches below the surface of the pool water will automatically turn the primary pump off.

c. The pipe ends of the primary line fitted with 10-inch pressure couplings will slowdown the water flow when sensing 2 inches below the surface of the pool water.

d. A valve, when open, allows air into the reactor loop, and breaks the siphoning action.

QUESTION C.03 [1.0]
Which of the following actions should **NOT** automatically occur when an evacuation button is depressed?

a. The clean up system blower turns off.

b. The off gas and rabbit blowers turn off.

c. The air conditioning and normal ventilation fans turn off.

d. The dampers on the ventilation ducts leading outside confinement close.

QUESTION C.04 [1.0 point]
On a loss of normal electrical power, which **ONE** of the following systems is **NOT** supplied by the Emergency Generator?

a. Exit lighting

b. Sump Pump

c. Emergency Exhaust Fans

d. Primary Cooling Pumps

QUESTION C.05 [1.0]
What is the maximum acceptable time between the initiation of a scram signal, and the time that any shim safety blade is fully inserted in the core?

a. 1000 msec.

b. 800 msec.

c. 400 msec.

d. 200 msec.

QUESTION C.06 [1.0 point]
Which **ONE** of the following is the design features for the RINSC HEU fuel?

a. Each fuel element contains 20 fuel-bearing plates with a nominal active length of 22 inches.

b. Each fuel element contains 22 fuel-bearing plates with a nominal active length of 24 inches.

c. Each fuel element contains 24 fuel-bearing plates with a nominal active length of 22 inches.

d. Each fuel element contains 26 fuel-bearing plates with a nominal active length of 26 inches.

QUESTION C.07 [2.0 points, 0.25 each] **Part a in column A and Part 7 in column B were deleted during the administrative of the examination. "6" is a correct answer for Part b.**

Match each monitor and instrument (channel) listed in column A with a specific purpose in column B. Items in column B are to be used only once.

Column A	Column B
~~a. Intermediate Range Monitor~~ .	1. Monitor radiation level in the reactor bridge.
b. Power Level Monitor.	2. Detect radioisotopes released due to fuel failure.
c. Wide Range Monitor.	3. Calculate safety limit.
d. Portable monitor.	4. Survey of laboratory.
e. Source Range Monitor .	5. Monitor neutron level during the reactor startup.
f. Area radiation monitor.	6. Provide a period scram.
g. Core outlet temperature.	~~7. Provide a high power level scram.~~
h. Particulate monitor.	8. Permit reactor power to be automatically controlled during the steady state mode.

QUESTION C.08 [1.0]
Which one of the following does **NOT** trigger an interlock that prevents the withdrawal of the Shim blades during start-up?

a. Master switch in "Test"

b. Reactor period is 25 sec

c. Start up counter recorder off

d. Start up counter reading less than 3 cps

QUESTION C.09 [1.0 point]
Which **ONE** of the following best describes the reason for the high sensitivity of Geiger-Mueller tube detector?

a. Coating with U-235.

b. A longer length tube, so target is larger for all incident events.

c. Lower voltage applied to the detector helps to amplify all incident events.

d. Any incident radiation event causing primary ionization results in ionization of entire detector.

QUESTION C.10 [1.0 point]
Which **ONE** of the following best describes the master switch when it is turned “ON” from “Test”?

a. Reactor scram.

b. Warning sound only.

c. Warning sound and a time-delay.

d. Operator can immediately withdraw the control rod (no time-delay).

QUESTION C.11 [1.0 point]
Which one of the following describes the detector that provides the signal to the Wide Range Linear channel for a servo controller?

a. Geiger-Mueller

b. Fission chamber

c. Gamma ion chamber

d. Compensated ion chamber

QUESTION C.12 [1.0 point]
Which **ONE** of the following describes the operation of the Reactor Room Intake and Exhaust dampers?

a. Air open, air close.

b. Air open, spring close.

c. Hydraulic operation (open and close).

d. Spring open, air close.

QUESTION C.13 [1.0 point]
Which **ONE** of the following is **NOT** a function of the Primary Makeup Water system?

a. A check valve prevents primary water from back flowing through the makeup system

b. Drop in the water level of one inch opens a solenoid valve to allow water flow into the pool.

c. A control room alarm is generated at -1.5 inches to warn of decreasing pool levels.

d. A low level alarm is sent to a security company off campus.

QUESTION C.14 [1.0 point]
A neutron flux will activate isotopes in air. This is the reason that off-gas blower is used to remove it from experiment facilities to the stack. The primary isotope we worry about in irradiating air is …

a. N^{16} (O^{16} (n,p) N^{16}).

b. Kr^{80} (Kr^{79} (n, γ) kr^{80}).

c. Ar^{41} (Ar^{40} (n, γ) Ar^{41}).

d. H^{2} (H^{1} (n, γ) H^{2}).

QUESTION C.15 [1.0 point]
Which **ONE** of the following is the main function of the demineralizer in the primary purification system?

a. Remove insoluble impurity to maintain low conductivity in the tank water.

b. Reduce N-16 formation, thus reduce the dose rate at the reactor pool.

c. Absorb thermal neutrons, thus increase life of the reactor pool.

d. Absorb tritium, thus maintain purity of the pool water.

QUESTION C.16 [1.0 point]
During reactor operation, a THERMAL COLUMN door open alarm will:

a. have no effect on the operation of the reactor.

b. prevent withdrawal of control blades.

c. cause a reactor scram.

d. cause a rod run in.

QUESTION C.17 [1.0 point]
Which ONE of the following is the correct statement regarding the materials used to construct the Shim blades at RINSC?

a. The SHIM blades are cadmium poison clad in aluminum.

b. The SHIM blades are boron carbide poison clad in aluminum.

c. The SHIM blades are cadmium poison clad in stainless steel.

d. The SHIM blades are boron carbide poison clad in stainless steel.

QUESTION C.18 [1.0]
Which of the following safety systems is **NOT** bypassed when the Power Level Selector Switch is in the 0.1 MW position?

a. The low pool level scram.

b. The bridge low power position scram.

c. The primary coolant low flow rate scram.

d. The primary coolant outlet temperature scram.

QUESTION C.19 [1.0 point]
The reactor operator is measuring the reactivity worth of the Shim blade by using the Positive Period Method. Before withdrawing the Shim blade to the new height, the reactor operator needs to stabilize the reactor power at:

a. 1 W for delayed neutrons to reach equilibrium.

b. 1 W for thermal neutron to reach equilibrium.

c. 1 kW for delayed neutrons to reach equilibrium.

d. 1 kW for thermal neutrons to reach equilibrium.

QUESTION C.20 [1.0 point]
Measuring the Shim rod drop time, the reactor operator uses:

a. a stop watch to measure the time between the initiation of a upper limit switch and a down limit switch signals of the Shim blade.

b. an oscilloscope to measure the time between the initiation of a scram signal and the noise signal that is pickup when the Shim blade is fully inserted in the core.

c. an oscilloscope to measure the time between the initiation of a upper limit switch and a down limit switch signals of the Shim blade.

d. a stop watch to measure the time between the initiation of a scram signal and the noise signal that is pickup when the Shim blade is fully inserted in the core.

******************* End of Section C *****************************
******************* End of the Exam ***************************

A.01 d
REF: Standard NRC question

A.02 a
REF: Glasstone, S. and Sesonske, A, *Nuclear Reactor Engineering,* 1991, § 5.18, p. 234.
$T = (\beta-\rho)/\lambda\rho$ $T = (.0078 - .00312)/.1 \times .00312 = 15$ seconds

A.03 c
REF: Burn, R., *Introduction to Nuclear Reactor Operations,* © 1982, Sec 4.5.

A.04 a
REF: $P=P_oe^{t/\tau}$ or $t/T= \ln (P/P_o)$. Given T=constant, t is the longest time if the ratio $\ln (P/P_o)$ is largest; hence: ln (4 kW/2kW) or 4 kW/2 kW

A.05 c
REF: Burn, R., Introduction to Nuclear Reactor Operations, © 1982, § 6.4, p. 6-4.

A.06 c
REF: Chart of the Nuclides

A.07 a
REF: Burn, R., *Introduction to Nuclear Reactor Operations,* © 1982, Sec 5.4, Inverse Multiplication, p. 5-14.

A.08 d
REF: Burn, R., *Introduction to Nuclear Reactor Operations,* © 1982, Sec 3.3.3, page 3-21.
. In order to solve the question A.08, the applicant can use one of the following methods:
At k=0.8; ρ = ∆Keff/Keff or ρ = Keff-1/Keff = -0.2/0.8 =-0.25. At k=0.95, ρ =-0.05/0.95
ρ = -0.053. The difference between ρ is the answer ,i.e. -0.053-(-0.25)=0.197
∆ ρ = ρ1 – ρ2 where ρ1 = Keff1-1/Keff1 and ρ2 = Keff2-1/Keff2. Substitute ρ1 and ρ2 with Keff1 and Keff2 into the equation above, the result is ∆ρ = keff1-keff2/(keff1 x keff2)

A.09 c
REF: Burn, R., *Introduction to Nuclear Reactor Operations,* © 1982, Sec 3.2.

A.10 a
REF $\rho_1=-0.086$; $K_{eff1}=1/1- \rho_1$
$K_{eff1} =1/(1-(-.086))$ —>$K_{eff1}= 0.9208$,
Remove ─3.1 % Δk/k from the core, means adding 3.1 % Δk/k to the core when removing the rod; new worth = -0.086 + 0.031= -0.055,
K_{eff2} = 1/1+0.055; —>0.948
$Count_1*(1-K_{eff1}) = Count_{2*}(1-K_{eff2})$
$Count_1*(1-0.9208) = Count_{2*}(1-0.948)$
$Count_1*(1-0.9208) = 1000(1-0.948)$; $Count_1 = 657$ cps

A.11 b
REF: Burn, R., *Introduction to Nuclear Reactor Operations,* © 1982, Sec 4.2.

A.12 d
REF: TS 1.0

A.13 a
REF: Total rod worth – (excess + most active SHIM blade + REG blade)
(0.30+0.45+0.5+0.1) %Δk/k –(0.6+0.5+0.1) %Δk/k =(1.35 -1.2) %Δk/k = 0.15 %Δk/k

A.14 d
REF: Burn, R., *Introduction to Nuclear Reactor Operations,* © 1982, Page 4-21. A.14 c

A.15 c
REF: Burn, R., *Introduction to Nuclear Reactor Operations,* © 1982, Section 2.51, page 2-36.

A.16 a
REF: Introduction to Nuclear Operation, Reed Burn, 1982, Sec 8.2, page 8-3.

A.17 c
REF NRC standard question

A.18 d
REF: Introduction to Nuclear Operation, Reed Burn, 1982, Sec 3.3.1, page 3-16.

A.19 b
REF Introduction to Nuclear Operation, Reed Burn, 1982, Sec 5.4, page 5-14.

A.20 d
REF Standard NRC question

B.01 a
REF: TSs 2.2, 3.3, and 3.4

B.02 b
REF: TSs 3.1 & 3.8

B.03 a(1) b(1) c(4) d(3)
REF: 10 CFR 20

B.04 b
REF: $DR = DR_o * e^{-\lambda t}$
40 rem/hr = 160 rem/hr* $e^{-\lambda(4hr)}$
Ln(40/160) = -λ*4 --> λ=0.347; solve for t: Ln(10/160)=-0.347 *t → t=8 hours

B.05 c
REF: Technical Specification, p. 12, Table F-1. & Rhode Island: Safeguards Report for Rhode Island Open Pool Reactor, paragraph 2.2.3

B.06 c
REF: EP 4.3, Site Area Emergency

B.07 a
REF: TS 1.0, Definition

B.08 c
REF: $DR = DR_o * e^{-\lambda t}$
20% is decayed, so 80% is still there
80% =100%* $e^{-\lambda(1hr)}$
Ln(80/100) = -λ*1 -->λ=0.223 t1/2=Ln(2)/ λ -->.693/.223 t=3.1 hours

B.09 c
REF: TS 3.1.2

B.10 c
REF: 10 CFR 20

B.11 a
REF: TS 2.1

B.12 b
REF: TS 6.5

B.13 b
REF: 6CEN = R/hr @ 1 ft. -> 6 x 2 x 1.8 x 1 = 21.6 R/hr at 1ft. $I_0 D_0^2 = I * D^2$
21.6 R/hr*1 ft = 0.1 R/hr *D^2
D= $\sqrt{(21.6/0.1)}$ = 14.7 ft.

B.14 b
REF: NRC standard question

B.15 a
REF: EP 7.5.1, Action in Less Urgent Emergency

B.16 c
REF: 10 CFR 50.54 (q); 10 CFR 50.59; 10 CFR 55.59

B.17 a (6) b(2) c(2) d(1)
REF: 10 CFR 55.55(a)

B.18 d
REF: TS 4.2.4

B.19 d
REF: $DR = DR_{o} * e^{-\mu X}$
HVL (=6.5 mm) means the original intensity will reduce by half when a lead sheet of 6.5 mm is inserted. Find μ if the HVL is given as follows: $1 = 2 * e^{-\mu * 6.5}$; μ = 0.10664
Find X: 5 mrem/hr = 500 mrem/hr* $e^{-0.10664 * X}$; X= 43.2 mm

B.20 c
REF: EP, Section 2.0

C.01 a
REF: TS 2.2 and TS Table 3.1

C.02 d
REF: SAR 5.2.1.1, Reactor Pool``

C.03 a
REF: TSs 4.4, 4.5, and 4.6

C.04 d
REF: SAR 8.3, Emergency Electrical Power Systems

C.05 a
REF: TS 3.2.3

C.06 b
REF: SAR 4.2.1, Reactor Fuel

C.07 ~~a(6)~~ ~~b(7)~~ b(6) c(8) d(4) e(5) f(1) g(3) h(2)
REF: TS 3.2 and SAR 7.0, Instrumentation and Control
Part a is deleted during the administrative of the examination. "6" is a correct answer for Part b.

C.08 c
REF: SAR 7.2.7, Servo Controlled Regulating Blade Drive System

C.09 d
REF: Standard NRC question

C.10 c
REF: SAR 7.2.3, Power Distribution System

C.11 d
REF: SAR 7.2.8, Automatic Power Level Channel

C.12 b
REF: SOP, MP-01

C.13 c
REF: SAR 5.5 Makeup Water System

C.14 c
REF NRC Standard Question

C.15 a
REF: NRC Standard Question

C.16 a.
REF: SAR 10.2.4 and TS Table 3.2

C.17 b
REF: SAR 4.2.2, Control Blades

C.18 a
REF: TS Table 3.1

C.19 a
REF: SOP TP-03, Control Rod Reactivity Worths

C.20 b
REF: SOP, TP-01