November 9, 2004

Dr. Dan Reece, Director
Nuclear Science Center
Texas A&M University
Building 1095
College Station, TX 77843-3575

SUBJECT: INITIAL EXAMINATION REPORT NO. 50-128/OL-05-1, Texas A&M University

Dear Dr. Reece:

During the week of October 4, 2004, the NRC administered an operator licensing examination at your Texas A&M University Reactor. The examination was conducted according to NUREG-1478, "Non-Power Reactor Operator Licensing Examiner Standards," Revision 1. 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 10 CFR 2.390 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 Agencywide Documents Access and Management 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. Paul Doyle at (301) 415-1058 or via internet e-mail pvd@nrc.gov.

Sincerely,

/RA/

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-05-1.
2. Examination with facility comments incorporated

cc w/encls: Please see next page

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Facility File (EBarnhill) O-6 F-2

EXAMINATION PACKAGE ACCESSION #: ML042080195
EXAMINATION REPORT ACCESSION #: ML043090523 **TEMPLATE #: NRR-074**

OFFICE	RNRP:CE		IROB:LA	E	RNRP:SC	
NAME	PDoyle		EBarnhill		PMadden	
DATE	11/5/2004		11/8/2004		11/9/2004	

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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.: 50-128/OL-05-1

FACILITY DOCKET NO.: 50-128

FACILITY LICENSE NO.: R--83

FACILITY: Texas A&M University

EXAMINATION DATES: October 5 & 6, 2004

SUBMITTED BY: ______________________________ ________________
Paul V. Doyle Jr., Chief Examiner Date

SUMMARY:

The NRC administered operator licensing examinations to four license candidates, two Reactor Operator, one Senior Reactor Operator (Instant) and one Senior Reactor Operator (Upgrade). All four candidates passed their examinations. The facility staff e-mailed their comments which have been incorporated into the examination included with this report.

REPORT DETAILS

1. Examiners: Paul V. Doyle Jr., Chief Examiner

2. Results:

	RO PASS/FAIL	SRO PASS/FAIL	TOTAL PASS/FAIL
Written	2/0	1/0	3/0
Operating Tests	2/0	2/0	4/0
Overall	2/0	2/0	4/0

3. Exit Meeting: Paul V. Doyle Jr., NRC, Examiner
James Remlinger, Texas A&M University, Reactor Supervisor

During the exit meeting the NRC examiner thanked the facility staff for their support in the administration of the examination. The facility found three typographical mistakes in the answer key which they later e-mailed to the examiner. The examiner reported that he noted no weak areas with respect to the candidates.

TEXAS A&M UNIVERSITY
With Answer Key

UNITED STATES NUCLEAR REGULATORY COMMISSION

OPERATOR LICENSING EXAMINATION
October 5, 2004

Enclosure 2

QUESTION A.1 [2.0 points, 0.5 each]
Match each term in column A with the correct definition in column B.

	Column A	Column B
a.	Prompt Neutron	1. A neutron in equilibrium with its surroundings.
b.	Fast Neutron	2. A neutron born directly from fission.
c.	Thermal Neutron	3. A neutron born due to decay of a fission product.
d.	Delayed Neutron	4. A neutron at an energy level greater than its surroundings.

QUESTION A.2 [1.0 point]
A reactor (not TAMU) has the following reactivity characteristics.
SS Rod 1 .... $2.25 SS Rod 2 .... $2.30 SS Rod 3 .... $2.15 SS Rod 4 .... $2.40
Reg Rod .... $1.10 Trans Rod … $2.35 ρ_{excess} ... $5.50
Which ONE of the following is the shutdown margin allowable by Technical Specifications. (NOTE: Rods which are able to scram, are the same as at TAMU.)

a. $3.65

b. $4.75

c. $5.85

d. $7.15

QUESTION A.3 [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.4 [1.0 point]
Which factor of the Six Factor formula is most easily varied by the reactor operator?

a. Thermal Utilization Factor (f)

b. Reproduction Factor (η)

c. Fast Fission Factor (ε)

d. Fast Non-Leakage Factor (L_f)

QUESTION A.5 [1.0 point]
Which ONE of the following is an example of alpha decay?

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

b. $_{35}Br^{87}$ o $_{35}Br^{86}$

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

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

QUESTION A.6 [1.0 point, ¼ each]
Using the drawing of the Integral Rod Worth Curve provided, identify each of the following reactivity worths.

a. Total Rod Worth	1. B - A
b. Actual Shutdown Margin	2. C - A
c. Technical Specification Shutdown Margin Limit	3. C - B
d. Excess Reactivity	4. D - C
	5. E - C
	6. E - D
	7. E - A

QUESTION A.7 [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.

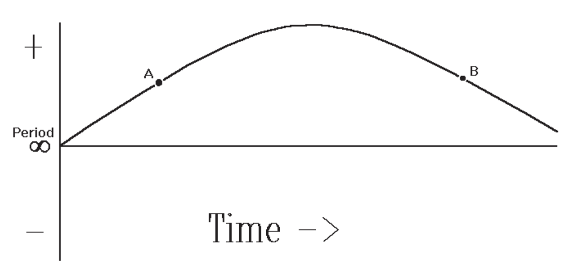
QUESTION A.8 [1.0 point]
Shown below is a trace of reactor period as a function of time. Between points A and B reactor power is:

a. continually increasing.

b. continually decreasing.

c. increasing, then decreasing.

d. constant.



QUESTION   A.9 [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.10[1.0 point]
The reactor had been running for 16 hours straight at 1 megawatt when it was shutdown for maintenance. The maintenance took six hours, and you have just restarted the reactor and raised power to 1 megawatt and placed the reactor in auto control. Which ONE of the following is the expected response of the regulating rod for the next half hour?

a. Drive in

b. Drive out

c. Not move

d. Drive out then back in

QUESTION   A.11[1.0 point]
The frequency on the local power grid increases from 60 Hz to 66 Hz. This results in all of the control rod drives running 10% faster. How will this change in rod speed effect reactor critical conditions compared to normal rod speed?

a. Rod height will be lower, Power will be lower.

b. Rod height will be higher, Power will be higher

c. Rod height will be the same, Power will be lower.

d. Rod height will be the same, Power will be the same.

QUESTION   A.12[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 β_{eff}.

QUESTION A.13[1.0 point]
The source was removed from an operating reactor. Later, the source was reinstalled and the Reactor Operator noted reactor power increasing LINEARLY. What was the condition of the reactor when the source was inserted? (Assume source has no reactivity worth, and no other changes in reactor parameters.) The reactor was …

a. very subcritical

b. slightly subcritical

c. exactly critical

d. slightly supercritical

QUESTION A.14[1.0 point]
Which one of the following is the definition of the FAST FISSION FACTOR? The ratio of the number of neutrons produced by …

a. fast fission to the number produced by thermal fission

b. thermal fission to the number produced by fast fission

c. fast and thermal fission to the number produced by thermal fission

d. by fast fission to the number produced by fast and thermal fission

QUESTION A.15[1.0 point]
In a reactor at full power, the thermal neutron flux (φ) is 2.5×10^{12} neutrons/cm^2/sec. and the macroscopic fission cross-section Σ_f is 0.1 cm^{-1}. The fission reaction rate is:

a. 2.5×10^{11} fissions/sec.

b. 2.5×10^{13} fissions/sec.

c. 2.5×10^{11} fissions/cm^3/sec.

d. 2.5×10^{13} fissions/cm^3/sec.

QUESTION A.16[1.0 point]
The reactor is required to pulse from low power levels (less than one KW). Which ONE of the following is the reason for this limitation on power level prior to the pulse?

a. To prevent exceeding the maximum power level limit

b. To prevent exceeding the fuel element temperature limit

c. To prevent exceeding the pool temperature limit

d. To prevent exceeding the reactivity insertion limits

QUESTION A.17[1.0 point]
If a $1.50 pulse has a peak power of 250 MW, a FWHM of 100 ms, and a fuel temperature rise of 145EC, what would you estimate the peak power, FWHM, and fuel temperature rise values would be for a $2.00 pulse?

a. Peak power: 780 MW FWHM: 80 ms Temp. rise: 210EC

b. Peak power: 1000 MW FWHM: 50 ms Temp. rise: 290EC

c. Peak power: 1200 MW FWHM: 50 ms Temp. rise: 350EC

d. Peak power: 900 MW FWHM: 80 ms Temp. rise: 210EC

QUESTION A.18[1.0 point]
Which ONE of the following statements is correct with respect to why Xenon peaks following a shutdown?

a. Delayed neutrons continue causing fissions increasing the "direct" Xenon.

b. The decay constant for Xenon is longer than the decay constant for Iodine.

c. The decay constant for Xenon is longer than the decay constant for Cesium.

d. The decay constant for Cesium is essentially zero.

QUESTION A.19[1.0 point]
The peak power produced in a fuel element during pulsing operations is greater in FLIP fuel than it is in Standard fuel because:

a. the absolute temperature rise is smaller.

b. the burnable poison is the main factor limiting the power peak.

c. the U^{235} loading is greater in FLIP fuel.

d. the neutron mean free path is longer allowing more time for moderation.

QUESTION B.1 [2.0 points, 0.5 each]
Identify each of the following as either a Safety Limit (**SL**), a Limiting Safety System Setting (**LSSS**) or a Limiting Condition for Operation (**LCO**)

a. The temperature in a TRIGA-FLIP fuel element shall not exceed 2100EF (1150EC) under any conditions of operation.

b. … shall be 975EF (525EC) as measured in an instrumented fuel element. The instrumented fuel element shall be located adjacent to the central bundle with the exception of corner positions.

c. The reactivity to be inserted for pulse mode operation shall not exceed that amount which will produce a peak fuel temperature of 1526EF (830EC).

d. Conductivity of the bulk pool water shall be no higher than 5×10^{-6} mhos/cm for a period not to exceed two weeks.

QUESTION B.2 [2.0 points, 0.5 each]
Identify each of the following as either a channel **check**, a channel **test** or a channel **cal**ibration.

a. Dipping a temperature detector in ice water and verifying the channel reads 32EF (0EF)

b. Verifying proper overlap between Nuclear Instrumentation Channels during startup.

c. After receiving an alarm on an Area Radiation Monitor, you verify the reading with a hand-held meter.

d. Performing a reactor pool water rate-of-temperature-rise measurement, then adjusting the detectors to correct readout.

QUESTION B.3 [2.0 points, 0.5 each]
Match the radiation reading from column A with its corresponding radiation area classification (per 10 CFR 20) listed in column B.

COLUMN A	COLUMN B
a. 10 mRem/hr	1. Unrestricted Area
b. 150 mRem/hr	2. Radiation Area
c. 10 Rem/hr	3. High Radiation Area
d. 550 Rem/hr	4. Very High Radiation Area

QUESTION B.4 [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) states 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 at facility).

d. NRC Project Manager

QUESTION B.5 [1.0 point]
The ***Quality Factor*** is used to convert …

a. dose in rads to dose equivalent in rems.

b. dose in rems to dose equivalent in rads.

c. contamination in rads to contamination equivalent in rems

d. contamination in rems to contamination equivalent in rads.

QUESTION B.6 [1.0 point]
Which ONE of the following is the 10 CFR 20 definition of **TOTAL EFFECTIVE DOSE EQUIVALENT (TEDE)**?

a. The sum of the deep does equivalent and the committed effective dose equivalent.

b. The dose that your whole body receives from sources outside the body.

c. The sum of the external deep dose and the organ dose.

d. The dose to a specific organ or tissue resulting from an intake of radioactive material.

QUESTION B.7 [1.0 point]
N^{16} has a very short half-life. If you assume that it takes 10 HALF-LIVES worth of time for the water to get from the core to the sample connection, then the activity due to N^{16} will have decrease by a factor of approximately ___ with respect to the level at the exit of the core.

a. 20

b. 100

c. 200

d. 1000

QUESTION B.8 [1.0 point]
Which ONE of the following checks must be performed following a **SCHEDULED** shutdown during which the bridge was moved?

a. Control rods must be driven through their full range of travel with no abnormalities or jamming.

b. All limit switches for the control rods must be verified for proper operation.

c. All scrammable rods must be raised to 10% positions then manually scrammed checking all indications for proper operation.

d. A complete pre-startup check is required.

QUESTION B.9 [1.0 point]
Which ONE of the following statements concerning emergency exposure limits is correct?

a. The emergency director may authorize an individual to receive up to 75 REM to perform actions to mitigate an accident.

b. The emergency director should use the youngest volunteer because that person will be best able to recover from an emergency exposure.

c. The emergency director may authorize an individual to receive up to 100 REM to save a life.

d. Emergency doses received are not tracked by the facility.

QUESTION B.10[1.0 point]
Technical Specification 5.5 requires "all fuel elements shall be stored in a geometrical array where K_{eff} is less than:

a. 0.80

b. 0.85

c. 0.90

d. 0.95

QUESTION B.11[1.0 point]
Which ONE of the following is the **MAXIMUM** amount of explosive materials allowed in the building per Technical Specification 3.6.2?

a. 25 milligrams

b. 5 grams

c. 5 pounds

d. 25 pounds

QUESTION B.12[1.0 point]
SOP II-C *Reactor Startup*, requires placing the diffuser in operation if anticipated power level is equal to or greater than …

a. 0.5 Kilowatts.

b. 5 Kilowatts.

c. 50 Kilowatts.

d. 500 Kilowatts.

QUESTION B.13[1.0 point]
Select the correct sequence of rod withdrawal during a normal reactor startup.

a. Shim-Safeties in gang to upper limit, Transient to mid position, Regulating to criticality

b. Regulating to upper limit, Transient to mid position, Shim-Safeties in gang to criticality

c. Transient to upper limit, Regulating to mid position, Shim-Safeties in gang to criticality

d. Transient to upper limit, Shim-Safeties in gang to mid position, Regulating to criticality.

QUESTION B.14[1.0 point]
Which ONE of the following Emergency classifications is NOT used at the Texas A&M TRIGA reactor?

a. Operational Event

b. Notification of Unusual Event

c. Alert

d. General Emergency

QUESTION B.15[1.0 point]
A small radioactive source is to be stored in the reactor building. The source reads 2 R/hr at 1 foot. Assuming no shielding is to be used, a Radiation Area barrier would have to be erected from the source at least a distance of approximately:

a. 400 feet

b. 40 feet

c. 20 feet

d. 10 feet

QUESTION B.16[1.0 point]
The Transient rod drive system and its associated air system were last inspected, cleaned and lubricated on May 23, 1999. Which one of the following dates is the latest the maintenance may be performed again without exceeding a Technical Specifications requirement?

a. Nov. 23, 1999

b. Jan. 23, 2000

c. May 23, 2000

d. July 23, 2000

QUESTION B.17[1.0 point]
While performing a power calibration the difference between the indicated power and the measured power is 10%. Which ONE of the below statements is correct for this condition?

a. Position the detector to match indicated and measured power.

b. A difference this great is suspect and may be an indication of thermocouple grounding or improper ice bath preparation.

c. Adjustments to the power instrumentation cannot be performed under any circumstances, if the difference is greater than 5%.

d. A difference this great is suspect and may be an indication of a "shadowing effect"

QUESTION C.1 [1.0 point]
A 1-¾ inch diameter hole through the grid plate is located at the southwest corner of the four rod fuel assemblies. The purpose of these holes is to …

a. accommodate a fuel followed control rod.

b. provide a mounting location for in-core experiments.

c. allow for accurate repositioning of the reactor core which is essential for numerous experiments.

d. provide a coolant flow path through the grid plate

QUESTION C.2 [1.0 point]
The gas used to move pneumatic tube “rabbit” samples into and out of the reactor is …

a. H_2

b. Air

c. CO_2

d. N_2

QUESTION C.3 [2.0 points, ⅔ each]
Match the detector type in column B with the proper reactor channel in column A.

a. Log Power Channel	1. Fission Chamber
b. Linear Power Measuring Channel	2. BF_3 Counter
c. Safety Power Measuring Channel	3. Compensated Ion Chamber
	4. Uncompensated Ion Chamber

QUESTION C.4 [1.0 point]
The purpose of the diffuser above the core during operation is to …

a. reduce dose rate at the pool surface due to N^{16}.

b. enhance heat transfer across all fuel elements in the core.

c. better distribute heat throughout the pool.

d. ensure consistent water chemistry in the core.

QUESTION C.5 [1.0 point]
Following a building ventilation isolation, how may the Emergency Director operate the system manually?

a. The Emergency Operating Panel in the central mechanical chase.

b. The Radiation Release Monitoring Panel in the Health Physicist's Office.

c. The Supervisor's Console in the control room.

d. The Air Handling Control Panel in the reception room.

QUESTION C.6 [1.0 point]
Which ONE of the following statements correctly describes system response for a pool level drop to less than 90%?

a. Two float switches actuate. One stopping the pool water recirculation pump and one energizing an alarm at the University Communications Room.

b. Two float switches actuate. Each stopping the pool water recirculation pump and energizing an alarm at the University Communications Room.

c. One float switch actuates. This switch both stops the pool water recirculation pump and energizes an alarm at the University Communications Room.

d. One float switch actuates. This switch energizes an alarm at the University Communications Room. The pool water recirculation pump continues to operate.

QUESTION C.7 [1.0 point]
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. Pool level will increase due to leakage from the secondary, the automatic level control will maintain level in the secondary.

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

QUESTION C.8 [1.0 point]
Which ONE of the following fuel element temperatures is NOT selected using the fuel element temperature selector switch?

a. Instrumented Fuel Element Temperature

b. Pool Temperature

c. Irradiation Cell Temperature

d. Instrumented Fuel Peak Temperature

QUESTION C.9 [1.0 point]
Fill in the blank: In the event of failure of the pool cooling system, the heat capacity of the reactor pool is sufficient to cool the reactor for several ____________, with the reactor operating at 1 Megawatt.

a. Minutes

b. Hours

c. Days

d. Weeks

QUESTION C.10 [1.0 point]
Which one of the following describes the MINIMUM action an operator would have to take, to prevent excessive loss of pool water in the event of a catastrophic rupture of the primary side of the cooling system heat exchanger? NOTE: PW-1 = Coolant extraction (pump suction) line valve. PW-2 and PW-3 = Coolant (pool) return line valves.

a. Manually shut PW-1, PW-2, and PW-3, in the valve pit of the heat exchanger room.

b. Manually shut PW-1 in the valve pit of the heat exchanger room; PW-2 and PW-3 may remain open due to the check valve installed downstream of the heat exchanger.

c. Remotely shut PW-1, PW-2, and PW-3, using the control switches on the auxiliary panel of the reactor console.

d. No action needed; PW-1, PW-2, and PW-3 will shut automatically when pool water level reaches a preset low level.

QUESTION C.11 [1.0 point]
Which one of the following describes the circuitry associated with the Log power channel?

a. Detector - Preamp - Amplifier - Period meter

b. Detector - Amplifier - Scaler - Bistable trips

c. Detector - picoammeter - power recorder - Digital power meter

d. Detector - integrator - digital power display - visicorder power indication

QUESTION C.12 [1.0 point]
On a decreasing pool level the university communications room will receive an alarm as a result of lowering level. What other automatic action will occur?

a. Core pump trip.

b. Purification pump trip.

c. Recirculation pump trip.

d. Skimmer pump trip.

QUESTION C.13 [1.0 point]
The air handler units have shutdown resulting in a facility isolation. Which ONE of the air monitoring systems below initiated this response?

a. Stack Fission Product Activity

b. Building Particulate Activity

c. Building Gas Activity

d. Stack Particulate Activity

QUESTION C.14 [1.0 point]
The purpose of the graphite slugs located at the top and bottom of each fuel rod is …

a. absorb neutrons, thereby reducing neutron embrittlement of the upper and lower guide plates.

b. absorb neutrons, thereby reducing neutron leakage from the core.

c. reflect neutrons, thereby reducing neutron leakage from the core.

d. couple neutrons from the core to the nuclear instrumentation, decreasing shadowing effects.

QUESTION C.15 [1.0 point]
The design basis for the confinement system ensures that:

a. the reactor building is maintained at a pressure lower than the atmosphere.

b. the reactor building is at a higher pressure than the atmosphere.

c. the reactor building is always equal to atmospheric pressure.

d. the reactor building and the adjacent laboratory are always at the same pressure.

QUESTION C.16 [1.0 point]
Which one of the following does NOT describe how the reactor power instrumentation system operates differently during pulsing operations.

a. Period scram is bypassed.

b. Pulsing detector output is fed to an integrator.

c. Linear Power is placed on full scale.

d. The normal channels are rebiased to detect pulsing levels.

QUESTION C.17 [1.0 point]
Why is Erbium added to TRIGA-FLIP fuel?

a. to improve the overall heat transfer coefficient, which is necessary due to higher temperatures generated when pulsing FLIP fuel.

b. to act as both a burnable poison, (allowing more fuel to be added), and as a resonance absorber, (enhancing prompt negative temperature coefficient).

c. to act as a burnable poison only (allowing more fuel to be added).

d. to act as a resonance absorber only, (enhancing prompt negative temperature coefficient).

QUESTION C.18 [2.0 points, ½ each]
Match the purification system conditions listed in column A with their respective causes listed in column B. Each choice is used only once.

Column A	Column B
a. High Radiation Level at Demineralizer.	1. Channeling in Demineralizer.
b. High Radiation Level downstream of Demineralizer.	2. Fuel element failure.
c. High flow rate through Demineralizer.	3. High temperature in Demineralizer system.
d. High pressure upstream of Demineralizer.	4. Clogged Demineralizer.

A.1 a, 2; b, 4; c, 1; d, 3
REF: Burn, R., Introduction to Nuclear Reactor Operations, © 1988, §§ 3.2.2, p. 3-7 and

A.2 b b Worth Rod Worth: $2.25 + $2.30 + $2.15 + $2.40 + $2.35 + $1.10 = $12.55. SDM = Worth of rods less Kexcess less reactivity of most worth rod, less reactivity of Reg Rod. SDM = $12.55 - $5.50 - $2.40 - $1.10 = ~~$10.20 - $8.00 = $4.75~~ $12.55 - $9.00 = $3.55 which is 10¢ from a. Give 100% credit for a.

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

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

A.5 a
REF: Burn, R., *Introduction to Nuclear Reactor Operations,* © 1988, § 2.4.6, P. 2-23.

A.6 a, 7; b, 2; c, 1; d, 5
REF: Standard NRC Question

A.7 d
REF: Lamarsh, J.R., *Introduction to Nuclear Engineering,* 1983. § 6.8, p. 267.

A.8 a
REF: STD NRC Question

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

A.10 a
REF: Lamarsh, J.R., *Introduction to Nuclear Engineering,* 1983. § 7.4, pp. 316 – 322.

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

A.12 a
REF: Lamarsh, J.R., *Introduction to Nuclear Engineering,* 1983. § 7.1, pp. 286 — 289.

A.13 c
REF: Burn, R., Introduction to Nuclear Reactor Operations, © 1988, §

A.14 c
REF: Burn, R., Introduction to Nuclear Reactor Operations, © 1988, §

A.15 c
REF: Lamarsh, J.R., *Introduction to Nuclear Engineering,* 1983. § 5.1, pp. 189 –191.
$R = \varphi G_f = (2.5 \times 10^{12}) \times 0.1 = 2.5 \times 10^{11}$

A.16 b
REF: TAMU Technical Specification 3.2.2 Basis

A.17 b
REF: SAR § XI: Peak Power is proportional to $\Delta\$_{prompt}^2$, FWHM is proportional to $1/\Delta\$_{prompt}$ and temperature increase is proportional to $\Delta\$_{prompt}$

A.18 b
REF: Burn, R., Introduction to Nuclear Reactor Operations, © 1988, §

A.19 c.
REF: SAR, III.C.2

B.1 a, SL; b, LSSS; c, LCO; d, LCO
REF: Technical Specifications §§ 2.1, 2.2, 3.1.2 and 3.8

B.2 a, test; b, check; c, check; d, cal
REF: Technical Specifications § 1.3.

B.3 a, 2; b, 3; c, 3; d, 4
REF: 10 CFR 20.1003, Definitions

B.4 b
REF: 10CFR50.54(y)

B.5 a
REF: 10CFR20.1004.

B.6 a
REF: 10 CFR 20.1003 *Definititions*

B.7 d $2^{10} = 1024$. 1000
REF: Standard NRC Question

B.8 c
REF: SOP-II-C.5 *Startup Following a Scheduled Shutdown.* Also NRC exam administered 11/1995.

B.9 ~~c~~ Question deleted per facility comment. No correct answer. Answer was based on OLD Emergency Procedure.
REF: SOP IX § B.1.i, pg. 3 and 10CFR20.1206, also NRC exam administered 11/95.

B.10 a
REF: Technical Specification 5.5

B.11 c
REF: Technical Specification 3.6.2, also NRC examination administered 06/99

B.12 d
REF: SOP II-C *Reactor Startup*

B.13 c
REF: SOP II-C pg. 2, also NRC examination administered 06/1990.

B.14 d
*REF: SOP IX § A Emergency Classification Guide, pp. 1 & 2, also NRC examination administered 11/95.

B.15 c
REF: $\frac{DR_1}{X_2^2} = \frac{DR_2}{X_1^2} \quad X_2^2 = \frac{DR_1 X_1^2}{DR_2} \qquad X_2^2 = \frac{2000}{5} \times 1^2 = 400 \text{ ft}^2 \quad X_2 = 20 \text{ ft}$

B.16 b
REFERENCE T.S. § 4.3.1

B.17 b
REF: SOP § II-J.2.b, pp. 1 – 2.

C.1 a
REF: SAR page 14.

C.2 c
REF: SAR § VI.D.1, Figure 6-3 on page 85.

~~C.3a, 1; b, 3; c, 4~~ Question Deleted. Examiner Error, left answer on question page.
REF: SAR § VII. B. Figures 7-1, 7-2 and 7-3.

C.4 a
REF: SAR Table V on page 100.

C.5 d
REF: SAR § V.B.3, Modification Authorization M

C.6 c
REF: SAT § VIII-G.1

C.7 d
REF: SAR § IV.B.2 p. 65, and figure 4-6. Also NRC exam administered April 1993.

C.8 d
REF: SAR VII.B.2 Figures 7-4 and 7-5.

C.9 b
REF: SAR, p. 112. Also NRC examination administered 3/95.

C.10 b
REF: SAR, pp. 63-66, 112, Fig.4-6

C.11 a
REF: SAR pg. 91; Figs. 7-1 through 7.3, Fig. 7-5

C.12 c
REF: SAR, § G.1, p. 112.

C.13 d
REF: SAR page 119

C.14 c
REF: SAR § III.B.4 ¶ 2, p. 14.

C.15 a
REF: SAR pg. 73

C.16 d
REF: SAR, p. 93

C.17 b
REF: SAR p. 50.

C.18 a, 2; b, 3; c, 1; d, 4
REF: Standard NRC question

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

FACILITY: Texas A&M University

REACTOR TYPE: TRIGA-FLIP

DATE ADMINISTERED: October 5, 2004

REGION: IV

CANDIDATE: ______________________________

INSTRUCTIONS TO CANDIDATE:
Answers are to be written on the answer sheet provided. Attach the answer sheets to the examination. Points for each question are indicated in brackets for each question. A 70% in each section is required to pass the examination. Examinations will be picked up three (3) hours after the examination starts.

Category Value	% of Total	% of Candidates Score	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

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 neither received nor 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 <u>only</u> to facilitate legible reproductions.

5. Print your name in the blank provided in the upper right-hand corner of the examination cover sheet and each answer sheet.

6. Mark your answers on the answer sheet provided. USE ONLY THE PAPER PROVIDED AND DO NOT WRITE ON THE BACK SIDE OF THE PAGE.

7. The point value for each question is indicated in [brackets] after the question.

8. If the intent of a question is unclear, ask questions of the examiner only.

9. When turning in your examination, assemble the completed examination with examination questions, examination aids and answer sheets. In addition turn in all scrap paper.

10. Ensure all information you wish to have evaluated as part of your answer is on your answer sheet. Scrap paper will be disposed of immediately following the examination.

11. To pass the examination you must achieve a grade of 70 percent or greater in each category.

12. There is a time limit of three (3) hours for completion of the examination.

13. When you have completed and turned in you examination, leave the examination area. If you are observed in this area while the examination is still in progress, your license may be denied or revoked.

EQUATION SHEET

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

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

$$\ell^* = 1 \times 10^{-4} \text{ seconds}$$

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

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

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

$$CR_1(-\rho_1) = CR_2(-\rho_2)$$

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

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

$$M = \frac{1}{1 - K_{eff}} = \frac{CR_f}{CR_0}$$

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

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

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

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

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

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

$$\Delta\rho = \frac{K_{eff_2} - K_{eff_1}}{K_{eff_1} \times K_{eff_2}}$$

$$T_{1/2} = \frac{0.693}{\lambda}$$

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

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

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

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

DR – Rem, Ci – curies, E – Mev, R – feet

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

1 Curie = 3.7 x 10^{10} dis/sec

1 kg = 2.21 lbm

1 Horsepower = 2.54 x 10^3 BTU/hr

1 Mw = 3.41 x 10^6 BTU/hr

1 BTU = 778 ft-lbf

°F = 9/5 °C + 32

1 gal (H_2O) ≈ 8 lbm

°C = 5/9 (°F - 32)

c_P = 1.0 BTU/hr/lbm/°F

c_p = 1 cal/sec/gm/°C

A.1a 1 2 3 4 ___

A.1b 1 2 3 4 ___

A.1c 1 2 3 4 ___

A.1d 1 2 3 4 ___

A.2 a b c d ___

A.3 a b c d ___

A.4 a b c d ___

A.5 a b c d ___

A.6a 1 2 3 4 5 6 7 ___

A.6b 1 2 3 4 5 6 7 ___

A.6c 1 2 3 4 5 6 7 ___

A.6d 1 2 3 4 5 6 7 ___

A.7 a b c d ___

A.7 a b c d ___

A.9 a b c d ___

A.10 a b c d ___

A.11 a b c d ___

A.12 a b c d ___

A.13 a b c d ___

A.14 a b c d ___

A.15 a b c d ___

A.16 a b c d ___

A.17 a b c d ___

A.18 a b c d ___

A.19 a b c d ___

B.1a SL LSSS LCO ___

B.1b SL LSSS LCO ___

B.1c SL LSSS LCO ___

B.1d SL LSSS LCO ___

B.2a Check Test Cal ___

B.2b Check Test Cal ___

B.2c Check Test Cal ___

B.2d Check Test Cal ___

B.3a 1 2 3 4 ___

B.3b 1 2 3 4 ___

B.3c 1 2 3 4 ___

B.3d 1 2 3 4 ___

B.4 a b c d ___

B.5 a b c d ___

B.6 a b c d ___

B.7 a b c d ___

B.8 a b c d ___

B.9 a b c d ___

B.10 a b c d ___

B.11 a b c d ___

B.12 a b c d ___

B.13 a b c d ___

B.14 a b c d ___

B.15 a b c d ___

B.16 a b c d ___

B.17 a b c d ___

C.1a a b c d ___

C.2 a b c d ___

C.3a 1 2 3 4 ___

C.3b 1 2 3 4 ___

C.3c 1 2 3 4 ___

C.4 a b c d ___

C.5 a b c d ___

C.6 a b c d ___

C.7 a b c d ___

C.8 a b c d ___

C.9 a b c d ___

C.10 a b c d ___

C.11 a b c d ___

C.12 a b c d ___

C.13 a b c d ___

C.14 a b c d ___

C.15 a b c d ___

C.16 a b c d ___

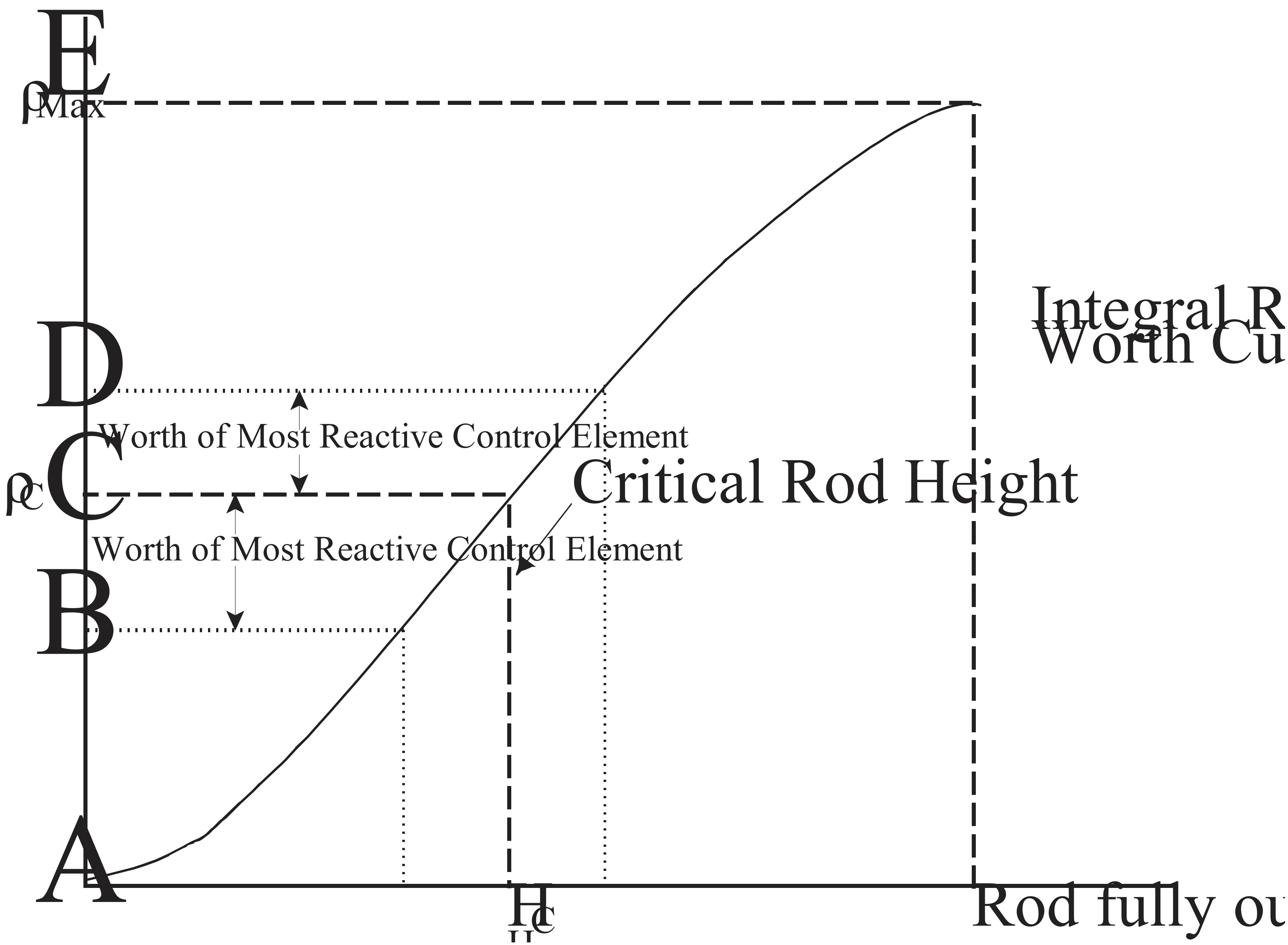
C.17 a b c d ___

C.18a 1 2 3 4 ___

C.18b 1 2 3 4 ___

C.18c 1 2 3 4 ___

C.18d 1 2 3 4 ___


E
ρ_{Max}
Integral R
Worth Cu
D
Worth of Most Reactive Control Element
ρ_C
C
Critical Rod Height
Worth of Most Reactive Control Element
B
A
H_C
Rod fully ou