ENCLOSURE 1

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

REPORT NO.: 50-62/OL-92-01

FACILITY DOCKET NO.: 50-62

FACILITY LICENSE NO.: R-66

FACILITY: University of Virginia

EXAMINATION DATES: July 13-16, 1992

EXAMINER: Frank Collins, Chief Examiner
Brian Hughes, Examiner

SUBMITTED BY: F. Collins 8/11/92
Frank Collins, Chief Examiner Date

APPROVED BY: James L. Caldwell 8/11/92
James L. Caldwell, Chief Date
Non-Power Reactor Section
Operator Licensing Branch
Division of Licensee Performance
and Quality Evaluation, NRR

SUMMARY:

Operator licensing requalification examinations were conducted at the University of Virginia Reactor (UVAR) on July 13-16, 1992. The examinations were administered by the Mr. Frank Collins, Chief Examiner and Mr. Brian Hughes, NRC Examiner. Written and operating examinations were administered for three Senior Reactor Operators (SRO). All operators passed their respective examinations.

REPORT DETAILS

1. Examiners:

Frank Collins, Chief Examiner
Brian Hughes, Examiner

2. Results:

	RO (Pass/Fail)	SRO (Pass/Fail	Total (Pass/Fail)
NRC Grading:	0/0	3/0	3/0
Facility Grading:	0/0	3/0	3/0

3. Written Examination:

The written examination was administered on Monday, July 13, 1992. All operators completed the examination within the allotted three hours. One clarification was requested by an operator after the examination, resulting in a change in the answer key for a single question. This change was entered by hand on the master copy of the examination that is provided as an attachment to this report.

4. Operating Examinations:

Operating examinations were administered on Wednesday and Thursday, July 15-16, 1992. The operators were given examinations in accordance with examiner standard ES-606 that included demonstrations of five tasks including core loading, shutdown margin and excess reactivity calculation, use of Emergency Plan Implementation Procedures (EPIPs), reactor startup and reactivity manipulations, and simulated malfunctions of the primary coolant system. A facility licensed SRO was present for and supervised all reactor operations. At no time was the licensed SRO required to intervene in the operations.

5. Exit Meeting:

The exit meeting was conducted by the Chief Examiner on May 27, 1992. The facility was represented by Mr. Robert Mulder, Director, Mr. Preston Farrar, Reactor Supervisor, and Mr. Donald Krause, SRO. The Chief Examiner, Frank Collins, represented the NRC.

The Chief Examiner identified a common deficiency in use of the EPIPs that was observed by both the facility and the NRC examiners. Each of the three operators failed one task because he neglected to open and use the procedures during a scenario in which pool coolant inventory was lost. The actions taken by the operators to add water to the pool were in accordance with those described in the procedures but, in every case, the operator failed to use the procedures to ensure proper

notifications, classification of emergency response levels, and activation of the Emergency Plan. A particular reticence was observed with respect to issuance of emergency notification involving organizations outside of the University. The facility cited difficulty with using the EPIPs and suggested that these difficulties might result in an operator's reluctance to use the procedures.

FOLLOW-UP ACTIVITIES

A conference call, between NRC management (both Headquarters and Region II) and University of Virginia management was held on August 6, 1992 to discuss a generic concern with the implementation of the emergency plan, NRCs. This concern involved the failure of the licensee operators to enter the EPIPs, properly classify the emergency, and make the required notifications. The facility management acknowledged the concern and will review both the EPIPs and their use by the facility operating staff.

NRC management emphasized the importance of the proper implementation of the emergency plan and their concern with the licensee's performance during the requalification examinations. The licensee was requested and agreed to document results of their review in a letter to the NRC. The Non-Power Reactors, Decommissioning and Environmental Projects Directorate will follow the licensee's review and ensure that corrective actions initiated by the licensee are adequate.

ENCLOSURE 2

1992 OPERATOR REQUALIFICATION EXAM

U.VA. REACTOR FACILITY

Grade	Category
_____	A. Theory
_____	B. Procedures and Radiological Control
_____	C. Facility and Radiation Monitoring Systems

Final Grade _____

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

_____

Signature Date

Proctor/s _____

NRC RULES AND GUIDANCE FOR EXAMINEES

1. Use black ink or dark pencil ONLY to facilitate legible reproduction.
2. Print your name in the blank provided on the cover sheet of the examination.
3. Fill in the date on the cover sheet of the examination, if necessary.
4. Answer each question on the examination.
5. Use abbreviations only if they are commonly used in facility literature.
6. The point value for each question is indicated in parentheses after the question.
7. Show all calculations, methods or assumptions used to obtain an answer to mathematical problem, whether asked for in the question or not. (This does not apply to multiple choice questions.)
8. Unless solicited, the location of references need not be stated.
9. If parts of the examination are not clear with respect to their intent, ask questions of the examiner only.
10. You must sign the statement on the cover sheet that indicates the work on the examination is your own and that you have not received or been given any assistance in completing the examination. This must be signed AFTER the examination has been completed.
11. Rest room trips are to be limited and only one examinee at a time may leave. You must avoid all contact with anyone outside the examination room to avoid even the appearance or possibility of examination compromise.
12. Cheating on the examination would result in a revocation of your license and could result in more severe penalties.
13. Each section of the examination is designated to take approximately 60 minutes to complete. You will be given 3 hours to complete the examination.
14. When you are finished and have turned in your completed examination, leave the examination area.
15. To pass the examination, you must achieve at least 70% in each category.

EQUATION SHEET

$\dot{f} = ma$

$w = mg$

$v = s/t$

$s = V_o t + \frac{1}{2} at^2$

$a = (V_f - V_o)/t$

$V_f = V_o + at$

$E = mc^2$

$KE = \frac{1}{2} mv^2$

$PE = mgh$

$\omega = \theta/t$

$W = v\Delta P$

$A = (\pi D^2)/4$

$\Delta E = 931\ \Delta m$

$\dot{m} = V_{ave} A \rho$

$\dot{Q} = \dot{m} C_p \Delta t$

$\dot{Q} = UA\Delta t$

$Pwr = W_f \Delta h$

$P = P_o 10^{sur(t)}$

$P = P_o e^{t/T}$

$SUR = 26.06/T$

$SUR = 26\rho/\ell^* + (\beta - \rho)T$

$T = \ell/(\rho - \beta)$

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

$P = (\Sigma\phi V)/(3 \times 10^{10})$

$A = \lambda N$

$A = A_o e^{-\lambda t}$

$\lambda = (\ln 2)/t_{\frac{1}{2}} = 0.693/t_{\frac{1}{2}}$

$I = I_o e^{-\mu x}$

$I = I_o e^{-\mu x}$

$I = I_o\ 10^{-x/(TVL)}$

$TLV = 1.3/\mu$

$HVL = -0.693/\mu$

$SCR = S/(1 - K_{eff})$

$CR_x = S/(1 - K_{effx})$

$CR_1(1 - K_{eff1}) = CR_2(1 - K_{eff2})$

$M = 1/(1 - K_{eff}) = CR_1/CR_o$

$M = (1 - K_{effo})/(1 - K_{eff1})$

$SDM = (1 - K_{e^-f})/K_{eff}$

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

$\bar{\lambda} = 0.1$ seconds^{-1}

$I_1 d_1 = I_2 d_2$

$I_1 d_1^2 = I_2 d_2^2$

$R/hr = (0.5\ CE)/d^2$ (meters)

$R/hr = (6\ CE)/d^2$ (feet)

$T = (\ell^*/\rho) + [(\beta - \rho)/(\bar{\lambda}\rho)]$

$T = (\beta - \rho)/(\bar{\lambda}\rho)$

$\rho = [(\ell^*/TK_{eff})] + [\bar{\beta}_{eff}/(1 - \bar{\lambda}T)]$

$\Sigma = \sigma N$

Cycle efficiency = (net work out)/(energy in)

Water parameters

1 gallon = 8.345 lbm

1 gallon = 3.78 liters

1 ft^3 = 7.48 gallons

Density = 62.4 lbm/ft^3

Density = 1 gm/cm^3

Heat of Vaporization = 970 Btu/lbm

Heat of Fusion - 144 Btu/lbm

1 Atm = 14.7 psi = 29.9 in Hg.

1 ft H_2O = 0.4335 lbf/in

Miscellaneous Conversions

1 Curie = 3.7×10^{10} dps

1 kg = 2.21 lbm

1 hp = 2.54×10^3 Btu/hr

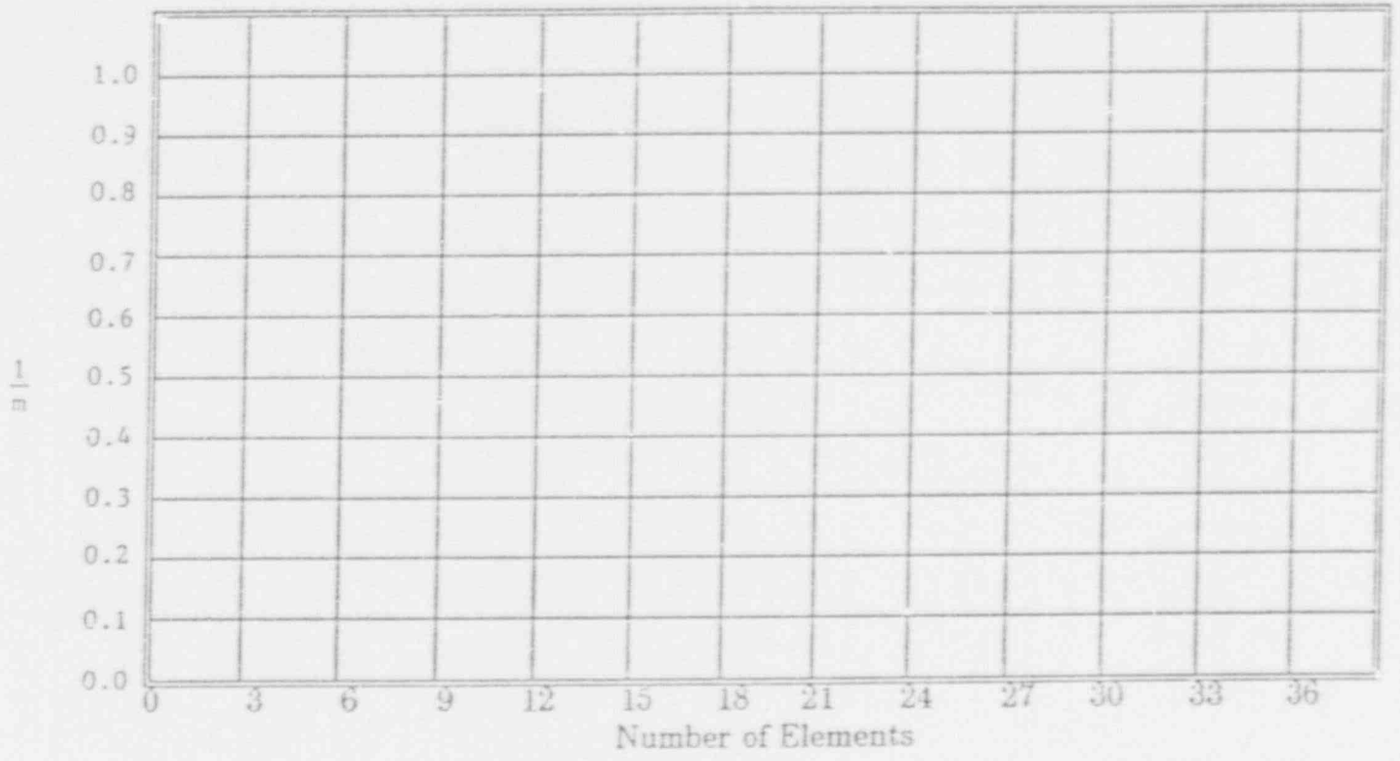
1 Mw = 3.41×10^6 Btu/hr

1 in = 2.54 cm

°F = 9/5 °C + 32

°C = 5/9(°F - 32)

1 Btu = 778 ft-lbf


1.0
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0.8
0.7
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0.5
0.4
0.3
0.2
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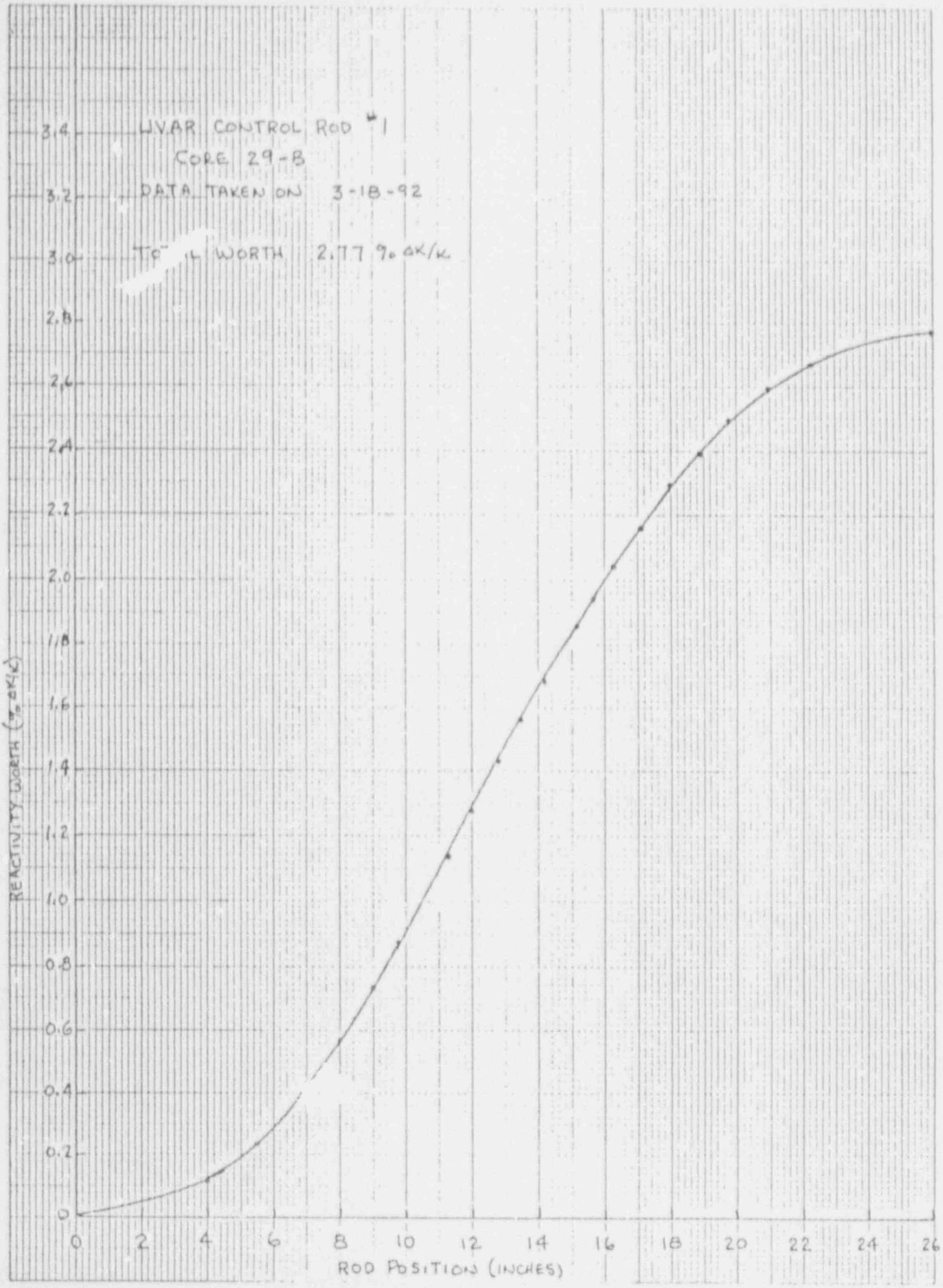
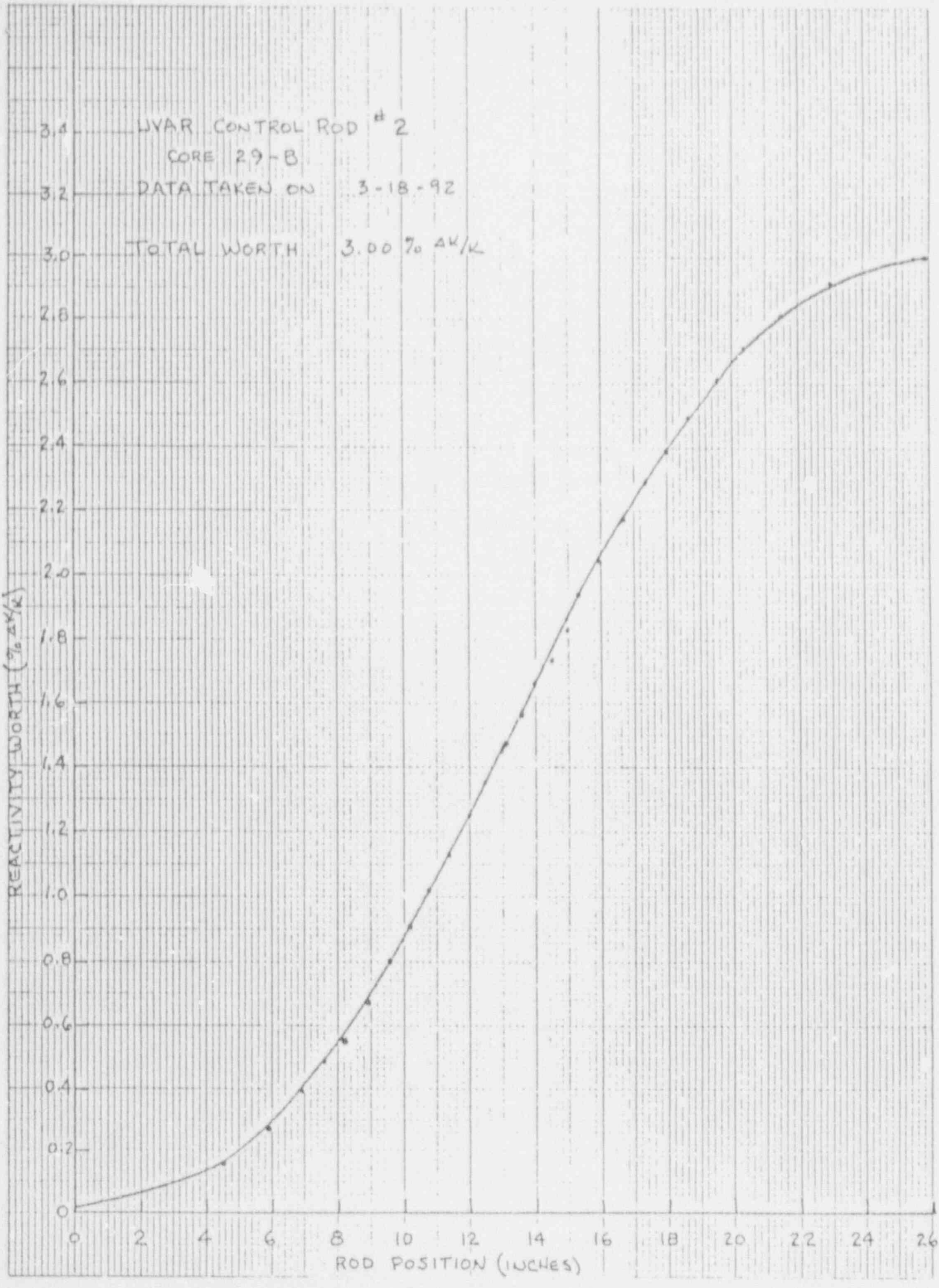
3
6
9
12
15
18
21
24
27
30
33
36
Number of Elements



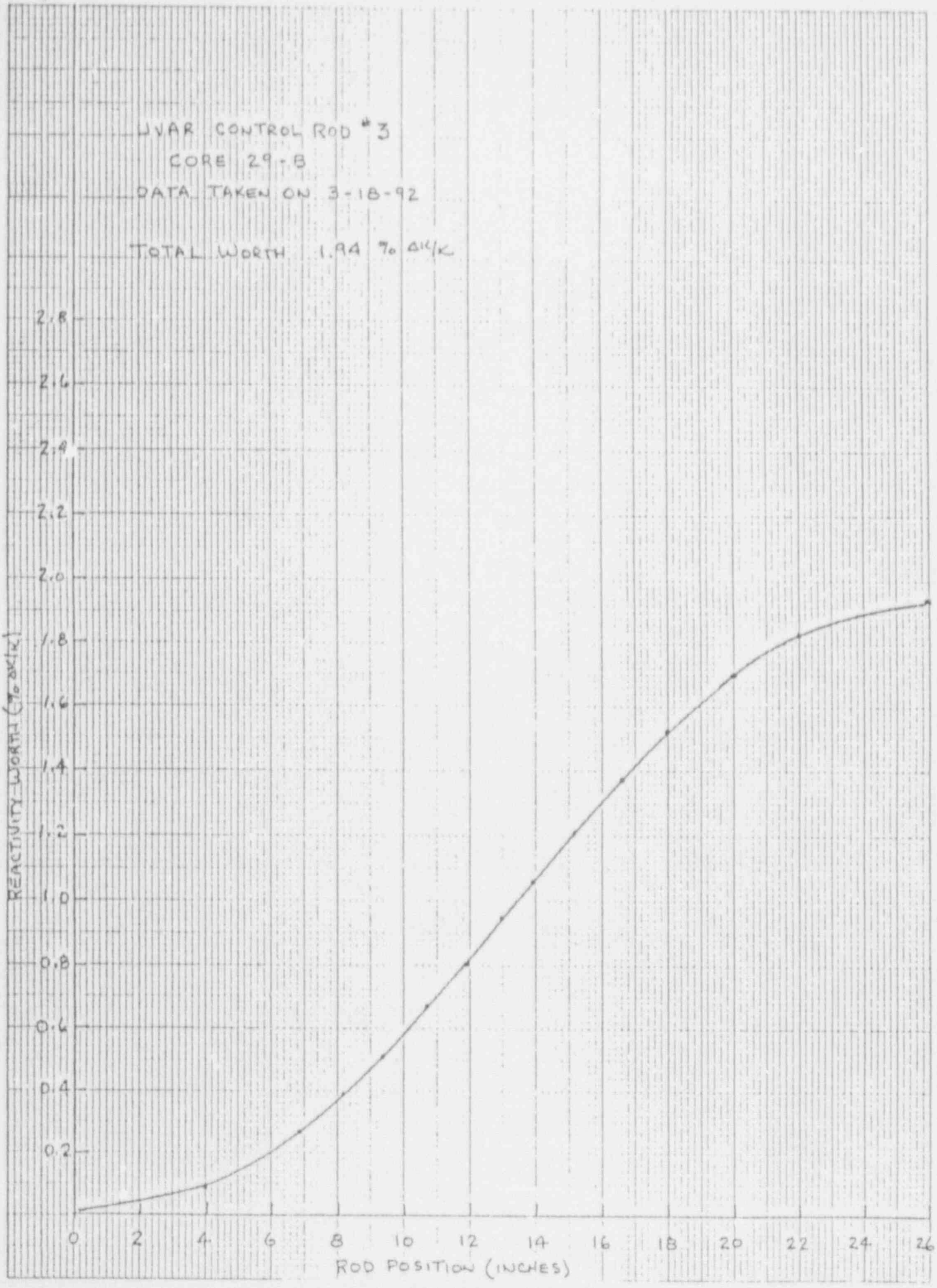


5 Squares to the Inch

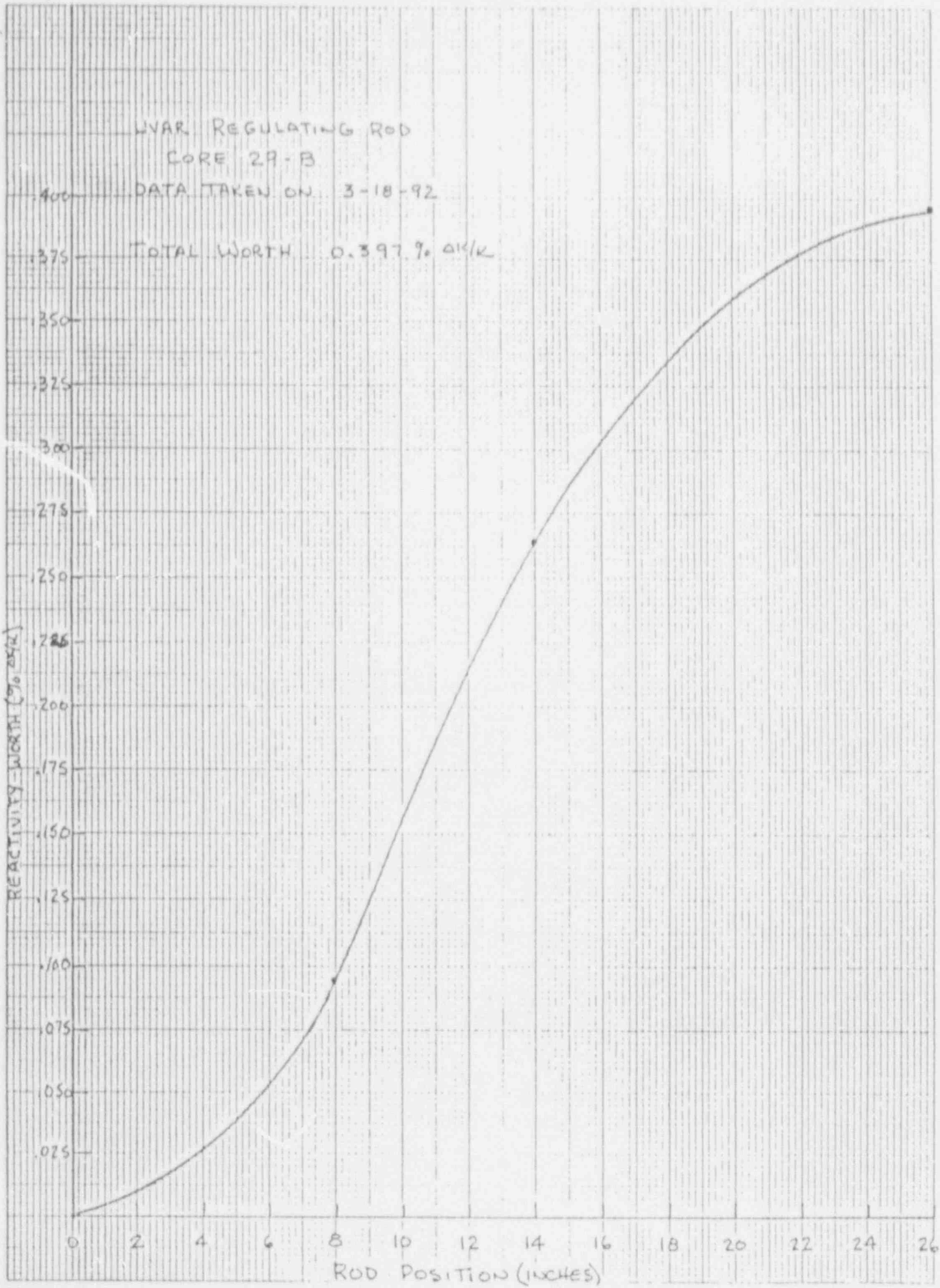
12-282

UVAR CONTROL ROD #3
CORE 29-B
DATA TAKEN ON 3-18-92

TOTAL WORTH 1.94 % Δk/k



20 Squares to the Inch


LVAR REGULATING ROD
CORE 2A-B
DATA TAKEN ON 3-18-92
TOTAL WORTH 0.397 % ΔK/K
REACTIVITY WORTH (% ΔK/K)
.400
.375
.350
.325
.300
.275
.250
.225
.200
.175
.150
.125
.100
.075
.050
.025
0
2
4
6
8
10
12
14
16
18
20
22
24
26
ROD POSITION (INCHES)

A. Reactor Theory, Thermo, & Facility Op. Chars.

QUESTION: 001 (4.00)

Reactor power is at 400 watts when a period of 50 seconds is established. What will the reactor power be in 4 minutes? (assume no temperature effects).

a) 10.5 Kilowatts

b) 48.5 Kilowatts

c) 75.5 Kilowatts

d) 100 Kilowatts

QUESTION: 002 (4.00)

Which one of the following is the definition of the diffusion length of a neutron?

a) The distance a neutron travels from birth to thermalization.

b) The distance a neutron travels from birth to absorption.

c) The distance a neutron travels from thermalization to absorption.

d) The distance a neutron travels from thermalization to fission.

******* CATEGORY A CONTINUED ON NEXT PAGE *******

A. Reactor Theory, Thermo, & Facility Op. Chars.

QUESTION: 003 (4.00)

Which of the following statements describes the concentration of Xenon in the core after a scram from extended operation at 2 MW?

a) Xenon concentration initially decreases due to the loss of Iodine production then increases to maximum concentration.

b) Xenon concentration decreases to a Xenon free condition in approximately ten (10) hours.

c) Xenon concentration increases to a maximum value in approximately ten (10) hours due to the reduction in the Xenon burn-up term.

d) Xenon concentration remains at equilibrium value since the production and burn-up term of Xenon has ceased.

QUESTION: 004 (4.00)

The shutdown margin for the existing UVAR core is 1.18 % $\Delta K/K$ with the rod of highest worth (3.19% $\Delta K/K$) fully withdrawn. What is the pre-start-up K_{eff}?

a) 0.578

b) 0.685

c) 0.875

d) 0.958

******* CATEGORY A CONTINUED ON NEXT PAGE *******

A. Reactor Theory, Thermo, & Facility Op. Chars.

QUESTION: 005 (4.00)

In a subcritical reactor, K_{eff} is increased from 0.861 to 0.965. Which one of the following is the amount of reactivity that was added to the core?

a) 0.086

b) 0.104

c) 0.125

d) 0.220

QUESTION: 006 (4.00)

The reactor has been shutdown from extended operation at 2 MW. Five hours later the reactor is started up and returned to 2 MW. Which one of the following describes the automatic regulating rod movement for the next several hours?

a) The regulating rod withdraws as Xenon increases to equilibrium value.

b) The regulating rod inserts as Xenon burns out to equilibrium value.

c) The regulating rod inserts initially as Xenon burns out, then withdraws as Xenon increases to equilibrium value.

d) The regulating rod withdraws initially as Xenon builds in, then inserts as burnout increases.

******* CATEGORY A CONTINUED ON NEXT PAGE *******

A. Reactor Theory, Thermo, & Facility Op. Chars.

QUESTION: 007 (4.00)

The reactor can be shutdown no faster than a ≈ 80 second period. Which one of the following is the reason for this?

a) The ability of U-235 to fission with source neutrons.

b) The amount of negative reactivity added on a scram being greater than the shutdown margin.

c) The doppler effect adds positive reactivity due to the temperature decrease following a scram.

d) The decay constant of the longest - lived group of delayed neutrons.

QUESTION: 008 (4.00)

For each of the following definitions, match the term that is defined with its definition:

a) The factor by which neutron population changes between generations.

b) The decay of an excited nucleus into a stable nucleus with the simultaneous ejection of electromagnetic energy.

c) The amount of time required for the neutron population to increase by a factor of "e" (2.718).

d) A gamma ray causes the ejection of an electron from a target atom; the gamma ray's energy is totally transmitted to the electron for ejection.

1. Pair Production
2. Compton Scattering
3. SUR (Start-up Rate)
4. Gamma Decay
5. Photo-electric Effect
6. Period
7. K_{eff}
8. ρ (Reactivity)

******* CATEGORY A CONTINUED ON NEXT PAGE *******

A. Reactor Theory, Thermo, & Facility Op. Chars.

QUESTION: 009 (4.00)

The reactor is just critical at a low power level. Which of the following is the stable reactor period resulting from the rapid insertion of a rod, adding reactivity of - 0.3 % ΔK/K?

a) - 12.5 seconds

b) - 35.0 seconds

c) - 80.0 seconds

d) - 120.0 seconds

QUESTION: 010 (4.00)

The reactor power has increased from 15 watts to 50 KW in 243 seconds. Which one of the following is the stable reactor period which resulted in the power change?

a) 10 second

b) 30 second

c) 202 second

d) 293 second

******* CATEGORY A CONTINUED ON NEXT PAGE *******

A. Reactor Theory, Thermo, & Facility Op. Chars.

QUESTION: 011 (4.00)

Which one of the following is a benefit provided by photo-neutrons?

a) Serve as a start-up source, thereby removing the need for an external source.

b) Contribute to Tritium production, thereby allowing detection of fuel leakage.

c) Increase the effective core burn-up, thereby providing better fuel utilization.

d) Increase the ratio of prompt to delayed neutrons, thereby increasing reactor control.

QUESTION: 012 (4.00)

Assuming the Samarium worth is 0.006 ΔK/K at full power, which one of the following is the Samarium worth 10 days after shutdown?

a) Essentially Zero

b) Essentially 0.006 ΔK/K

c) Less than 0.006 ΔK/K, but greater than zero

d) Greater than 0.006 ΔK/K

******* CATEGORY A CONTINUED ON NEXT PAGE *******

A. Reactor Theory, Thermo, & Facility Op. Chars.

QUESTION: 013 (4.00)

Both the Demineralizer room and the Heat Exchanger room are "high radiation" areas when the reactor is operating at full power. This is caused by:

a) Direct radiation from the reactor

b) N-16 activity produced in the water as it passes through the reactor

c) Ar-41 activity produced in the water from dissolved air

d) Na-24 activity produced from activation of aluminum

QUESTION: 014 (4.00)

During a reactor start-up, equal increments of reactivity are added after allowing the count rate to reach equilibrium following each reactivity addition. Which statement below describes what the operator should observe on the Source Range Instrument?

a) The change in equilibrium count rate is the same while the time to reach equilibrium is shorter for the later reactivity addition

b) The change in equilibrium count rate is larger while the time to reach equilibrium is longer for the later reactivity addition

c) The change in equilibrium count rate is smaller while the time to reach equilibrium is longer for the later reactivity addition

d) The change in equilibrium count rate is larger and the time to reach equilibrium is shorter for the later reactivity addition

******* CATEGORY A CONTINUED ON NEXT PAGE *******

A. Reactor Theory, Thermo, & Facility Op. Chars.

QUESTION: 015 (4.00)

The UVAR core is being reloaded with new fuel and the following data has been taken:

Number of elements	Detector A (cpm)	Detector B (cpm)
0	16	30
6	22	32
12	29	37
18	48	60
24	150	177

What is the approximate number of fuel elements that will be required to achieve criticality?

a) 27

b) 30

c) 33

d) 36

QUESTION: 016 (4.00)

Which one of the following terms of the six factor formula is most affected by "Poisons"?

a) Fast Fission Factor

b) Thermal Utilization Factor

c) Thermal Non-Leakage Probability

d) Reproduction Factor

******* CATEGORY A CONTINUED ON NEXT PAGE *******

A. Reactor Theory, Thermo, & Facility Op. Chars.

QUESTION: 017 (4.00)

When the reactor is critical and a control rod is withdrawn, the initial indicated period is much shorter than the stable period that develops after some period of time. The initial shorter period is caused by:

a) Delayed neutrons

b) N-16 activity

c) Xenon buildup

d) Prompt neutrons

QUESTION: 018 (4.00)

Which one of the following statements most accurately describes the effect of the doppler coefficient of reactivity as temperature increases?

a) More neutrons are absorbed in the resonance absorption region because the capture cross section peaks become broader

b) More neutrons are absorbed in the resonance absorption region because the capture cross section peaks become narrower

c) Less neutrons are absorbed in the resonance absorption region because the capture cross section peaks become broader

d) Less neutrons are absorbed in the resonance absorption region because the capture cross section peaks become narrower

******* CATEGORY A CONTINUED ON NEXT PAGE *******

A. Reactor Theory, Thermo, & Facility Op. Chars.

QUESTION: 019 (4.00)

The reactor is critical at low power when a control rod is withdrawn and the power rises on a stable 40 second period. Two minutes later the power is at 5 KW. What power was the reactor at before the rod was withdrawn?

a) ≈ 100 watts

b) ≈ 175 watts

c) ≈ 250 watts

d) ≈ 500 watts

QUESTION: 020 (4.00)

The reactor is critical at 250 KW when a control rod is withdrawn and the power rises on a 200 second period. If the operator takes no further action, what will happen to the reactor?

a) The reactor will scram on high power at 125%

b) The power will probably level off below 2 MW due to temperature effects

c) As the power rises, the period will get progressively shorter and the reactor will scram on a short period of 3.5 seconds

d) The core gamma monitor will alarm and insert the rods automatically

******* CATEGORY A CONTINUED ON NEXT PAGE *******

A. Reactor Theory, Thermo, & Facility Op. Chars.

QUESTION: 021 (4.00)

Rods are continuously withdrawn to give a constant reactivity addition rate of 10^{-4} Delta K/K per second. With no temperature effects and the initial power level at 200 watts the reactor would scram on_____. However, if the initial power was 400 watts, the reactor would scram on _____.

a) High Power, Short Period

B) Low Flow, High Temperature

C) Short Period, High Power

D) High Temperature, Low Flow

QUESTION: 022 (4

Assume a moderator coefficient of reactivity equal to 1.5 x 10^{-4} $\Delta k/k$-°F with the reactor operating at 1.5 Mw. Which of the following is the closest to the amount of regulating rod movement for a moderator temperature increase of 10 °F?

A) 1 INCH

B) 2 INCHES

C) 5 INCHES

D) 10 INCHES

******* CATEGORY A CONTINUED ON NEXT PAGE *******

A. Reactor Theory, Thermo, & Facility Op. Chars.

QUESTION: 023 (4.00)

Which of the following is a correct statement concerning Doppler Broadening?

A) Neutron absorption by the target is dependent on the temperature of the target and independent of the neutron energy.

B) An increase in the target temperature results in thermal expansion that increases the space between the target atoms causing a smaller target area for neutrons.

C) An increase in the target temperature results in an increase in the vibration of target atoms causing the target atoms to appear larger to incoming neutrons

D) Neutron absorption by the target is dependent on the temperature of the target and independent of the isotopic makeup of the target.

QUESTION: 024 (4.00)

The reactor is subcritical with a K_{eff} of 0.999 and an equilibrium count rate of 6000 cps. Enough positive reactivity is added to increase the equilibrium count rate to 12000 cps with the reactor still subcritical. The same amount of **reactivity** is <u>again</u> added to the core. Which of the following is the condition of the core after the second reactivity addition?

A) Subcritical with a count rate of 18000 cps.

B) Subcritical with a count rate of 24000 cps.

C) Just critical.

D) Supercritical with count rate increasing.

******* CATEGORY A CONTINUED ON NEXT PAGE *******

A. Reactor Theory, Thermo, & Facility Op. Chars.

QUESTION: 025 (4.00)

Which one of the following statements describes how Samarium reactivity is effected by power level?

A) The EQUILIBRIUM (at power) value of Samarium is DEPENDENT upon power level. The PEAK value of Samarium following a shutdown is DEPENDENT of power level prior to the shutdown.

B) The EQUILIBRIUM (at power) value of Samarium is DEPENDENT upon power level. The PEAK value of Samarium following a shutdown is INDEPENDENT of power level prior to the shutdown.

C) The EQUILIBRIUM (at power) value of Samarium is INDEPENDENT of power level. The PEAK value of Samarium following a shutdown is DEPENDENT upon power level prior to the shutdown.

D) The EQUILIBRIUM (at power) value of Samarium is INDEPENDENT of power level. The PEAK value of Samarium following a shutdown is INDEPENDENT of power level prior to the shutdown.

******* END OF CATEGORY A *******

B. Procedures and Radiological Control

QUESTION: 001 (4.00)

What radiation limits are placed on irradiated samples being transported through the pneumatic transfer system?

a) 50 mr/hr

b) 140 mr/hr

c) 240 mr/hr

d) 500 mr/hr

QUESTION: 002 (4.00)

What constitutes a core configuration change?

a) Any reactivity change greater than 0.01 % Delta K/K that does not involve unsecured experiments

b) Any reactivity change greater than 0.10 % Delta K/K that does not involve unsecured experiments

c) Any installation of a new experiment

d) Any time the reactor has been operated for 500 MW-hr

******* CATEGORY B CONTINUED ON NEXT PAGE *******

B. Procedures and Radiological Control

QUESTION: 003 (4.00)

The reactor bridge monitor will scram the reactor and isolate the reactor room if the radiation level at the top of the pool exceeds:

a) 10 mr/hr

b) 20 mr/hr

c) 30 mr/hr

d) 40 mr/hr

QUESTION: 004 (4.00)

The shim rod drop times are measured:

a) If a fuel element is added to the core

b) Annually

c) Semi-annually or if the rods are moved to a new position or if maintenance is performed on the mechanism

d) Whenever a new experiment is added to the reactor

******* CATEGORY B CONTINUED ON NEXT PAGE *******

B. Procedures and Radiological Control

QUESTION: 005 (4.00)

You are operating the reactor at 100 KW in the natural circulation mode when an experimenter requests that you increase the power to 2 MW to activate samples. You should:

a) Raise the header, start the primary pump and increase power

b) Make sure an IRF form has been properly filled out and signed and then raise power

c) Make sure the duct monitor is turned on and then raise power

d) Shut down the reactor, raise the header, energize the primary pump and start up again

QUESTION: 006 (4.00)

When loading fuel, no reactor core shall be taken critical with the shim rods below 10 inches and the regulating rod fully withdrawn. Which one of the following is the basis for this restriction?

a) This assures that the reactor will not go critical when pulling shim rods two at a time during start-up

b) This assures that sufficient excess reactivity is available to operate the reactor for long periods of time

c) This assures that shim and regulating rod positions at 100 % power will maximize fuel burn-up

d) This assures the regulating rod will remain in the operating band.

******* CATEGORY B CONTINUED ON NEXT PAGE *******

B. Procedures and Radiological Control

QUESTION: 007 (4.00)

The shim rods are visually inspected:

a) Quarterly

b) Semi-annually

c) Annually

d) Bi-annually

QUESTION: 008 (4.00)

Which one of the following defines "xenon free" conditions for the core?

a) Xenon worth less than 0.1% delta K/K

b) Xenon worth less than 0.2% delta K/K

c) All of the fuel in the reactor has not been at a power above 1 KW for the last 96 hours

d) All of the fuel in the reactor has not been at a power above 1 MW for the last 48 hours

QUESTION: 009 (4.00)

In order to maintain ALARA, the University limits personnel radiation exposure to:

a) 500 mr/yr

b) 5 R/yr

c) 100 mr/yr

d) 250 mr/yr

******* CATEGORY B CONTINUED ON NEXT PAGE *******

B. Procedures and Radiological Control

QUESTION: 010 (4.00)

You are working 2 feet from an unshielded 25 millicurie gamma source with a disintegration energy of 2 Mev. How long can you work there and not exceed 50 mrem exposure?

a) 10 minutes

b) 25 minutes

c) 40 minutes

d) 1 hour

QUESTION: 011 (4.00)

You are asked to activate a Co-59 sample to produce Co-60 that gives a dose rate of 100 mr/hr at 3 feet (disintegration energies of 1.33 Mev and 1.17 Mev given off 100% of the time). What would be the source strength in millicuries?

a) 25 millicuries

b) 60 millicuries

c) 75 millicuries

d) 100 millicuries

******* CATEGORY B CONTINUED ON NEXT PAGE *******

B. Procedures and Radiological Control

QUESTION: 012 (4.00)

Which one of the following amounts of radiation would be most damaging to the body?

a) A beta emitting point source of 0.5 mrad per hour on contact

b) An alpha emitting point source of 0.5 mrad per hour on contact

c) A gamma emitting point source of 10 mrad per hour on contact

d) A fast neutron emitting point source of 10 mrad per hour on contact

QUESTION 013 (4.00)

Which one of the following is a condition that requires a senior operators presence at the facility?

a) Planned shutdowns

b) Removal of an experiment from the reactor

c) Discharging liquid waste from the facility

d) Recovery from a shutdown due to an unplanned scram

******* CATEGORY B CONTINUED ON NEXT PAGE *******

B. Procedures and Radiological Control

QUESTION: 014 (4.00)

The total shutdown margin of the reactor is the degree of sub-criticality with all of the rods fully inserted. The shutdown margin as required by the Technical Specifications is different. How do we adjust the total shutdown margin to ascertain if we meet the Tech. Spec. requirement of > -0.4 % delta K/K?

a) Add the worth of the highest worth rod and the regulating rod

b) Subtract the worth of Shim rod #3 and the regulating rod

c) Subtract the worth of the highest worth rod and the worth of the regulating rod

d) Subtract the worth of the rods at their critical positions

QUESTION: 015 (4.00)

The reactor is started up after being shutdown for 2 weeks. After reaching full power, all indications are that the reactor is at 2 MW, except both power range channels are reading 90 %. The operator should:

a) Call two staff members to adjust the power range detectors until they read 100 %

b) Shut the reactor down immediately and call a reactor supervisor

c) Increase the power until both power range channels read 100 %

d) Do nothing since this is a conservative reading

******* CATEGORY B CONTINUED ON NEXT PAGE *******

B. Procedures and Radiological Control

QUESTION: 016 (4.00)

The reactor is about to be started up and operated at 1 KW, but the pool temperature system is inoperable. The following action should be taken by the operator:

a) The reactor can be operated at this power since the pool temperature system is only required in the forced circulation mode

b) The reactor can still be operated since the pool temperature can be determined from the "Yellow Springs" instrument

c) The reactor can be operated if the operator has a staff member monitor the pool temperature with a thermometer

d) The reactor cannot be operated since the pool temperature system is required for all modes of operation

QUESTION: 017 (4.00)

The U.Va. hospital requests 163 millicuries of Au-198 for treatment of a cancer patient. The disintegration energy is 0.41 Mev. What is the ≈ dose rate at 1 foot, when removed from the reactor?

a) 200 mr/hr

b) 300 mr/hr

c) 400 mr/hr

d) 500 mr/hr

******* CATEGORY B CONTINUED ON NEXT PAGE *******

B. Procedures and Radiological Control

QUESTION: 018 (4.00)

Given Iodine has a biological half-life of ≈138 days and a radiological half-life of ≈ 8 days, then, theoretically, one-half (1/2) of any ingested/inhaled Iodine-131 atoms would remain in an individual after approximately:

a) 130.2 days (effectively the biological minus the radiological)

b) 61.3 days (effectively 1/2 the biological minus radiological)

c) 8.0 days (effectively "the lesser" of the two (2) half-lives)

d) 7.6 days (effective half-life of biological and radiological)

QUESTION: 019 (4.00)

Given that the "Exposure Rate Constant" for Cobalt-60 is equal to ≈13.2 Roentgens/cm^2/hr/mci, at what minimum distance would an individual need to stand from a two (2) curie point source such that the individual's exposure rate would be held to less than 50 mr/hr?

a) 10.5 feet

b) 18.3 feet

c) 23.8 feet

d) 35.4 feet

******* CATEGORY B CONTINUED ON NEXT PAGE *******

B. Procedures and Radiological Control

QUESTION: 020 (4.00)

A lead slab is placed between a point source and a radiation worker causing the radiation level to drop from 500 mrem/hr to 100 mrem/hr as detected by the worker. If two (2) more identical slabs were placed between the point source and the worker, what would be the radiation level detected by the worker?

a) One (1) mrem/hr

b) Four (4) mrem/hr

c) Ten (10) mrem/hr

d) Twenty (20) mrem/hr

QUESTION: 021 (4.00)

Detection of which of the following isotopes is least likely to indicate a fission product release?

a) I-131

b) Rb-85

c) Xe-133

d) Mn-56

******* CATEGORY B CONTINUED ON NEXT PAGE *******

B. Procedures and Radiological Control

QUESTION: 022 (4.00)

A fuel cladding failure is indicated by increased fission product activity in the pool. Which of the following actions should be taken to determine which fuel element(s) is (are) leaking

a) Reduce reactor power to less than 1 MW and monitor the pool for decreased activity.

b) Take a sample above each element until the suspect fuel element(s) is (are) located, then shut down the reactor.

c) Shut down the reactor and take a sample above each fuel element to determine which fuel element(s) is (are) leaking.

d) Increase pool sampling frequency to hourly intervals, and shutdown the reactor if two successive samples increase in activity.

QUESTION: 023 (4.00)

An emergency has occurred requiring the evacuation of the facility. Which on of the following individuals (by title) is responsible for authorizing re-entry into the facility.

a) Radiation Safety Officer

b) Facility Director (Emergency Director)

c) Reactor Health Physicist

d) Reactor Supervisor (Emergency Coordinator)

******* CATEGORY B CONTINUED ON NEXT PAGE *******

B. Procedures and Radiological Control

QUESTION: 024 (4.00)

During an inspection of the core at the 500 KW power level, air bubbles are observed on the core. Which of the following methods should be used to remove the bubbles?

a) Gradually increase power to 1 MW, observing the core to assure the air bubbles have been removed.

b) Reduce power to sub-critical, return to 500 KW and observe that the air bubbles have been removed.

c) Shutdown the reactor, observe that the air bubbles have been removed and call the cognizant senior operator.

d) Shutdown the reactor, stop the primary pump and observe that the air bubbles have been removed.

QUESTION: 025 (4.00)

During reactor power operation the "RAD ZONE ENTRY" alarm is annunciated. Which one of the following will initiate the alarm?

a) The electric eye system in the neutron beam port blockhouse.

b) The entry alarm on the demineralizer room door.

c) The entry alarm on the neutron beam port room.

d) The entry alarm on the truck door entrance to the reactor room.

******* END OF CATEGORY B *******

C. Facility and Radiation Monitoring Systems

QUESTION: 001 (4.00)

An operator attempts to start up the reactor but the rod interlock system prevents rod withdrawal. What should the operator do?

a) Check that the Sb-Be source is installed in the reactor

b) Check all instruments to make sure that none are in the by-pass position

c) Check the position of the fission chamber to make sure it is fully inserted

d) All of the above

QUESTION: 002 (4.00)

The core Gamma monitor utilizes the following detector:

a) Ion chamber

b) Geiger tube

c) Compensated ion chamber

d) Sodium Iodide Crystal

******* CATEGORY C CONTINUED ON NEXT PAGE *******

C. **Facility and Radiation Monitoring Systems**

QUESTION: 003 (4.00)

The N-16 detector is located in the heat exchanger room and is used to measure:

a) Fission product activity

b) Ar-41 from absorbed air in the primary water

c) Nitrogen activity produced by the activation of oxygen in the primary water

d) Na-24 from the activation of aluminum components in the system

QUESTION: 004 (4.00)

The return line of the primary water to the pool is directed by a flow diverter toward the wall that is the greatest distance from the reactor. Which one of the following is the reason for this flow diversion?

a) Prevents thermally induced power oscillations by preventing cooler water from impinging on the fuel

b) Minimizes the Nitrogen 16 gamma activity at the surface of the pool by providing better mixing

c) Minimizes vibration of the core by preventing water exiting close to the core

d) Prevents thermal stratification by causing pool turbulence when deflecting off the wall

******* CATEGORY C CONTINUED ON NEXT PAGE *******

C. Facility and Radiation Monitoring Systems

QUESTION: 005 (4.00)

Which one of the following conditions will result from a short circuit in the Silicon Controlled Rectifiers (SCR's) in the Solid State Relay modules?

a) A short circuit in one SCR will result in current being supplied to the associated safety rod even if an unsafe input is applied

b) A short circuit in one SCR will result in all safety rods being scrammed

c) A short circuit in both SCR's will result in current being supplied to the scram magnets even if an unsafe input is applied

d) A short circuit in both SCR'S will result in all safety rods being scrammed

QUESTION: 006 (4.00)

Four grooves are cut in each side of an absorbing section of a shim rod. Which one of the following is the design basis for these grooves?

a) Provide coolant flow channels to maintain minimum temperature increase in the rod during operation

b) Allow for thermal expansion of the rod during high power operation

c) Minimize hydriding of the stainless steel due to prolonged exposure to primary coolant at elevated temperatures

d) To increase the surface area for the absorption of neutrons during reactor operation

******* CATEGORY C CONTINUED ON NEXT PAGE *******

C. Facility and Radiation Monitoring Systems

QUESTION: 007 (4.00)

Which statement below regarding the UVAR forced circulation system is INCORRECT?

a) The primary pump is a centrifugal pump with a maximum flow rate of 1000 gpm

b) The air operated header can only be positioned when the reactor is in the south end of the pool

c) The air operated header is held in place by differential pressure caused by downward flow of cooling water

d) When establishing forced circulation flow, the air lift pressure for the header must drop below 2 psi to allow reactor start-up

QUESTION: 008 (4.00)

Which of the following is NOT a daily check performed on portable survey meter?

a) Response check

b) Calibration check

c) Zero check

d) Battery check

******* CATEGORY C CONTINUED ON NEXT PAGE *******

C. Facility and Radiation Monitoring Systems

QUESTION: 009 (6.00)

Fill in the blanks concerning the emergency cooling system

There shall be ___A___ separate emergency core spray systems, each capable of maintaining a flow rate of at least ___B___ gpm over the ___C___ grid plate positions for the first ___D___ minutes, and at least ___E___ gpm over the grid plate positions for the next ___F___ minutes following a total loss of coolant.

QUESTION: 010 (4.00)

The reactor room ventilation exhaust vent and the personnel door become part of the reactor room isolation in the event of high radiation. Which one of the following describes the mechanism by which the vent and door are closed for a high radiation condition?

a) The vent and door are held open by a pneumatic cylinder which is depressurized on high radiation in the ventilation exhaust duct, closing the vent and door

b) The vent and door are held open by a solenoid operated mechanical latch which releases on high radiation detected on the constant air monitor

c) The vent and door are opened manually and held open by a magnet which releases on high radiation at the reactor bridge

d) The vent and door are held open by ventilation air flow which is stopped by a trip of the ventilation fans on high radiation in the ventilation exhaust duct

******* CATEGORY C CONTINUED ON NEXT PAGE *******

C. Facility and Radiation Monitoring Systems

QUESTION: 011 (4.00)

Which one of the following ranges of nuclear instrumentation utilizes a compensated ion chamber as the neutron detection device?

a) Source range

b) Intermediate range

c) Power range

d) N-16 detector

QUESTION: 012 (4.00)

Which one of the following fuel configurations will provide the highest neutron flux in the core?

a) A 4x4 array including the four control rod assemblies with water as a reflector

b) A 4x4 array including the four control rod assemblies with 48 graphite assemblies surrounding the 4x4 array

c) A 4x5 array including the four control rod assemblies with water as a reflector

d) A 4x5 array including the four control rod assemblies with 44 graphite assemblies surrounding the 4x5 array

******* CATEGORY C CONTINUED ON NEXT PAGE *******

C. Facility and Radiation Monitoring Systems

QUESTION: 013 (4.00)

Which one of the following parameters is NOT an input to the Mixer Driver relay?

a) Pool level

b) Period

c) Minimum 2 cps signal from Source Range circuitry

d) Pool temperature

QUESTION: 014 (4.00)

The ventilation duct-work leading from the experimental facilities is equipped with an internal radiation monitor. Which one of the following describes the type and operation of the monitor?

a) The instrument is a thin-walled scintillation detector sensitive to low levels of Beta-Gamma radiation and isolates the duct-work on a count rate of 800 cpm

b) The instrument is a thin walled G-M tube sensitive to Beta radiation and alarms in the control room on a count rate of 800 cpm

c) The instrument is a thin walled scintillation detector sensitive to Beta radiation and alarms in the control room on a count rate of 100 cps above background

d) The instrument is a thin walled G-M tube sensitive to low levels of Beta-Gamma radiation and isolates the duct at 100 cps above background

******* CATEGORY C CONTINUED ON NEXT PAGE *******

C. Facility and Radiation Monitoring Systems

QUESTION: 015 (4.00)

Which one of the following is NOT a surveillance requirement for the UVAR safety system?

a) A channel test of each of the reactor safety system measuring channels shall be performed before each day's operation or before each operation extending for more than one day

b) A channel check of each of the reactor safety system measuring channels shall be performed daily when the reactor is in operation

c) A channel calibration of the reactor safety system measuring channels shall be performed annually

d) Power Range channels #1 and #2 shall be checked against a primary heat balance at least once each week the reactor is in operation above 100 KW in the forced convection mode

QUESTION: 016 (5.00)

Which one of the following failures does NOT require the shutdown of the reactor as an IMMEDIATE ACTION?

a) A pool water level monitor is sticking at 19'4"

b) The solid state relay failure lights comes on

c) A shim rod will not move from 10" in or out

d) The pool temperature is at 100° F and rising

******* CATEGORY C CONTINUED ON NEXT PAGE *******

C. Facility and Radiation Monitoring Systems

QUESTION. 017 (5.00)

The buildup of Argon-41 in the North Neutron Beamport has been minimized by a modification. Which one of the following describes the method used to minimize the Argon-41 buildup?

a) A constant purge flow of air is circulated through the beamport during operation and exhausted to the stack

b) When the front tube is drained it is filled with Helium gas eliminating air activation in the tube

c) The front tube is filled with demineralized water during operation to minimize neutron activation

d) A Boron Paraffin sleeve surrounds the experiment to be irradiated to minimize the air activation

QUESTION: 018 (5.00)

The core gamma monitor is located ≈7 feet above the reactor. Which of the following is the reason for this?

a) The monitor is located 7 feet from the reactor to minimize activation of the detector and conserve gas in the chamber

b) The monitor detects radiation from fission products in the core and is relatively insensitive to changes in core configuration or rod positions, making it a good backup power monitor

c) The detector is placed far enough away from the reactor so that it is only sensitive to fast neutrons, making it a good flux monitor

d) The detector is placed far enough away from the core so that the Sb-Be neutron source will have little effect on the response

******* CATEGORY C CONTINUED ON NEXT PAGE *******

C. Facility and Radiation Monitoring Systems

QUESTION: 019 (5.00)

Which one of the following statements describes the method for maintaining the level and purity of the water in the Emergency Cooling System tanks?

a) The discharge of the primary coolant pump supplies flow through a small line into the tanks causing overflow into the pool

b) A small flow of city water into the tanks causes the tanks to overflow into the pool

c) Convective flow within the tanks prevents stagnation and minimizes corrosion

d) Continuous flow through a discharge line from the demineralizer enters the tanks causing a slight flow through the spray headers

QUESTION: 020 (5.00)

You are operating the UVAR at 2 MW when both SSR failure lights come on. What would be the easiest way to shut the reactor down?

a) Unplug the rod drive cables at the reactor bridge.

b) Turn off the power to the console at the breaker.

c) Actuate the console manual scram button and insert the regulating rod by manual control.

d) Reduce the magnet current to the shim rods to zero and insert the regulating rod by manual control.

******* CATEGORY C CONTINUED ON NEXT PAGE *******

C. Facility and Radiation Monitoring Systems

QUESTION: 021 (4.00)

Which one of the following describes the operation of the rod withdrawal interlock?

a) If source range count rate drops below 2 counts per second (cps) the Auxiliary Control Relay (ACR) output increases from zero to +10 volts preventing the withdrawal of any rod.

b) A +10 volt signal is generated if any neutron monitoring channel is in test, de-energizing the regulating rod drive motor.

c) A reactor period of less than 10 seconds de-energized the shim rod drive motors, preventing rod withdrawal.

d) If source range count rate is less than 2 cps, or any neutron monitoring channel is in test, withdrawal of any shim rod is prevented.

QUESTION: 022 (4.00)

Which one of the following is a description of the operation of the primary coolant header?

a) The header is raised and held in place at the reactor grid plate by 50 psig air pressure.

b) The header is held in place by the diferential pressure generated by coolant flowing down through the core.

c) A trip of the Primary Pump de-energizes an electro-magnet that holds the header in position, thereby allowing the header to drop.

d) Stopping the Primary Pump vents the air from the header operating system, thereby allowing the header to drop.

******* CATEGORY C CONTINUED ON NEXT PAGE *******

C. Facility and Radiation Monitoring Systems

QUESTION: 023 (5.00)

A fueled experiment is being irradiated in the reactor pool when a failure of the experiment releases fission byproducts. By what detector would the release be detected and what (if any) automatic action would be initiated?

a) Either of two air monitoring instruments sense the fission product release and provide automatic closure of the reactor room.

b) A gamma sensitive ion chamber just above the reactor pool provides automatic closure of the reactor room and a reactor trip on high gamma level.

c) Either of two air monitoring instruments sense the fission product release and provide a reactor trip.

d) A gamma sensitive ion chamber just above the reactor pool provides an alarm in the control room allowing the operator to take action on high gamma level.

******* END OF CATEGORY C *******
********** END OF EXAMINATION **********

ANSWER SHEET

Part 1. Theory	Part 2. Procedures & Radiological Control	Part 3. Facility & Monitoring Systems
1. A B C D	1. A B C D	1. A B C D
2. A B C D	2. A B C D	2. A B C D
3. A B C D	3. A B C D	3. A B C D
4. A B C D	4. A B C D	4. A B C D
5. A B C D	5. A B C D	5. A B C D
6. A B C D	6. A B C D	6. A B C D
7. A B C D	7. A B C D	7. A B C D
8. A__ B__ C__ D__	8. A B C D	8. A B C D
9. A B C D	9. A B C D	9. A___ B___ C___ D___ E___ F___
10. A B C D	10. A B C D	10. A B C D
11. A B C D	11. A B C D	11. A B C D
12. A B C D	12. A B C D	12. A B C D
13. A B C D	13. A B C D	13. A B C D
14. A B C D	14. A B C D	14. A B C D
15. A B C D	15. A B C D	15. A B C D
16. A B C D	16. A B C D	16. A B C D
17. A B C D	17. A B C D	17. A B C D
18. A B C D	18. A B C D	18. A B C D
19. A B C D	19. A B C D	19. A B C D
20. A B C D	20. A B C D	20. A B C D
21. A B C D	21. A B C D	21. A B C D
22. A B C D	22. A B C D	22. A B C D
23. A B C D	23. A B C D	23. A B C D
24. A B C D	24. A B C D	
25. A B C D	25. A B C D	

Part A. Reactor Theory, Thermo, & Facility Op. Chars.

Answer: 001 (4.00) **B** Reference: Reactor Theory for the Reactor Training Program

Answer: 002 (4.00) **C** Reference: ibid 001

Answer: 003 (4.00) **C** Reference: ibid 001

Answer: 004 (4.00) **D** Reference: ibid 001

Answer: 005 (4.00) **C** Reference: ibid 001

Answer: 006 (4.00) **D** Reference: ibid 001

Answer: 007 (4.00) **D** Reference: General Theory

Answer: 008 (4.00) Reference: General Theory

A (1.00) **7**
B (1.00) **4**
C (1.00) **6**
D (1.00) **5**

Answer: 009 (4.00) **C** Reference: ibid 001

Answer: 010 (4.00) **B** Reference: ibid 001

Answer: 011 (4.00) **A** Reference: General Theory

Answer: 012 (4.00) **D** Reference: ibid 001

Answer: 013 (4.00) **B** Reference: General Theory

Answer: 014 (4.00) **B** Reference: General Theory

Answer: 015 (4.00) **A** Reference: ibid 001

Answer: 016 (4.00) **B** Reference: ibid 001

******* CATEGORY A CONTINUED ON NEXT PAGE *******

Part A. Reactor Theory, Thermo, & Facility Op. Chars.

Answer: 017 (4.00) D Reference: ibid 001

Answer: 018 (4.00) A Reference: Lamarsh, Introduction to Nuclear Engineering; 2nd Ed.

Answer: 019 (4.00) C Reference: ibid 001

Answer: 020 (4.00) B Reference: ibid 001

Answer: 021 (4.00) C Reference: UVAR Design & Analysis Handbook

Answer: 022 (4.00) D Reference: ibid 001

Answer: 023 (4.00) C Reference: ibid 018

Answer: 024 (4.00) C Reference: ibid 001

Answer: 025 (4.00) C Reference: ibid 001

Total Points Section A (100.00)

******* END OF CATEGORY A *******

B. Procedures and Radiological Control

Answer: 001 (4.00) C Reference: UVAR Maintenance folder

Answer: 002 (4.00) A Reference: UVAR SOP 5.4.1

Answer: 003 (4.00) C Reference: UVAR SOP 11.S Table 11.S.1

Answer: 004 (4.00) C Reference: UVAR SOP 7.3

******* CATEGORY B CONTINUED ON NEXT PAGE *******

B. Procedures and Radiological Control

Answer:	005 (4.00)	D	Reference:	UVAR Design & Analysis Handbook
Answer:	006 (4.00)	A	Reference:	UVAR SOP 5.4.2.A
Answer:	007 (4.00)	C	Reference:	UVAR Technical Specifications, 4.1
Answer:	008 (4.00)	C	Reference:	UVAR SOP 5.6
Answer:	009 (4.00)	A	Reference:	ibid 005
Answer:	010 (4.00)	C	Reference:	General Theory
Answer:	011 (4.00)	B	Reference:	General Theory
Answer:	012 (4.00)	D	Reference:	10 CFR 20.5
Answer:	013 (4.00)	D	Reference:	UVAR SOP 3.5
Answer:	014 (4.00)	C	Reference:	UVAR SOP 5.5.B
Answer:	015 (4.00)	A	Reference:	UVAR SOP 11.F
Answer:	016 (4.00)	D	Reference:	ibid 003
Answer:	017 (4.00)	C	Reference:	General Theory
Answer:	018 (4.00)	D	Reference:	General Theory
Answer:	019 (4.00)	C	Reference:	General Theory
Answer:	020 (4.00)	B	Reference:	General Theory
Answer:	021 (4.00)	D	Reference:	General Theory
Answer:	022 (4.00)	C	Reference:	UVAR SOP 11.R
Answer:	023 (4.00)	B	Reference:	UVAR Emergency Plan 3.2.2

******* CATEGORY B CONTINUED ON NEXT *******

B. Procedures and Radiological Control

Answer: 024 (4.00) D Reference: UVAR SOP 11.I

Answer: 025 (4.00) B Reference: UVAR SOP 11.C

Total Points Section B (100.00)

******* END OF CATEGORY B *******

C. Facility and Radiation Monitoring Systems

Answer: 001 (4.00) D Reference: UVAR Design & Analysis Handbook

Answer: 002 (4.00) A Reference: ibid 001

Answer: 003 (4.00) C Reference: ibid 001

Answer: 004 (4.00) B Reference: ibid 001

Answer: 005 (4.00) C Reference: ibid 001

Answer: 006 (4.00) D Reference: ibid 001

Answer: 007 (4.00) A Reference: ibid 001

Answer: 008 (4.00) B Reference: ibid 001

Answer: 009 (6.00) Reference: ibid 001

A (1.00) 2
B (1.00) 10
C (1.00) 64
D (1.00) 30
E (1.00) 7½
F (1.00) 60

Answer: 010 (4.00) C Reference: ibid 001

******* CATEGORY C CONTINUED ON NEXT PAGE *******

C. Facility and Radiation Monitoring Systems

Answer: 011 (4.00) B Reference: ibid 001

Answer: 012 (4.00) B Reference: ibid 001

Answer: 013 (4.00) C Reference: ibid 001

Answer: 014 (4.00) B Reference: ibid 001

Answer: 015 (4.00) C Reference: ibid 001

Answer: 016 (5.00) D Reference: UVAR SOP 11.M

Answer: 017 (5.00) B Reference: ibid 001

Answer: 018 (5.00) B Reference: ibid 001

Answer: 019 (5.00) D Reference: ibid 001

Answer: 020 (5.00) C Reference: ibid 001

Answer: 021 (4.00) D Reference: ibid 001

Answer: 022 (4.00) B Reference: ibid 001

Answer: 023 (5.00) B Reference: ibid 001

Total Points Section C (100.00)

******* END OF CATEGORY C *******

********** END OF EXAMINATION **********