U.S. NUCLEAR REGULATORY COMMISSION
REGION I

Examination Report No. 88-03 (OL)

Facility Docket No. 50-170

Facility License No. R-84

Licensee: Armed Forces Radiobiology Research Institute (AFFRI)

Facility: Armed Forces Radiobiology Research Institute Reactor

Examination Date: July 21, 1988

Chief Examiner: ______________________________ ____________
David Wallace — date
Operations Engineer (Examiner)

Approved By: ______________________________ ____________
Peter W. Eselgroth, Chief — date
PWR Section, Operations Branch, DRS

Summary: A written examination was administered to one Senior Reactor Operator (SRO). The candidate passed the examination.

DETAILS

Type of Examination: Retake

Examination Results: The SRO candidate passed the written exam. (Operating exam had been previously passed and was waived).

1. Chief Examiner At Site: David Wallace

2. Personnel Present at Exit Interview:

   USNRC

   D. Wallace

   AFFRI

   M. Moore

Attachments:
1. Written Examination and Answer Key
2. NRC reply to Facility comment and modifications to the written examination after the facility review.

ATTACHMENT 2

Facility written comments and NRC resolutions for the AFRRI senior reactor operations exam administered on July 21, 1988.

Question H.02

Facility Comment:

"AFRRI Uses an AmBe neutron source because of its long half-life. The situation presented in this question is not relevant to our reactor. We do not use the term power level to indicate the subcritical multiplication level, we use the term source level. The "power level of the present startup" is confusing. It could be interpreted as the startup neutron population, but more likely, our staff interprets it is as a cold critical conditions. Interpreted as the subcritical neutron population, the source level would be LESS and interpreted as a cold critical condition the power would be about the same."

NRC Resolution:

Comment noted. Question will be deleted.

Questions H.06, b. and c.

Facility Comment:

"Sections b. and c. are irrelevant to the AFRRI TRIGA Reactor."

NRC Resolution:

Comment is not valid. Under unusual conditions sections b. and c. would be relevant.

Question 1.01

Facility Comment:

"The Pneumatic Transfer System is not used, has been removed from the pool and should be deleted from the answer key."

NRC Resolution

Comment noted. Answer Key will be changed.

Question 1.06

Facility Comment:

"The words "high radiation field" and "relatively high levels of contamination" are subjective dependent on: the situation, the actual radiation levels, the radioisotope in question, and the way the individual has been trained. Sections b. and c. could realistically be answered either TRUE or FALSE."

NRC Resolution:

The comment is not valid. The same "subjective" words are used in the referenced procedure. The candidate must be able to interpret the meaning of the procedure.

Question 1.09

Facility Comment:

"This question can be answered either theoretically or practically. In theory, GM detectors are not energy dependent. In reality, we refer to several different detectors (incorrectly) as geiger counters. A trainee is taught to use the 6CEN to get an estimate of the dose expected from a source and to verify this using a "geiger counter". It would not be unexpected to receive either a "SAME" or "HIGHER" response to this question."

NRC Resolution:

Comment is not valid. If an operator uses a GM detector, he or she should understand that it is NOT energy dependent. If an operator uses a detector that is energy dependent, then he or she should also be aware of its capabilities.

Question J.03

Facility Comment:

"The answer to section b. is incorrect. In the event that any/all control rods remain stuck after a pulse, the reactor core would convert into a steady state power operation. At full power (1MW), the temperatures of the fuel safety channels do not exceed 450 degrees C. At maximum calculated power, it is still below the 575 degrees C. scram point as well as the 600 degrees C. Tech Spec limit. The reactor will not scram by temperature scram. In fact, we hold the "tail" of pulses for as long as 15 seconds at which time steady state conditions exist. The power generated would be equivalent to a slightly higher than normal steady state operation."

NRC Resolution:

The comment is valid and will be incorporated into the answer sheet.

Question J.04

Facility Comment:

"This question is misleading. In an exam situation, the pressure could easily cause a 0.2 to be read as a 2.0. First, a false statement is given and then, the examinee is asked "why this limitation is necessary." When the false statement is corrected, there are several additional answers that are acceptable:

1. Minimize corrosion to reactor components.
2. Minimize activation products in pool.
3. Optical purity of water in reactor tank."

NRC Resolution:

The comment is valid in that a false statement is given and then the examinee is asked "why this limitation is necessary". Part a. will be deleted and the answer to part b. will be changed to include the additional answers.

Question J.06

Facility Comment:

"The answer to section b. is incorrect. In Mode 1A-AUTOMATIC, all manual upward motion of control rods is prohibited, therefore nothing would happen."

NRC Resolution:

Comment is valid. Answer Key will be changed.

Question J.07

Facility Comment:

"The answer to section b. is incorrect. In the event of an electrical failure, RAM-a as well as the criticality monitor R-5 are kept in service automatically by a battery backed electrical system."

NRC Comment:

Comment is assumed valid. Answer Key will be changed. It would be helpful to include this information in the operation manual in Chapter 6.

Question J.08

Facility Comment:

"The power defect (referred to at AFRRI as the power coefficient of reactivity) is computed incorrectly. The total power coefficient at 1 MW is \$3.47 (this includes the \$.59 to reach 100 KW). However the question as stated was at the time of the rod insertion what was the K-eff of the core, therefore, the power level has nothing to do with the solution....."

NRC Resolution:

Comments are valid concerning calculation, however, it is doubtful that a candidate would interpret the question to be at the exact moment of shutdown. Since the candidate taking the exam interpreted the question correctly no further comment is necessary. The answer key will be changed to correct the reactivity calculation.

MASTER COPY

U.S. NUCLEAR REGULATORY COMMISSION
SENIOR REACTOR OPERATOR LICENSE EXAMINATION

Facility: AFRRI
Reactor Type: TRIGA MARK-F
Date Administered: 88/06/21
Examiner: Robinson, G.E.
Candidate: ____________

INSTRUCTIONS TO CANDIDATE

Use separate paper for the answers. Write answers on one side only. Staple question sheet on top of the answer sheets. Points for each question are indicated in parentheses after the question. The passing grade requires at least 70% in each category. Examination papers will be picked up six (6) hours after the examination starts.

Category Value	% of Total	Applicant's Score	% of Cat. Value	Category
20.00	20.00	______	______	H. Reactor Theory
20.00	20.00	______	______	I. Radioactive Materials Handling Disposal and Hazards
20.00	20.00	______	______	J. Specific Operating Characteristics
20.00	20.00	______	______	K. Fuel Handling and Core Parameters
20.00	20.00	______	______	L. Administrative Procedures, Conditions and Limitations
100.00	100.00	______	______	Totals

Final Grade _____%

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

____
Candidate's Signature

NRC RULES AND GUIDELINES FOR LICENSE EXAMINATIONS

During the administration of this examination the following rules apply:

- Cheating on the examination means an automatic denial of your application and could result in more severe penalties.
- 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.
- Use black ink or dark pencil <u>only</u> to facilitate legible reproductions.
- Print your name in the blank provided on the cover sheet of the examination.
- Fill in the date on the cover sheet of the examination (if necessary).
- Use only the paper provided for answers.
- Print your name in the upper right-hand corner of the first page of <u>each</u> section of the answer sheet.
- Consecutively number each answer sheet, write "End of Category __" as appropriate, start each category on a <u>new</u> page, write <u>only on one side</u> of the paper, and write "Last Page" on the last answer sheet.
- Number each answer as to category and number, for example, 1.4, 6.3.

10. Skip at least <u>three</u> lines between each answer.
11. Separate answer sheets from pad and place finished answer sheets face down on your desk or table.
12. Use abbreviations only if they are commonly used in facility <u>literature</u>.
13. The point value for each question is indicated in parentheses after the question and can be used as a guide for the depth of answer required.
14. Show all calculations, methods, or assumptions used to obtain an answer to mathematical problems whether indicated in the question or not.
15. Partial credit may be given. Therefore, ANSWER ALL PARTS OF THE QUESTION AND DO NOT LEAVE ANY ANSWER BLANK.
16. If parts of the examination are not clear as to intent, ask questions of the <u>examiner</u> only.
17. You must sign the statement on the cover sheet that indicates that the work is your own and you have not received or been given assistance in completing the examination. This must be done after the examination has been completed.

5. When you complete your examination, you shall:

a. Assemble your examination as follows:

(1) Exam questions on top.

(2) Exam aids - figures, tables, etc.

(3) Answer pages including figures which are part of the answer.

b. Turn in your copy of the examination and all pages used to answer the examination questions.

c. Turn in all scrap paper and the balance of the paper that you did not use for answering the questions.

d. Leave the examination area, as defined by the examiner. If after leaving, you are found in this area while the examination is still in progress, your license may be denied or revoked.

H. REACTOR THEORY

QUESTION H.01 (3.0)

A critical reactor is placed on a stable reactor period of 60 seconds at low power.

a. What is the approximate reactivity which has been inserted? (Assume lambda is 0.1/sec. and beta - effective is 0.007.) SHOW ALL WORK. (1.5)

b. If an additional 0.001 reactivity is added to the supercritical reactor, what would be the resulting DOUBLING TIME. Assume no heating effects. SHOW ALL WORK. (1.5)

QUESTION H.02 (2.5)

Question Deleted

Your reactor has not been operated for a long period of time because of building repairs and other necessary maintenance. The neutron source strength is about half of what it was when the reactor was last started up. ALL OTHER FACTORS are equal when criticality is reached.

a. Is the power level of the present startup GREATER, LESS, or about the SAME as that of the previous startup? Briefly explain your answer. (1.25)

b. Are the critical rod heights for the present startup HIGHER, LOWER, or about the SAME when compared with those of the previous startup? Briefly explain your answer. (1.25)

(***** CATEGORY H CONTINUED ON NEXT PAGE *****)

QUESTION H.03 (2.0)

Your reactor is located in position 567. After several weeks of being shutdown the reactor is taken critical and the rod positions noted. The regulating rod position was at 400 units. The reactor is again shutdown, six days later after maintenance and tests on the primary cooling system, the reactor is again taken critical. A sample worth a NEGATIVE $0.25 has been placed in the core and the pool temperature has decreased by 6 degrees centigrade. If all rods except the regulating rod are placed in the same position of the previous criticality, what would be the new position of the regulating rod when criticality is achieved. Assume no other reactivity changes occur. Useful constants, equations, and reactivity curves are appended to back of the exam. (2.0)

QUESTION H.04 (2.0)

Indicate whether the following statements concerning fission product poisoning are TRUE or FALSE.

a. The amount of positive reactivity needed to overcome the equilibrium value of xenon-135 poisoning at 100 per cent of full power is twice that needed to overcome equilibrium xenon-135 at 50 per cent power. (0.5)

b. When increasing power from 50% power (after extended operation) to 100% power, the xenon-135 concentration initially decreases and then increases. (0.5)

c. The equilibrium value of samarium-149 is NOT dependent on power level. (0.5)

d. Shutting down the reactor from full power does NOT change the samarium-149 concentration. (0.5)

(***** CATEGORY H CONTINUED ON NEXT PAGE *****)

QUESTION H.05 (3.0)

Your reactor is subcritical and K-effective is 0.98. Your startup channel reads 50 cps.

a. When the count rate has increased to 100 cps, what is the new K-effective? SHOW ALL WORK. (2.0)

b. Would the reactor be subcritical, critical, or supercritical if enough reactivity was added to double the count rate again? SHOW ALL WORK. (1.0)

QUESTION H.06 (2.0)

Will the following conditions cause the fuel centerline temperature to increase, decrease, or remain the same? Assume the reactor is operating at 90 per cent of full power. Consider each separately.

a. Reactor power is decreased to 50 per cent. (0.5)

b. Crud builds up on the fuel elements. (0.5)

c. Nucleate boiling occurs on the surface of the fuel element. (0.5)

d. The primary cooling system pump is turned on. (0.5)

QUESTION H.07 (2.5)

With the core in position 231, K-excess is found to be $3.55. The core is then moved to position 567. With the help of the AFRRI parameters and graphs located at the end of this exam, calculate the SHUTDOWN MARGIN of the reactor when in position 567. (2.5)

(***** CATEGORY H CONTINUED ON NEXT PAGE *****)

H. REACTOR THEORY

QUESTION H.08 (1.5)

Your reactor has just reached criticality after being shutdown for two weeks and is placed on a ninety second period. Therafter no rod movement occurs. Later, you find that the power increases by a factor of 10 in 300 seconds. Have you reached the point where temperature effects are noticeable? Justify your answer and show all work. (1.5)

QUESTION H.09 (1.5)

Briefly explain HOW and WHY the worth of a regulating rod would change if another rod is placed adjacent to it. (1.5)

(***** END OF CATEGORY H *****)

I. RADIOACTIVE MATERIALS HANDLING DISPOSAL AND HAZARDS

QUESTION I.01 (3.0)

a. Briefly describe how nitrogen-16 and argon-41 are produced by the operation of your reactor. Include the source(s) of these radioactive isotopes and describe where the source(s) is found. (2.0)

b. Indicate which of the above two radioactive isotopes is more likely to find its way into the environment outside the reactor building. Briefly explain your answer. (1.0)

QUESTION I.02 (3.0)

Work must be performed in Exposure Room 1 where there is a 900 mRem/hr gamma radiation field. The person performing the work is 23 years old and has a lifetime exposure through last quarter of 23 Rem as indicated by his NRC FORM 4 and no exposure this quarter.

a. In accordance with 10CFR20, how long is this person permitted to work in this area? (2.0)

b. In accordance with facility procedures how long is this person permitted to work in this area without obtaining special permission to receive a larger dose? (1.0)

QUESTION I.03 (2.0)

After working in an area for 2 hours, a worker discovers that his pocket dosemeter reads off-scale. He immediately leaves the area. A survey indicates that a radioactive source left out of its shield is reading 1600 mr/hr gamma at a distance of 2 feet. The man had been working about 4 feet from the source. Estimate the dose which the worker received. Show all calculations. (2.0)

(***** CATEGORY I CONTINUED ON NEXT PAGE *****)

QUESTION I.04 (3.0)

List the three conditions which must be satisfied before the exposure rooms may be opened WITHOUT A SAF monitor present. Assume that no radioactive material or equipment is to be removed from the prep area, that the proper entries will be made in the exposure room log, and that the reactor has not been to power in that ER since the last survey. (3.0)

QUESTION I.05 (2.0)

A radioactive sample was taken from the air going into the stack. (Assume only one isotope.)
The sample was counted at the following times:

Time (minutes)	Counts per Minute
Initial Count	900
30	740
60	615
90	512
180	294

What is the half-life of the sample?
SHOW ALL WORK (2.0)

(***** CATEGORY I CONTINUED ON NEXT PAGE *****)

QUESTION I.06 (2.0)

In accordance with AFRRI INSTRUCTION 6310.1F, "Management of Injured and /or Irradiated or Contaminated Personnel, indicate whether the following are TRUE or FALSE.

a. First aid usually takes precedence over decontamination procedures. (0.5)

b. Do not move an injured person, even if he or she is in a high radiation field, until the injured person has been examined by a competent medical professional. (0.5)

c. The presence of even relatively high levels of contamination rarely constitutes a hazard to the individual. (0.5)

d. The primary method for decontamination of an individual is through the use of a mild soap and warm water. (0.5)

QUESTION I.07 (1.5)

Does the biological effect of 10 REM depend on whether it is a neutron or gamma dose? Briefly explain your answer. (1.5)

QUESTION I.08 (1.5)

Two centimeters of lead placed at a certain location in a beam of gamma rays reduced the gamma radiation level from 400 mr/hr to 200 mr/hr. What additional thickness of lead placed in this beam would reduce the gamma level to 25 mr/hr. Assume no buildup. SHOW ALL WORK. (1.5)

QUESTION I.09 (2.0)

Consider two point sources each having the same curie strength (for example, 1 curie each). Source A gamma's have an energy of 1 MeV while source B gamma's have an energy of 2 MeV. Your obtain a reading from the same Geiger counter 10 feet from each source. Would the reading from source A be about twice, one-half, or about the same as that from source B? Briefly explain your answer. (2.0)

(***** END OF CATEGORY I *****)

J. SPECIFIC OPERATING CHARACTERISTICS

QUESTION J.01 (3.0)

During operation of your reactor, what direction of movement of the control rod, if any, will be required to maintain constant power level by the following changes. Assume each change occurs independently. BRIEFLY EXPLAIN YOUR ANSWER.

a. An experiment containing air that is placed next to the core leaks and fills with water. (1.0)

b. Conductivity of the primary coolant decreases. (1.0)

c. A boron sample is placed in the core via the rabbit system. (1.0)

QUESTION J.02 (2.0)

Consider the Primary Cooling System

a. What is the purpose of the small holes drilled in the suction and return lines about 4 inches beneath the pool surface? (1.0)

b. In the event of a large loss of water (below core height) due to a reactor leak, what means are used to provide water to maintain the reactor coolant level above the reactor core? (1.0)

QUESTION J.03 (2.5)

Consider the pulse mode.

a. Explain why the temperature channel normally has no effect on limiting the peak power generated. (1.0)

b. Explain under WHAT condition and HOW the temperature channel will have an effect on limiting the power being generated. (1.5)

(***** CATEGORY J CONTINUED ON NEXT PAGE *****)

QUESTION J.04 (1.5)

Consider the Primary Water Purification System. Pt A deleted

a. TRUE or FALSE? Your technical specifications state that "the reactor shall not be operated if the conductivity of the water is GREATER than 0.2 micromhos/cm at the output of the purification system, averaged over one week. (0.5)

b. Give two reasons why this limitation is necessary. (1.0)

QUESTION J.05 (3.0)

Assume your reactor has been at rated power for one week. The reactor is shutdown for a period of two hours. During this time an experiment is inserted. Also during this time the primary coolant temperature decreases 5 degrees C. Briefly describe what information would be necessary to calculate the critical rod positions. (3.0)

QUESTION J.06 (2.0)

The reactor is operating at 500 KW in Mode 1A-AUTOMATIC. Indicate whether the following are TRUE or FALSE. Consider each statement separately.

a. When the up button for the regulating rod is pushed, the reactor increases in power. (0.5)

b. When the up button for the safety rod is pushed, the regulating rod moves into the core. (0.5)

c. When the mode switch is changed to MODE II, the reactor automatically scrams. (0.5)

d. When the mode switch is changed to MODE II, the 3-second period rod withdrawal prevent interlock is bypassed. (0.5)

(***** CATEGORY J CONTINUED ON NEXT PAGE *****)

QUESTION J.07 (1.5)

a. Which TWO of the following receives its power from transformer 42B (located in room 3152)? (1.0)

   i. G.E. Nuclear Instrumentation
   ii. Reactor Control Panel
   iii. Reactor Room Radiation Monitoring Equipment
   iv. Control Console Voltage Regulator

b. TRUE or FALSE - If all AC electrical power is lost to AFRRI, there will be no installed radiation monitoring system alarms operable except the criticality monitor? (0.5)

QUESTION J.08 (3.0)

Your reactor is operating at 1 MW in position 567 with the regulating rod withdrawn 625 units. If the regulating rod is fully inserted, what is K-effective of the core at this time? Assume no change in pool temperature or poison concentration. Useful reactivity curves are appended to back of the exam. (3.0)

QUESTION J.09 (1.5)

List three conditions that must be satisfied before ER #1 door can be opened. (1.5)

(***** END OF CATEGORY J *****)

K. FUEL HANDLING AND CORE PARAMETERS

QUESTION K.01 (3.5)

Your reactor has just been taken critical after being shutdown for two weeks. The following data was noted:

Core at position 567
Safe and Shim rods 100 percent withdrawn
Transient rod 250 units
Regulating rod 300 units

a. Using app.opriate curves appended to the end of this exam, compute K-excess. SHOW ALL WORK. (2.5)

b. Is excess reactivity within Tech Spec limits? JUSTIFY YOUR ANSWER. (1.0)

QUESTION K.02 (2.0)

Give TWO reasons why your technical specifications limit the amount of elongation of a fuel element. (2.0)

QUESTION K.03 (2.0)

In accordance with operating Procedure VII, "Reactor Core Loading and Unloading", indicate whether the following statements are TRUE or FALSE.

a. It is permissible to unload the core under the supervision of the Reactor Operations Supervisor. (0.5)

b. It is permissible to load the core with just one nuclear instrumentation channel operational. (0.5)

c. Fuel elements are loaded in the core with all rods but the safe rod inserted. (0.5)

d. Fuel elements are loaded starting with the B-ring and C-ring thermocouple elements. (0.5)

(***** CATEGORY K CONTINUED ON NEXT PAGE *****)

K. FUEL HANDLING AND CORE PARAMETERS

QUESTION K.04 (2.0)

Consider the reactivity effect of replacing a fuel element with new fuel near the center of the core (B-ring) versus the edge of the core (F-ring). Which new fuel element will add the most reactivity? Briefly explain your answer. (2.0)

QUESTION K.05 (2.5)

Consider the Technical Specifications concerning SHUTDOWN MARGIN.

a. What is the minimum shutdown margin allowed? (0.5)

b. For the core position 567 what would be the assumed position of the shim rod, safe rod, regulating rod, and transient rod when calculating the shutdown margin? (Consider each rod separately.) (2.0)

QUESTION K.06 (3.5)

The following data was taken during a core loading:

No. of elements	Detector A (CPM)	Detector B (CPM)
0	60	32
12	61	44
24	68	61
36	80	98
42	100	140
48	142	256

a. Estimate the number of fuel elements needed to go critical. (Use graph paper provided.) (2.0)

b. Which detector curve did you use for your prediction of criticality? JUSTIFY YOUR ANSWER. (1.5)

(***** CATEGORY K CONTINUED ON NEXT PAGE *****)

K. FUEL HANDLING AND CORE PARAMETERS

QUESTION K.07 (2.0)

No work is in progress involving in-core fuel handling or refueling operations, there are no insertion or withdrawal of in-core experiments, and the reactor is subcritical. Maintenance is being performed on the regulating rod. List ALL other required conditions that must be satisfied to secure the reactor. (2.0)

QUESTION K.08 (1.0)

The thermocouples in the instrumented fuel rod measure temperature: (Choose the most correct answer.)

A. on the surface of the fuel cladding

B. on the outer surface of the fuel

C. in the interior of the fuel-moderator sections

D. in the center of the zirconium rod (1.0)

QUESTION K.09 (1.5)

When storing irradiated fuel other than in the reactor core, what two conditions must be satisfied in accordance with your Technical Specifications? (1.5)

(***** END OF CATEGORY K *****)

L. ADMINISTRATIVE PROCEDURES, CONDITIONS AND LIMITATIONS

QUESTION L.01 (3.0)

You are the SRO on duty. You are also the only person at the console. The reactor is operating at 1 MW in position 567 for an extended run. If the fire alarm sounds, what are your immediate actions? (3.0)

QUESTION L.02 (3.0)

The reactor is in the shutdown condition and is about to be secured when it is discovered that the console key has been lost. What are the minimum staff requirements for this situation? (3.0)

QUESTION L.03 (3.0)

Indicate whether or not each of the following are violations of Technical Specifications. Briefly explain why it is or is not a violation.

a. Operating at full power with one disabled Fuel Temperature Safety Channel (1.0)

b. The reactor is operated at full power for two hours with the purification system input water temperature at 40 degrees C. (1.0)

c. The reactor was inadvertently pulsed with a $3.50 step insertion when a $2.50 pulse was planned. (1.0)

QUESTION L.04 (2.0)

Give two Technical Specification BASES for the annual surveillance requirements to determine the reactivity worth of each control rod. (2.0)

(***** CATEGORY L CONTINUED ON NEXT PAGE *****)

QUESTION L.05 (2.0)

a. Define "burnable poison". (1.0)

b. In accordance with your Technical Specifications, what limitation is placed on use of "burnable poisons" in your reactor. (1.0)

QUESTION L.06 (3.0)

Technical Specifications require the following radiation monitors to be operable during reactor operation:

i. Two ARM detectors located in the reactor room (R1 and R2).
ii. One ARM detector placed near each exposure room plug door.
iii. A gas stack monitor.
iv. An air particulate monitor in the reactor room.

a. Indicate the AUTOMATIC FUNCTIONS (other than alarms) associated with the above listed radiation monitors and the purpose of these functions. (1.0)

b. What is the reason for placing an ARM detector near each exposure room plug door? (1.0)

c. Which of the above listed radiation monitors give both an audible and visual alarm in the control room? (1.0)

QUESTION L.07 (3.0)

a. Define Emergency Action Levels (EAL). (1.0)

b. Briefly describe the difference between a class 0 and a class 1 Emergency Action Level. (2.0)

(***** CATEGORY L CONTINUED ON NEXT PAGE *****)

QUESTION L.08 (1.0)

Consider the operating procedures required by your Technical Specifications.

a. Who may make temporary changes to the procedure providing these changes do not change the original intent? (0.5)

b. Who must eventually review the temporary change? (0.5)

(***** END OF CATEGORY L *****)

$f = ma$

$v = s/t$

Cycle efficiency = (Network out)/(Energy in)

$w = mg$

$s = V_o t + 1/2\, at^2$

$E = mc^2$

$KE = 1/2\, mv^2$

$a = (V_f - V_o)/t$

$A = \lambda N$

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

$PE = mgh$

$V_f = V_o + at$

$w = \theta/t$

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

$W = v\, \Delta P$

$t_{1/2}eff = \dfrac{[(t_{1/2})(t_b)]}{[(t_{1/2}) + (t_b)]}$

$\Delta E = 931\, \Delta m$

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

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

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

$Pwr = W_f \Delta h$

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

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

$TVL = 1.3/\mu$

$HVL = -0.693/\mu$

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

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

$SUR = 26.06/T$

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

$\Sigma = \sigma N$

$I_1 d_1 = I_2 d_2$

$I_1 d_1^{\,2} = I_2 d_2^{\,2}$

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

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

Water Parameters

1 gal. = 8.345 lbm.

1 gal. = 3.78 liters

1 ft^3 = 7.48 gal.

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 O = 0.4335 lbf/in. 2

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

AFRRI-TRIGA REACTOR PARAMETERS

Prompt Neutron Lifetime 39 uSec
Beta effective (B_{eff}) 0.0070

Prompt Negative Temperature Coefficient of Reactivity

-1.26×10^{-4} ^k/k/°C (-$0.018/°C)

Steady State Temperature Coefficient of Reactivity

-5.1×10^{-5} ^k/k/°C (-$0.007/°C)

Void Coefficient of Reactivity

-0.2×10^{-4} ^k/k/1% Void

Tank Constant 1.48°C/100 KW-hr

Power Coefficient of Reactivity:

15 Watts to 100KW	$0.59
15 Watts to 1 MW	$3.47

Nominal Fuel Element Worth (compared to H2O)

RING	%^k/k	($)
B	0.89	1.27
C	0.73	1.04
D	0.57	0.82
E	0.31	0.44
F	0.20	0.28

Nominal Control Rod Worths:

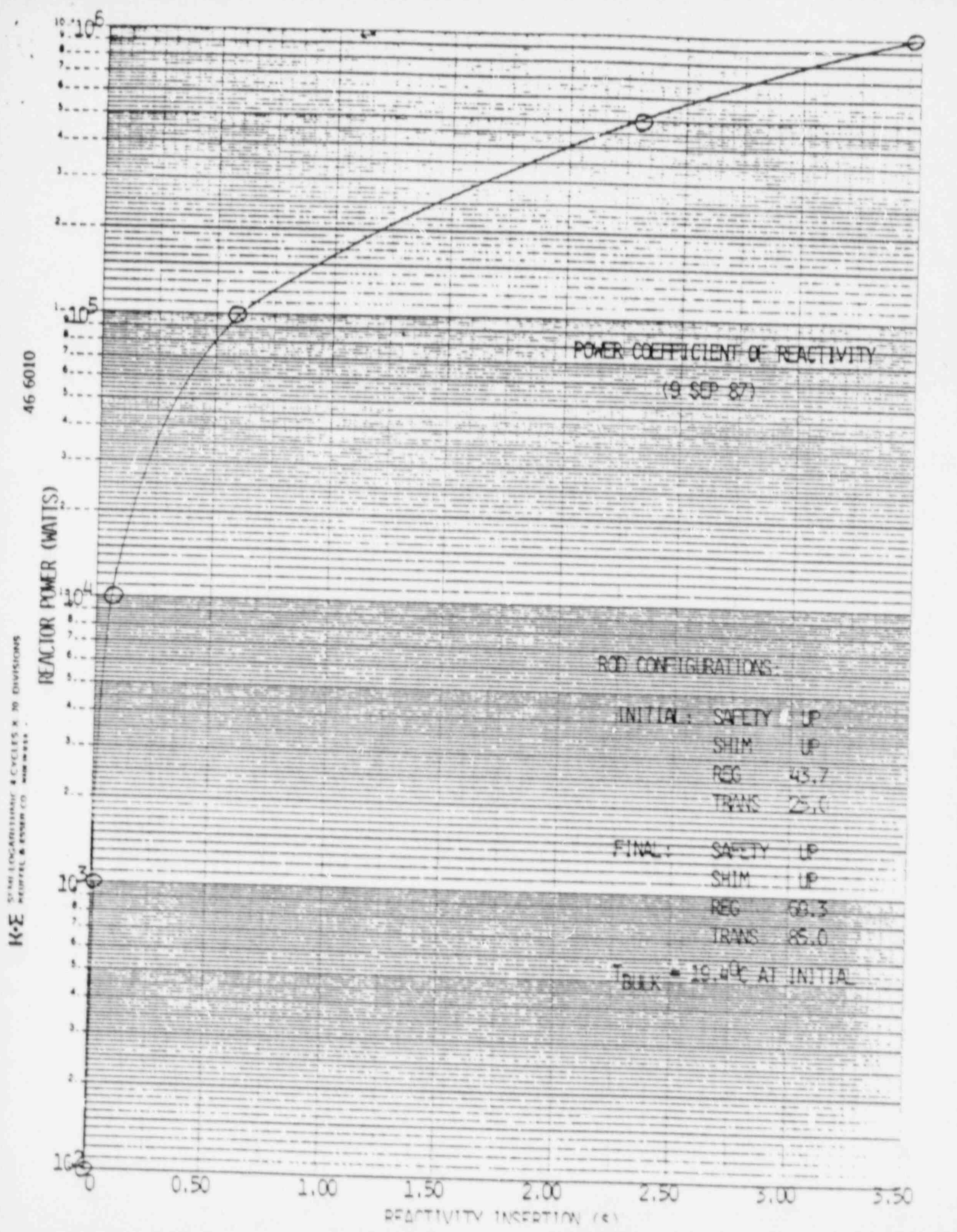
Standard Control Rod	$1.84
Transient Control Rod	3.66
Standard Control Rod Follower	0.20
Transient Control Rod Follower	0.30

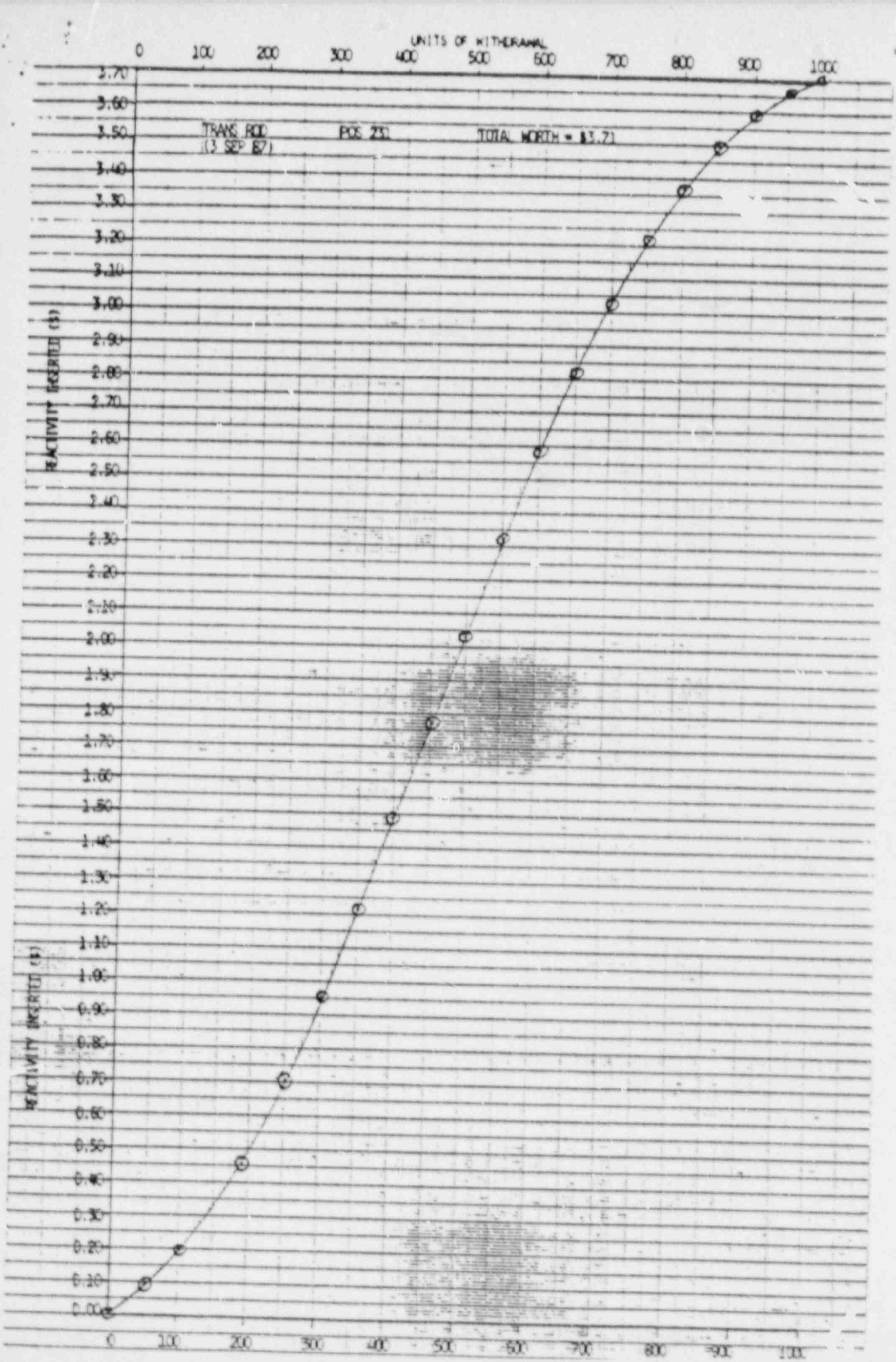
Other Magic Numbers:
E = 3.1×10^{10} fissions/Watt-second
v = 2.47 neutrons/fission

REFLECTOR COEFFIENTS

Core Position	Rod Position	Measured Excess	Difference from Pos 567
231	REG 63.3	$3.66	$0.51
567	REG 43.2	4.17	----
833	REG 44.0	4.12	0.05
903	REG 61.2	3.68	0.49

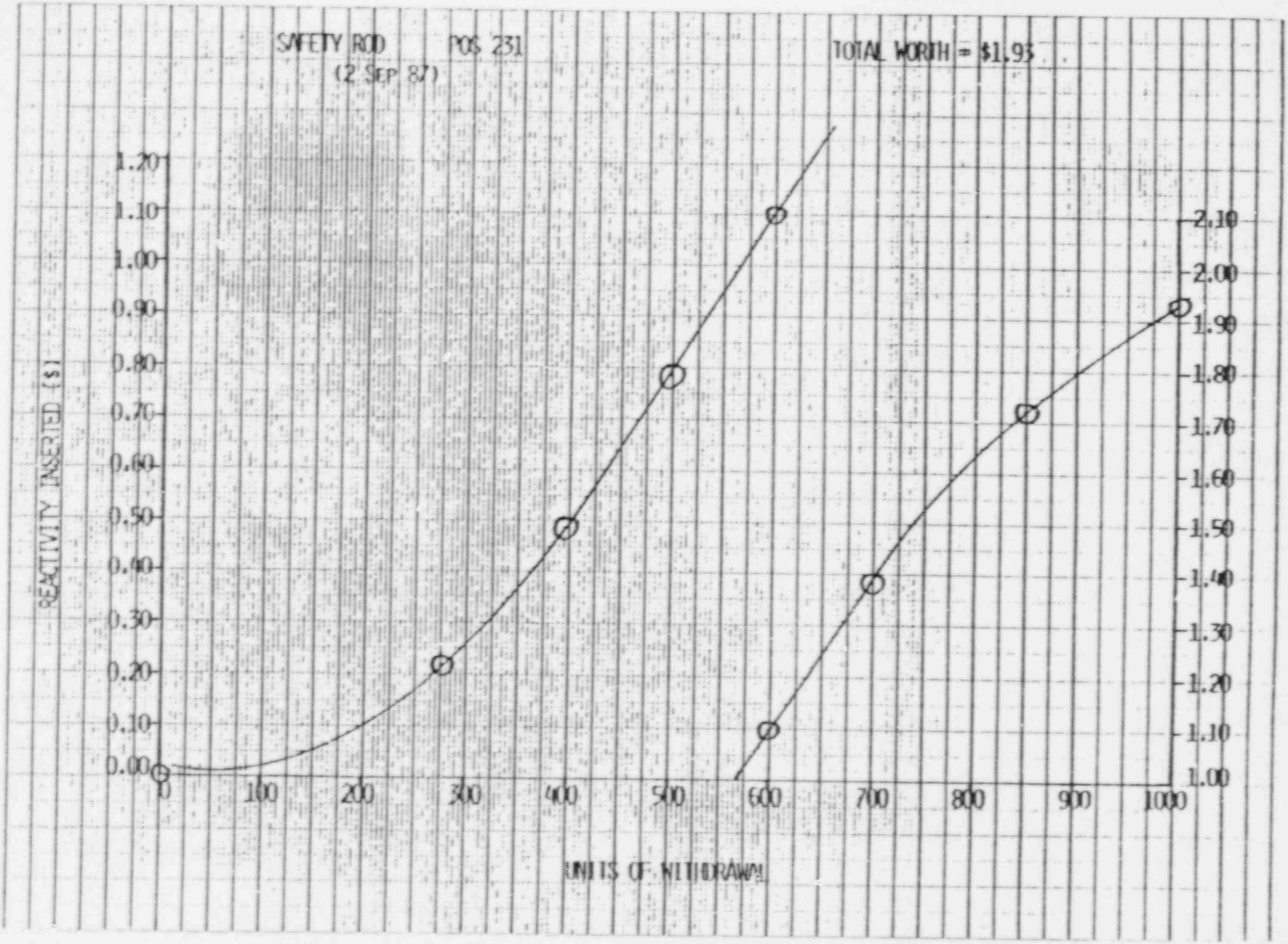
In all positions, the remaining control rods were configured as follows: SAFETY - UP SHIM - UP TRANS - 25.0


POWER COEFFICIENT OF REACTIVITY
(9 SEP 87)
ROD CONFIGURATIONS:
INITIAL: SAFETY UP
SHIM UP
REG 43.7
TRANS 25.0
FINAL: SAFETY UP
SHIM UP
REG 50.3
TRANS 85.0
T_{BULK} = 19.4°C AT INITIAL
REACTOR POWER (WATTS)
REACTIVITY INSERTION ($)
10^6
10^5
10^4
10^3
10^2
0
0.50
1.00
1.50
2.00
2.50
3.00
3.50
K·E SEMI-LOGARITHMIC 4 CYCLES X 70 DIVISIONS KEUFFEL & ESSER CO.
46 6010

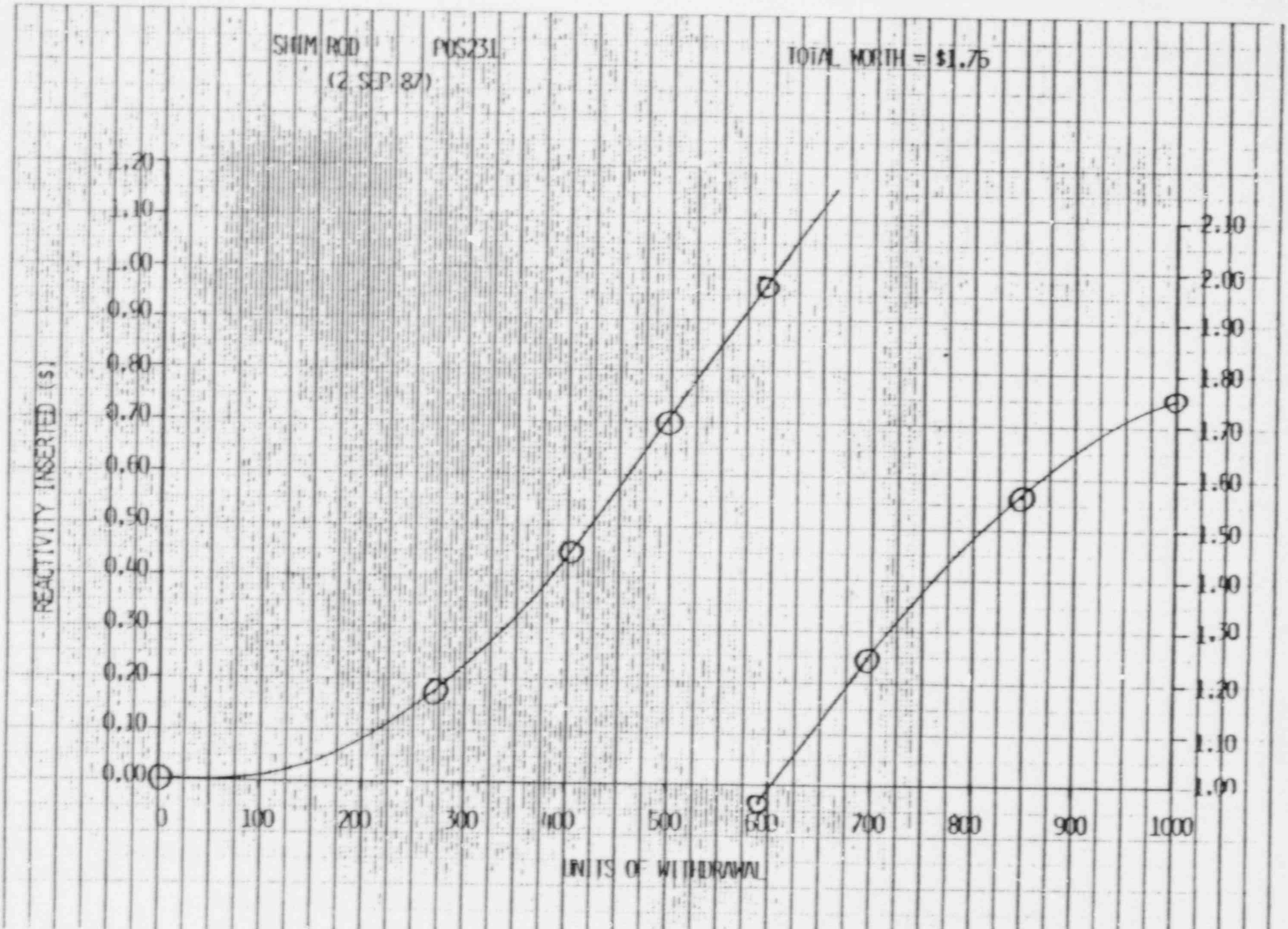


UNITS OF WITHDRAWAL
TRANS ROD
(3 SEP 87)
POS 231
TOTAL WORTH = $3.71
REACTIVITY INSERTED ($)

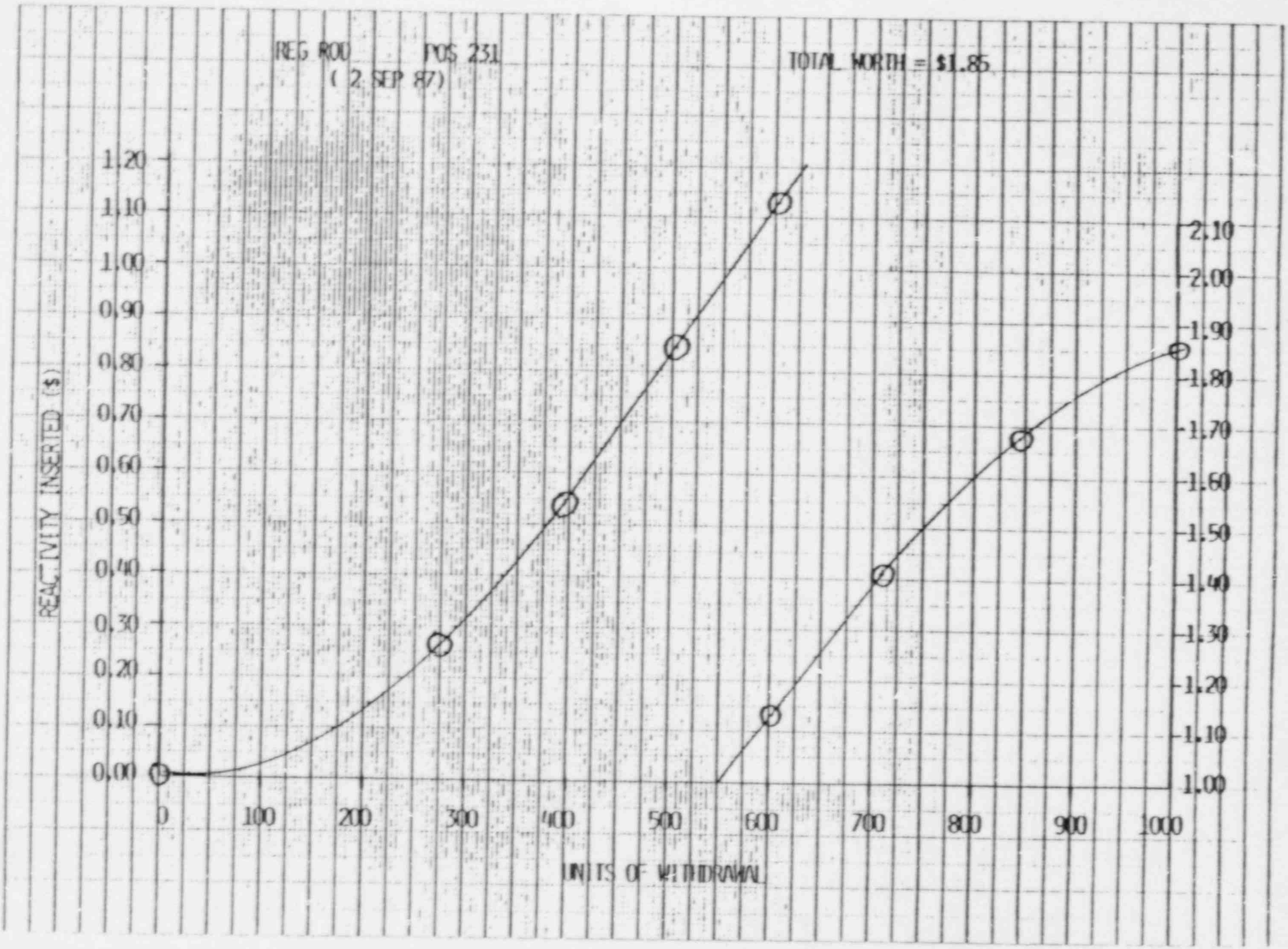
K-E 46 1510

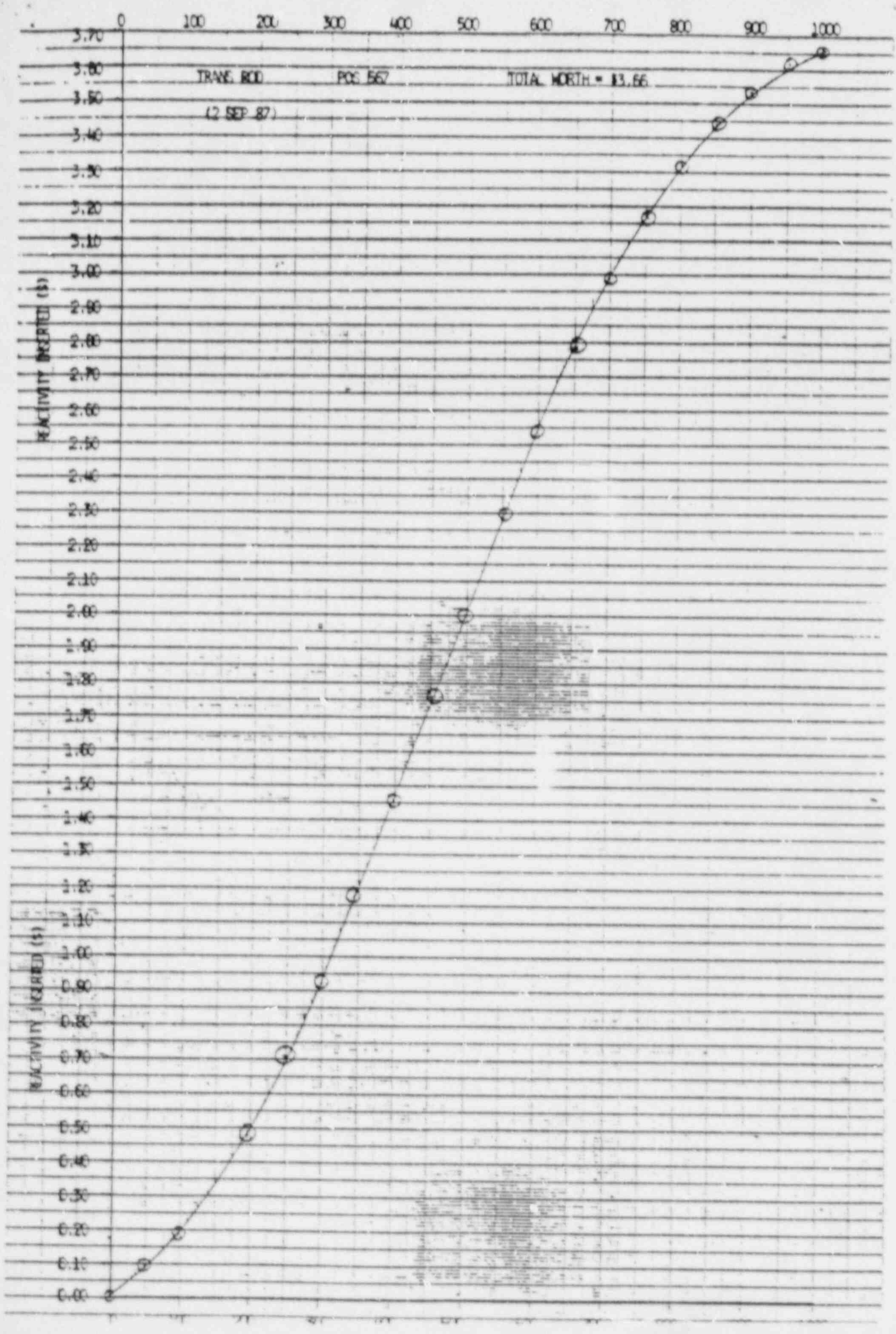

SAFETY ROD POS 231
(2 SEP 87)
TOTAL WORTH = $1.93
REACTIVITY INSERTED ($)
1.20
1.10
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
2.10
2.00
1.90
1.80
1.70
1.60
1.50
1.40
1.30
1.20
1.10
1.00
0
100
200
300
400
500
600
700
800
900
1000
UNITS OF WITHDRAWAL

K-E 46 1510

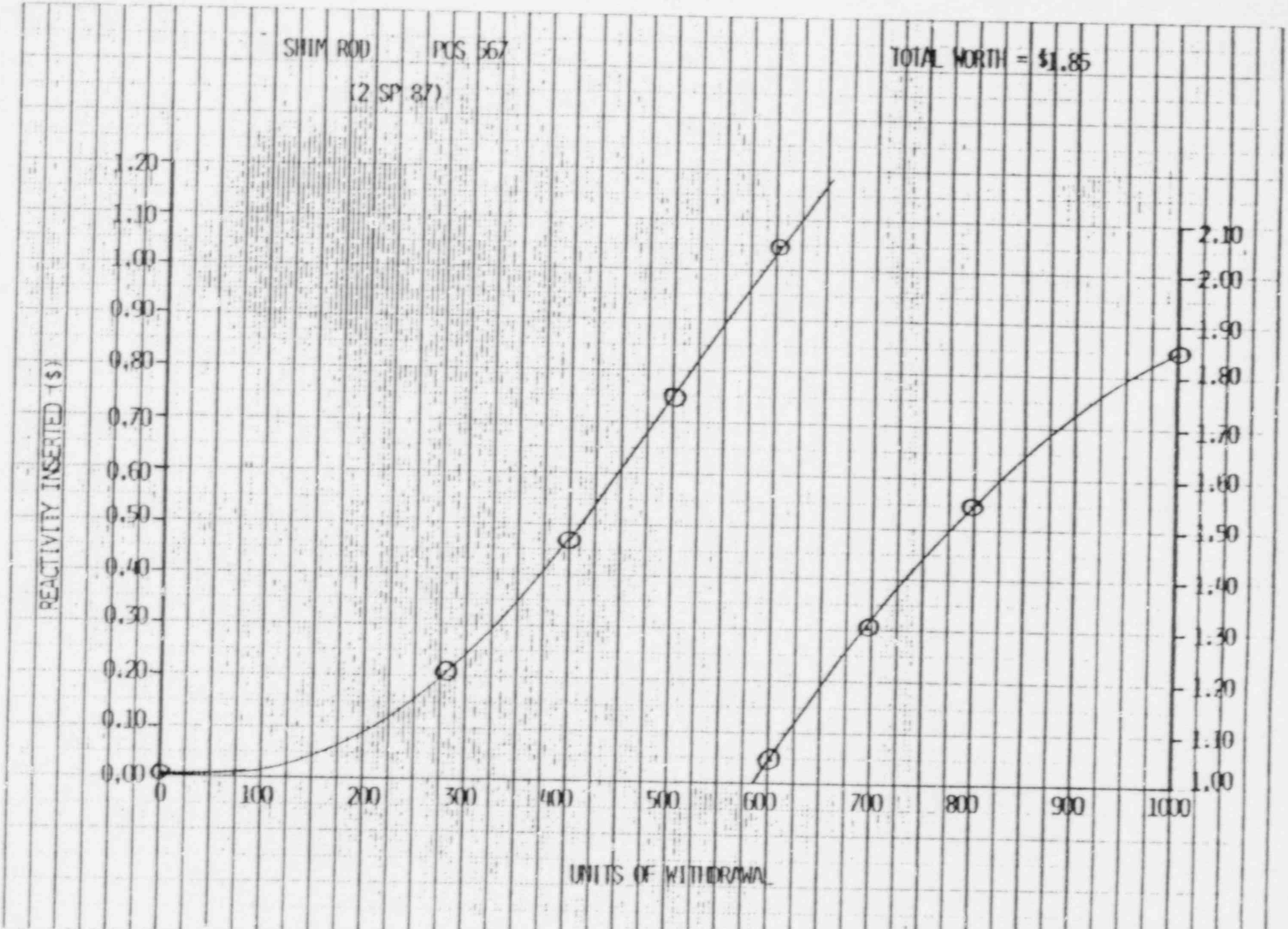

SHIM ROD POS231
(2 SEP 87)
TOTAL WORTH = $1.75
REACTIVITY INSERTED ($)
UNITS OF WITHDRAWAL
0.00
0.10
0.20
0.30
0.40
0.50
0.60
0.70
0.80
0.90
1.00
1.10
1.20
1.00
1.10
1.20
1.30
1.40
1.50
1.60
1.70
1.80
1.90
2.00
2.10
0
100
200
300
400
500
600
700
800
900
1000

K·E 10 X 10 TO THE CENTIMETER 46 1510

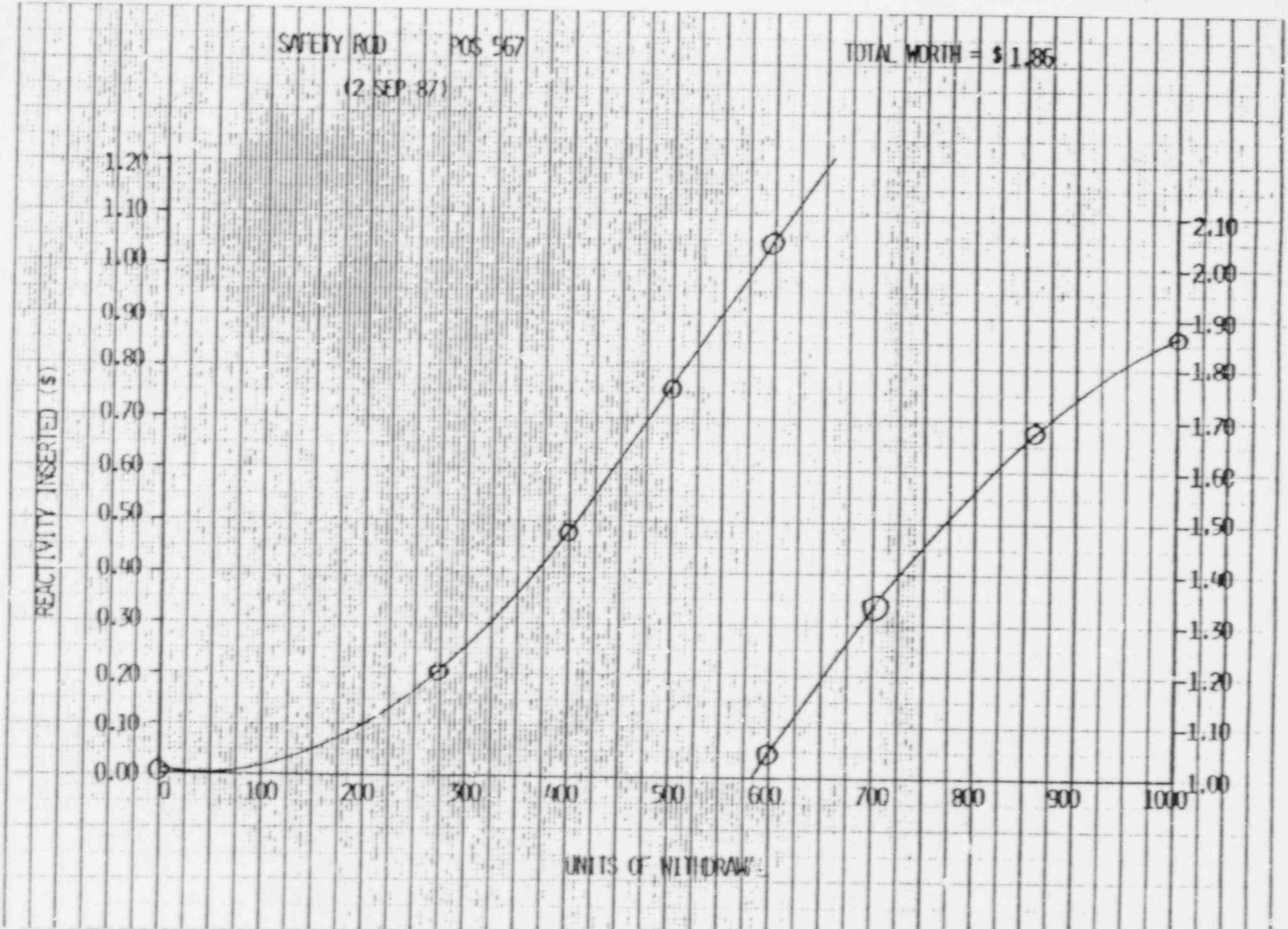



TRANS ROD
POS 567
TOTAL WORTH = $3.66
(2 SEP 87)
REACTIVITY INSERTED ($)
0
100
200
300
400
500
600
700
800
900
1000
0.00
0.10
0.20
0.30
0.40
0.50
0.60
0.70
0.80
0.90
1.00
1.10
1.20
1.30
1.40
1.50
1.60
1.70
1.80
1.90
2.00
2.10
2.20
2.30
2.40
2.50
2.60
2.70
2.80
2.90
3.00
3.10
3.20
3.30
3.40
3.50
3.60
3.70

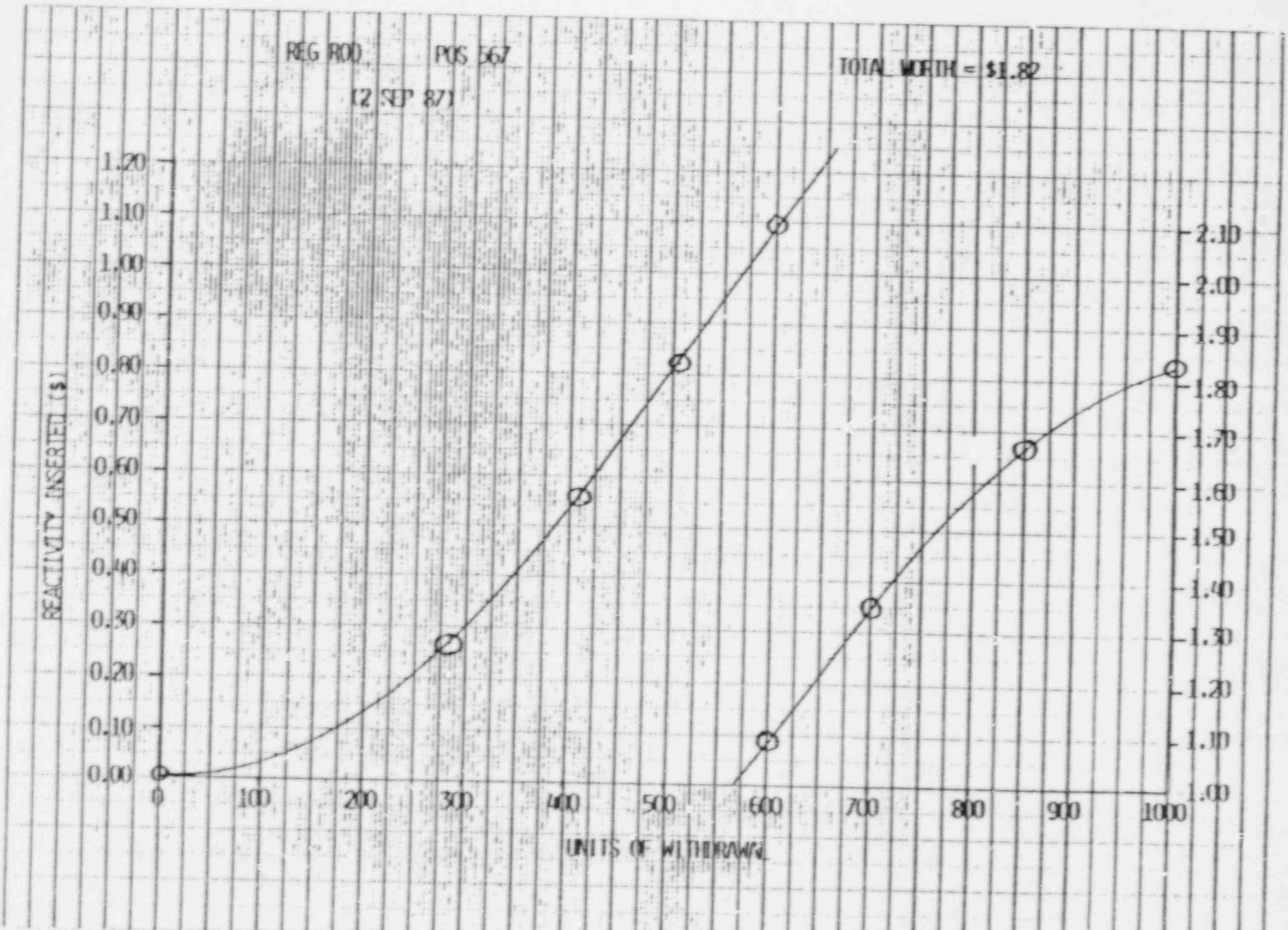
K-E 10 X 10 TO THE CENTIMETER 46 1510



K·E 46 1510


SAFETY ROD POS 567
(2 SEP 87)
TOTAL WORTH = $ 1.86
REACTIVITY INSERTED ($)
UNITS OF WITHDRAWAL
0.00
0.10
0.20
0.30
0.40
0.50
0.60
0.70
0.80
0.90
1.00
1.10
1.20
0
100
200
300
400
500
600
700
800
900
1000
1.00
1.10
1.20
1.30
1.40
1.50
1.60
1.70
1.80
1.90
2.00
2.10

K·E 46 1510


REG ROD POS 567
(2 SEP 87)
TOTAL WORTH = $1.82
REACTIVITY INSERTED ($)
1.20
1.10
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
2.10
2.00
1.90
1.80
1.70
1.60
1.50
1.40
1.30
1.20
1.10
1.00
0
100
200
300
400
500
600
700
800
900
1000
UNITS OF WITHDRAWAL

Master ANSWER Key - Changes incorporated

H. REACTOR THEORY

ANSWERS -- ARMED FORCES RADIOBIO. RES-88/07/21-ROBINSON, G.

ANSWER H.01 (3.0)

a. Rho = Beta /(1 + Lambda x Tau)
= .007/(1 + 0.1 x 60)
= .001 (1.5)

b. Rho = .001 + .001 = .002
Tau = (Beta - Rho) / (Lambda x Rho)
= (.007 - .002) / (0.1 x .002)
= 25 seconds (1.0)
Doubling Time = Tau x ln2 = 17.3 seconds (0.5)

NOTE: If applicants answers part a. incorrectly, use applicant's answer to part a. to calculate the answer for part b.

REFERENCES
AFRRI Reference Package, Reference equations
Reactor Operator Requalification Program H - 2e.2 p.21
Fundamentals of Nuclear Reactor Engineering p. 65

ANSWER H.02 (2.5)

THIS QUESTION DELETED

a. Present startup power level will be lower. (0.5)
For a given reactivity addition, subcritical multiplication results in a lower neutron population increase for the reactor with the lower initial neutron population. (0.75)

b. Critical rod positions will be approximately the same. (0.5)
The critical rod position is dependent upon the positive reactivity necessary to bring the reactor critical and is independent of source magnitude. (0.75)

REFERENCE
Schultz, M. A., Control of Nuclear Reactors and Power Plants p. 17, 372.

ANSWER H.03 (2.0)

6 degrees reactivity change = -6c x -$0.007 / c = +$0.042 (0.5)
At 400 units rod worth = $0.54 (0.5)
Total rod worth = $0.54 + $0.042 - $0.25 = $0.748 (0.5)
Rod position is 475 units (0.5)

REFERENCES
AFRRI Reference Package
Fundamentals of Nuclear Reactor Engineering p. 79

ANSWER H.04 (2.0)

a. FALSE (0.5)
b. TRUE (0.5)
c. TRUE (0.5)
d. FALSE (0.5)

REFERENCE
Fundamentals of Nuclear Engineering p. 84-91

ANSWER H.05 (3.0)

a. $\frac{CR-2}{CR-1} = \frac{1-(K\text{-}eff1)}{1-(K\text{-}eff2)} = 2 = \frac{1-.98}{1-(K\text{-}eff2)}$; (K-eff2) = .99 (2.0)

b. $\frac{1-(K\text{-}eff2)}{1-(K\text{-}eff3)} = 2 = \frac{1-.99}{1-(K\text{-}eff3)}$; (K-eff3) = 0.995 (0.5)

THEREFORE THE REACTOR IS STILL SUBCRITICAL (0.5)

REFERENCE
Fundamentals of Nuclear Reactor Engineering p. 144-146
AFRRI Reference Package

ANSWER H.06 (2.0)

a. Decrease (0.5)
b. Increase (0.5)
c. Decrease (0.5)
d. Decrease (0.5)

REFERENCE
Fundamentals of Nuclear Reactor Engineering p. 100-110
Lamarsh, J. R., Introduction to Nuclear Engineering
p. 321-326, 343-350

ANSWER H.07 (2.5)

K-excess in position 567 = $3.55 + $.51 = $4.06 (1.0)
Total rod worth $3.66 + $1.86 + $1.82 + $1.85 = $9.19 (1.0)
Shutdown margin = $9.19 - $4.06 = $5.13 (0.5)

REFERENCE
AFRRI glossary - rod worth, shutdown margin, excess reactivity
Reference packet

ANSWER H.08 (1.5)

P(t) = P(o) exp(t/tau); ln 10 = 300 sec/tau
tau = 300 sec/2.3 = 130.2 seconds (1.0)
The period has become longer, therefore the negative temperature coefficient has reduced the reactivity. (0.5)

REFERENCE
Reactor Operator Requalification Program H-2e.3, p. 21
Fundamentals of Nuclear Reactor Engineering p. 64, 138

ANSWER H.09 (1.5)

Placing a second rod adjacent to the first rod will depress the flux in that area and thus decrease the worth of the first rod. (1.5)

REFERENCE
Fundamentals of Nuclear Reactor Engineering p. 78

ANSWER 1.01 (3.0)

a. N-16 is produced by fast neutron activation of oxygen in the coolant water in the vicinity of the core. (1.0)

Ar-41 is generated by neutron activation of Ar 40, a constituent of air, disolved in the coolant water and in the air of ~~pneumatic transfer systems and~~ the exposure rooms. (Each part worth 0.25 points.) (1.0)

b. Ar-41 is most likely to end up in the environment. (0.5)
N-16 has a seven second half life and decays before it becomes an environmental problem. (0.5)

REFERENCE

AFRRI SAR p. 22, 23

ANSWER 1.02 (3.0)

a. 5(23-18) = 25 Rem (0.5)
Lifetime limit = 25 - 23 = 2 Rem (0.5)
With Form 4 on file, person permitted 3 Rem/qtr.
lifetime limit is more restrictive. (0.5)
2.0 Rem /(0.9 Rem/hr) = 133 minutes (0.5)

b. Facility limit is 50 mr/day (0.5)
50 mr/(900 mr/hr) = 3.3 minutes (0.5)

REFERENCE
10CFR20.102
Health Physics Procedure 3-1-3

ANSWER 1.03 (2.0)

D1/(R2 X R2) = D2/(R1 X R1): 1600/(4 X 4) = D2/(2 X 2)
D2 = 400 mr/hr (1.5)
For 2 hours he received 2 x 400 mr = 800 mr (0.5)

REFERENCE
Lamarsh, J. R., Introduction to Nuclear Engineering p. 409

ANSWER 1.04 (3.0)

1. The last survey indicated that there were no radiation levels in excess of 100 mr/hr in any area of the ER where extended stay time is possible. (1.0)
2. Survey meter readings at the door indicate safe entry conditions (less than 1 mr/hr). (1.0)
3. The ER /Cam should be observed and its reading (net) should be less than 200 CPM above background. (1.0)

REFERENCE
Operating Procedure 1 Conduct of Experiments, Tab A-3e
Reactor Operator Requalification Program 11b p.3

ANSWER 1.05 (2.0)

A = Ao e(-lambda x t)
ln(900/294) = lambda x 180; lambda = .00623/min (1.5)
t(one-half) = 0.693/lambda = 111 minutes (0.5)

REFERENCE
Lamarsh, J. R., Introduction to Nuclear Engineering p. 22

ANSWER 1.06 (2.0)

a. TRUE (0.5)
b. FALSE (0.5)
c. TRUE (0.5)
d. TRUE (0.5)

REFERENCE
AFRRI Instruction 6310.1F

ANSWER 1.07 (1.5)

NO (0.5)
The unit REM considers the different effects. REM is a biological unit, thus different radiation causing the same dose in REM should have the same effect. (1.0)

REFERENCE
10CFR 20
AFRRI Glossary p. 53

ANSWER 1.08 (1.5)

One half thickness is 2 centimeters of lead. (0.5)
Need three more half-thicknesses to reduce 200 mr/hr to 25 mr/hr. Therefore need six (6) additional centimeters of lead. (1.0)

REFERENCE
Radiological Health Handbook p. 426

ANSWER 1.09 (2.0)

About the same (1.0)
Geiger counters are not energy dependent (1.0)

REFERENCES
Fundamentals of Nuclear Reactor Engineering p. 142

J. SPECIFIC OPERATING CHARACTERISTICS

ANSWERS -- ARMED FORCES RADIOBIO. RES-88/07/21-ROBINSON, G.

ANSWER J.01 (3.0)

a. Rod will be inserted. (0.5)
   Water is a better reflector (scatterer) than air. (0.5)
b. No effect. (0.5)
   Variation of conductivity within the allowable operating limits will have no effect on reactivity. (0.5)
c. Rod will be withdrawn. (0.5)
   Boron has a large absorption cross section thus negative reactivity will be added. (0.5)

REFERENCE
Fundamentals of Nuclear Engineering p. 40, 73

ANSWER J.02 (2.0)

a. These holes prevent water from being syphoned out of the reactor pool and uncovering the core in the event of a primary coolant line leak or rupture. (1.0)
b. An emergency fill line will be connected from an outside, adjacent hydrant main to the primary coolant loop. (1.0)

REFERENCE
SAR p. 3-16

ANSWER J.03 (2.5)

a. The time constant of the temperature channel is relatively long (seconds) when compared to the pulse width (milliseconds). (1.0)
b. In the event that the pulse rod remains stuck in the fully withdrawn position, ~~the temperature channel will cause the reactor to trip.~~ (0.75)
   ~~This reduces the amount of energy generated by cutting the "tail" of a pulsed power transient with enough reactivity to exceed the temperature limiting safety system setting.~~ (0.75)

REFERENCE
Tech Spec p. 6, Section 2.2 "Basis"

NOTE: At full power in the event that any or all control rods remain stuck after a pulse, the temperature will still be below the 575 °C scram point. The power generated would be equivalent to a slightly higher than normal steady state operation.

ANSWER J.04 (1.5)

a. FALSE (0.5)
b. i. This value is an acceptable level of water-borne contaminants in an aluminum / stainless steel system. Based on experience, activation at this level does not pose a significant radiological hazard. (0.5)
ii. This value is consistent with the fuel vendor's experience and with similar reactors (0.5)

REFERENCE
Tech Spec p. 12 and p. 13, Section 3.3 "Basis"

ANSWER J.05 (3.0)

Previous rod positions. (0.6)
Xenon shutdown vs. reactivity curves (or calculate it). (0.6)
Worth of experiment added (0.6)
Reactivity decrease due to burnup (0.6)
Negative temperature coefficient (0.6)

REFERENCE
Fundamentals of Nuclear Reactor Engineering p. 80, 88, 97

ANSWER J.06 (2.0)

a. FALSE (0.5)
b. ~~TRUE~~ FALSE (0.5)
c. FALSE (0.5)
d. TRUE (0.5)

REFERENCE
Operations Manual p. 97, 98

ANSWER J.07 (1.5)

a. i. and iii. (1.0)
b. ~~TRUE~~ FALSE (0.5)

REFERENCE
Operations Manual p. 74

ANSWER J.08 (3.0)

From regulating rod curve - inserting reg. rod adds - $1.15. (1.0)

Power defect from AFRRI parameters = $3.47 ~~[illegible]~~ ($3.47 − (1.0)

Rho: ~~[illegible] 1.000~~ + (~~[illegible]~~ $1.15) × .007 = 0.0162

.~~Rod delta K/K~~. Keff = 1.0165 (1.0)

(which would be about 800 kW)

REFERENCE

AFRRI Reference Packet

AFRRI Glossary, Power Coefficient of Reactivity

ANSWER J.09 (1.5)

a. Lead shield doors must be closed. (0.5)

b. Core dolly must be in Position 3. (0.5)

c. Electrical power control box to ER #1 door must be unlocked and turned on. (0.5)

REFERENCE

Operations Manual p. 104

K. FUEL HANDLING AND CORE PARAMETERS

ANSWERS -- ARMED FORCES RADIOBIO. RES-88/07/21-ROBINSON, G

ANSWER K.01 (3.5)

a. K-excess = total transient rod worth - transient rod worth at 250 units + total reg rod worth - reg rod worth at 950 units. (1.5)
$3.66 - $0.7 + $1.82 - $0.30 = $4.48 (1.0)

b. YES, K-excess is within T.S. limits (0.5)
T.S. limit is $5.00 (0.5)

REFERENCE
Operation Procedure VIII, TAB D
Reference Packet
Tech Spec 3.1.3

ANSWER K.02 (2.0)

a. To assume that the cladding material will not be subjected to stresses that could cause a loss of integrity in the fuel containment. (1.0)

b. Assure adequate coolant flow (1.0)

REFERENCES
Tech Spec 5.2.2e "BASIS" p. 27

ANSWER K.03 (2.0)

a. TRUE (0.5)
b. TRUE (0.5)
c. FALSE (All rods inserted) (0.5)
d. TRUE (0.5)

REFERENCE
Operating Procedure VII, Reactor Core Loading and Inloading

ANSWER K.04 (2.0)

a. Near the center of the core (B-ring) (0.5)
b. Replacing a fuel element near the edge of the core does not add as much reactivity because more of the fission neutrons are lost due to leakage. (1.5)

REFERENCE
Reference Packet
Fundamentals of Nuclear Reactor Engineering p. 74

ANSWER K.05 (2.5)

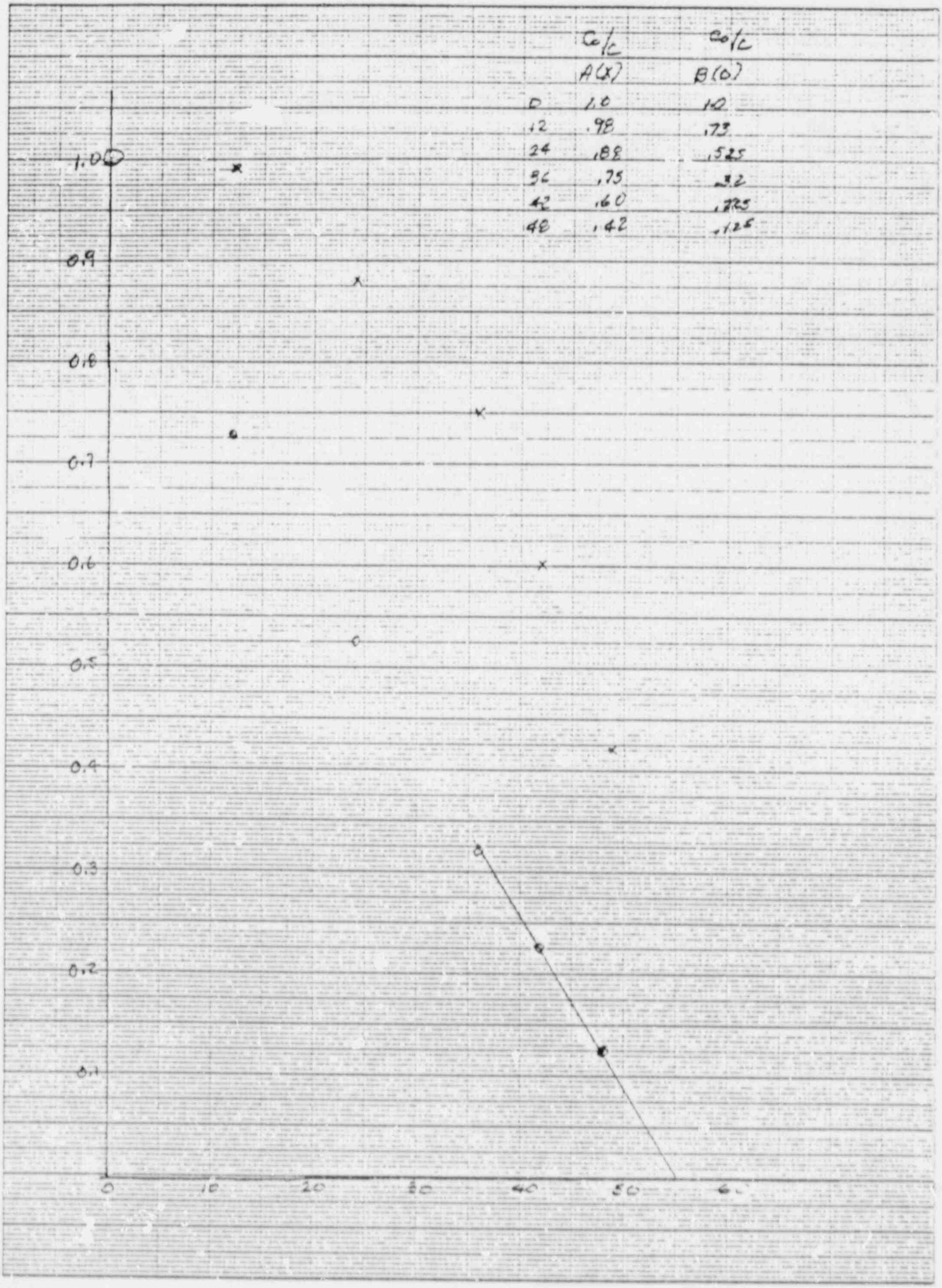
a. Minimum shutdown margin is $0.50. (0.5)
b. Transient rod - fully withdrawn (0.5)
   Safe rod - fully inserted (0.5)
   Shim rod - fully inserted (0.5)
   Regulating rod - fully inserted (0.5)

REFERENCE
Tech Spec 3.1.3.b p. 8

ANSWER K.06 (3.5)

a. 55 elements (1.0)
   Proper calculation of Co/C (0.5)
   Proper plotting of points (0.5)
b. Detector B curve (0.75)
   Detector A curve is nonconservative because the tangent to the curve has a continually increasing slope. (0.75)

REFERENCE
Fundamentals of Nuclear Reactor Engineering p. 147-150



	Co/C A(X)	Co/C B(O)
0	1.0	1.0
12	.98	.73
24	.88	.525
36	.75	.32
42	.60	.225
48	.42	.125

ANSWER K.07 (2.0)

"*.e reactor must be subcritical by $0.50 of reactivity with the most reactive rod removed. i.e Reactor is Shutdown" (1.0)
The console key switch is in the "off" position and the key is removed from the console and is under the control of a licensed operator or is stored in a locked storage area. (1.0)
* NOTE - Tech Spec definition of SHUTDOWN is subcritical by $0.50

REFERENCE
Tech Specs 1.19 p. 3

ANSWER K.08 (1.0)

C. In the interior of the fuel-moderator section (1.0)

REFERENCE
SAR p. 4 - 14

ANSWER K.09 (1.5)

a. Stored in an array that will permit sufficient natural convection cooling by air or water (0.75)
b. Storage shall be such that groups of stored fuel elements will remain subcritical under all conditions of moderation. (0.75)

REFERENCE
Tech Specs 5.3 p. 28

ANSWERS -- ARMED FORCES RADIOBIO. RES-88/07/21-ROBINSON, G.

ANSWER L.01 (3.0)

Scram the reactor.	(0.5)
Secure any exposure facilities.	(0.5)
Remove logbook, emergency guide, teletector tool kit and keys.	(1.0)
Report to EAS.	(0.5)
Do not lock reactor doors.	(0.5)

REFERENCE
Operating Procedure VI, Emergency Procedures
AFRRI, Emergency Scenarios (No. 2)

ANSWER L.02 (3.0)

Since the reactor is NOT secured

SRO on call	(0.75)
RO or SRO in the main control room	(0.75)
Radiation Control Technician on call	(0.75)
Another person within the AFRRI Complex	(0.75)

REFERENCE
Tech Spec 6.1.3.2 p. 30

ANSWER L.03 (3.0)

a. T.S. violation	(0.5)
Two Fuel Temperature Safety Channels are required for operation.	(0.5)
b. No T.S. violation	(0.5)
Above 5 kilowatts and above 60 degrees C. would be a T.S. violation.	(0.5)
c. No T.S. violation	(0.5)
Maximum step insertion allowed is $4.00.	(0.5)

REFERENCE
Tech Spec 3.2.1 p. 9, 3.3 p. 12, 3.1.2 p. 7

ANSWER L.04 (2.0)

a. To assure that the required shutdown margin is available. (1.0)
b. To provide an accurate means for determining the reactivity worths of experiments in the core. (1.0)

REFERENCES
Tech Spec 4.1 "BASIS" p.19

ANSWER L.05 (2.0)

a. Any material with a large neutron absorption cross section which, when it absorbs a neutron, is converted into material with a low absorption cross section. (1.0)
b. Any burnable poison used for the specific purpose of compensating for fuel burnup or long-term reactivity adjustments shall be an integral part of the manufactured fuel elements. (1.0)

REFERENCE
AFRRI Definitions
Tech Spec 5.2.1d p. 26

ANSWER L.06 (3.0)

a. Alarm of the air particulate monitor will cause closure of the positive sealing dampers and (0.5)
cause reactor room isolation. (0.5)
b. To detect streaming radiation (1.0)
c. Air particulate monitor (0.5)
R1 of the reactor room ARM's (0.5)

REFERENCE
Tech Spec p.14
Operations Manual p. 111-134
SAR p. 3-25 to 3-34

ANSWER L.07 (3.0)

a. EALs are thesholds for establishing (entering) an emergency class (1.0)

b. Class 0, events less severe than the lowest category, are events generally peripheral to reactor operations. (1.0)
Class 1, notification of unusual events, consists of a situation that exists or develops that presents a potentially serious hazard to the reactor. (1.0)

REFERENCE
Emergency Plan p.39, 45 and 48

ANSWER L.08 (1.0)

a. Reactor Operation Supervisor or Reactor Facility Director (0.5)

b. Reactor Facility Director (0.5)

REFERENCE
Tech Spec 6.3.2 p. 34