UNITED STATES
NUCLEAR REGULATORY COMMISSION
REGION II
101 MARIETTA STREET, N.W.
ATLANTA, GEORGIA 30323

ENCLOSURE 1

EXAMINATION REPORT - 50-62/OL-86-01

Facility Licensee: University of Virginia
Charlottesville, VA 22901

Facility Name: University of Virginia

Facility Docket Nos. 50-62 and 50-396

Written and oral examinations were administered at the University of Virginia near Charlottesville, Virginia.

Chief Examiner: K. E. Brockman — 6/23/86
K. E. Brockman — Date Signed

Approved by: John F. Munro, Acting Section Chief — 6/30/86
John F. Munro, Acting Section Chief — Date Signed

Summary:

Examinations on May 13, 1986

An oral examination was administered to one candidate, who passed. Two candidates were administered written examinations, one of whom passed.

REPORT DETAILS

1. Facility Employees Contacted:

   J. P. Farrar, Operations Manager

2. Examiner:

   *K. E. Brockman

   *Chief Examiner

3. Examination Review Meeting

   At the conclusion of the written examinations, the examiner provided J. P. Farrar with a copy of the written examination and answer key for review. The following comments were made by the facility reviewers.

   a. SRO Exam

      (1) Question H.08

      Facility Comment: The solvency of gases in water is not relevant to reactor operations. Recommend delete question.

      NRC Resolution: Disagree. Gas content is a factor in the corrosion process. The concept is valid exam material. Question retained.

      (2) Question H.14(a)

      Facility Comment: "Power Defect" is not presented as a topic of study at the University of Virginia (UVA). Recommend delete question.

      NRC Resolution: Accepted. Since the terminology is not taught, it is unfair to ask for this definition. Question deleted from exam.

      (3) Question J.08

      Facility Comment: The new storage facility makes this caution no longer valid. The procedure has yet to be updated. Recommend delete question.

      NRC Resolution: Accepted. Caution is now invalid as per examiner inspection. Deleted from exam.

(4) Question K.06

Facility Comment: UVA does not have pressurized fuel rods. Recommend delete question.

NRC Resolution: Not accepted. Concepts investigated are heat transfer mechanisms and materials sciences. Question retained.

(5) Question K.08

Facility Comment: The term "cold clean, excess" is not used at UVA. Recommend delete question.

NRC Resolution: Not accepted. Clarification was provided during the exam. Question retained.

(6) Question K.12

Facility Comment: The procedure addresses "refueling" activities, vice "fuel handling" activities. Recommend answers be graded, allowing for potential confusion.

NRC Resolution: Acknowledged. Answers will be evaluated with attention to this possibility.

4. Exit Meeting

At the conclusion of the site visit, the examiner met with representatives of the plant staff to discuss the results of the examination. There were no generic weaknesses noted during the oral examination.

The cooperation given to the examiner was noted and appreciated.

The licensee did not identify as proprietary any of the material provided to or reviewed by the examiner.

-MASTER-

ENCLOSURE 2

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

FACILITY: UNIVERSITY OF VIRGINIA

REACTOR TYPE: TEST

DATE ADMINISTERED: 86/05/13

EXAMINER: BROCKMAN, K.

APPLICANT: _____

INSTRUCTIONS TO APPLICANT:

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 and a final grade of at least 80%. Examination papers will be picked up six (6) hours after the examination starts.

CATEGORY VALUE	% OF TOTAL	APPLICANT'S SCORE	% OF CATEGORY VALUE	CATEGORY
~~19.50~~	19.60			H. REACTOR THEORY
20.50	20.60			I. RADIOACTIVE MATERIALS HANDLING DISPOSAL AND HAZARDS
18.50	18.59			J. SPECIFIC OPERATING CHARACTERISTICS
20.50	20.60			K. FUEL HANDLING AND CORE PARAMETERS
20.50	20.60			L. ADMINISTRATIVE PROCEDURES, CONDITIONS AND LIMITATIONS
99.50	100.00			TOTALS

FINAL GRADE _____%

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

_____
APPLICANT'S SIGNATURE

QUESTION H.01 (1.00)

Using the UVAR core as the basis for your discussion, EXPLAIN why the average thermal neutron flux is LOWER for a WATER REFLECTED core than for a GRAPHITE REFLECTED core of the same thermal power level.

QUESTION H.02 (1.00)

Which one of the following describes the HOTTEST CHANNEL in the UVAR?

a. The channel where a control rod was just withdrawn leaving a large water gap.

b. The channel next to the rod with the highest reactivity worth with that rod INSERTED 60% to 70%.

c. The channel adjacent to a large water gap where a rod was just withdrawn.

d. The channel adjacent to a rod that was just INSERTED.

QUESTION H.03 (2.50)

SKETCH the following two (2) curves on attached Diagram # 692. USE THE SAME SCALES FOR EACH CURVE.

a. XENON Concentration buildup on a startup from a clean core to 100% power. (1.0)

b. XENON Concentration variation after a scram from 50% power for an extended period of time. (i.e., 50% equilibrium Xenon) (1.5)

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

QUESTION H.04 (3.00)

Using the attached integral rod worth curve for a three-rod reactor, answer the following:

a. Assuming that criticality is achieved with Rods A and B 80% withdrawn and Rod C 45% withdrawn, STATE the SHUTDOWN REACTIVITY was present - AND - the PRE-STARTUP K-EFF. (1.0)

b. If Rod C is moved to 55% withdrawn, from the critical positions in (a) above, STATE what the STABLE PERIOD meter indication would be. (1.0)

c. An A - B - C rod withdrawal sequence is used.
Rods can only be WITHDRAWN TO 90%.
Shutdown K-eff is 0.88 with counts of 15 cps.

CALCULATE the Rod Position necessary to attain counts stable at 60 cps. (1.0)

QUESTION H.05 (1.00)

Which of the following is the correct definition of microscopic cross section?

a. The actual target area of the nucleus.

b. The effective target area of the nucleus.

c. The total actual target area of all nuclei within the core.

d. The total effective target area of all nuclei within the core.

QUESTION H.06 (1.00)

Which of the following can be defined as "the number of neutrons causing fission that were originally born delayed divided by the total number of neutrons causing fission"?

a. Lambda effective

b. Rho

c. Beta effective

d. Tau

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

QUESTION H.07 (1.00)

In a subcritical reactor, Keff is increased from .88 to .965. Which of the following is the amount of reactivity that was added to the core?

a. .085 (8500 pcm)

b. .10 (10000 pcm)

c. .125 (12500 pcm)

d. .220 (22000 pcm)

QUESTION H.08 (1.00)

One of the characteristics of water is that it will hold gases dissolved in solution. Which of the following will INCREASE the concentration of dissolved gases in a quantity of water?

a. INCREASING the pressure and LOWERING the temperature.

b. DECREASING the pressure and LOWERING the temperature.

c. INCREASING the pressure and RAISING the temperature.

d. DECREASING the pressure and RAISING the temperature.

QUESTION H.09 (1.00)

The reactor is being started up after shutdown for two weeks with the startup source installed. The rod withdrawal is stopped at the -0.2 % ^k/k position and power level stablizes. Which of the following statements concerning how power level will respond in the next hour if no other actions are taken is correct?

a. Reactor power will remain essentially constant.

b. Reactor power will slowly decrease due to being subcritical.

c. Reactor power will rapidly decrease to initial prestartup level.

d. Reactor power will slowly increase due to long-lived delayed neutrons.

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

QUESTION H.10 (1.00)

The -1/3 DPM SUR following a reactor trip is caused by which of the following?

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

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

c. The amount of negative reactivity added on a trip being greater than the Shutdown Margin.

d. The doppler effect adding positive reactivity due to the temperature decrease following a trip.

QUESTION H.11 (1.00)

With the reactor initially at a keff of 0.99, a certain reactivity change causes the count rate to double. If this same amount of reactivity is again added to the reactor, which of the following will be the status of the reactor?

a. Subcritical

b. Critical

c. Supercritical

d. Prompt Critical

QUESTION H.12 (1.50)

Indicate whether the following statements are TRUE or FALSE.

a. A positive 100 pcm reactivity addition and a negative 100 pcm addition produce the same value of startup rates; only the signs are different. (0.5)

b. A delayed neutron has a higher probability of causing fission than does a prompt neutron. (0.5)

c. If a reactor is supercritical, the fraction of delayed neutrons shifts to the shorter lived precursors and the value of the average decay constant (lambda) decreases. (0.5)

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

QUESTION H.13 (2.00)

Indicate how (INCREASE, DECREASE, or REMAIN THE SAME) an increase in moderator temperature will affect the following parameters.

a. Resonance Escape Probability (0.5)

b. Thermal Utilization Factor (0.5)

c. Fast Non-Leakage Probability (0.5)

d. Fast Fission Factor (0.5)

QUESTION H.14 ~~(1.50)~~ 1.00

For the following definitions, give the term that is defined.

a. ~~The amount of reactivity that is needed to go from hot zero power to hot full power.~~ DELETE ~~(0.5)~~

b. The fractional change in neutron population per generation. (0.5)

c. The decay of a neutron into a proton with the simultaneous ejection of an electron (and antineutrino) from the nucleus. (0.5)

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

QUESTION I.01 (1.00)

Which one of the following statements describes the correct action(s) to be taken, if a film badge is lost?

a. Until a new film badge is obtained, no entry into a radiation area is allowed.

b. A direct-reading dosimeter is used in lieu of the lost film badge, until a new film badge is obtained.

c. The individual dose is estimated by processing the film badges of individuals with similar work functions, then a new film badge is issued.

d. A direct-reading dosimeter is issued, but entry into high radiation areas is not allowed until the next quarter to ensure quarterly exposure limits are not exceeded.

QUESTION I.02 (1.00)

Which one of the following statements regarding the release of pond water into Meadow Creek is NOT CORRECT?

a. The Reactor Supervisor must approve all pond water releases.

b. If the pond water reaches a level less than two feet below the top of the spillway, three samples must be taken.

c. If the pond water activity is greater than 3E-8 uc/ml, the water must be diluted prior to release.

d. One week prior to discharge, three samples must be drawn to determine the pond water activity.

QUESTION I.03 (2.50)

Concerning Effluent Releases:

a. If a release from a waste hold-up tank is to be performed in conjunction with pond water, LIST the four items of information which should be present on the "JOINT RELEASE OF WASTE TANK AND POND WATER AUTHORIZATION" Form for release approval to be given. (2.0)

b. STATE who may perform the actual release. (0.5)

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

QUESTION I.04 (2.00)

When a person becomes contaminated and the area of contamination on his body is large or not easily decontaminated, then certain personnel at the University are to be immediately contacted for the purpose of recommending decontamination procedures. LIST the Job Titles for the four (4) persons who are to be immediatelty notified.

QUESTION I.05 (2.00)

A segment of Amendment 1 to the UVAR SAR analyzes AR-41 exposure problems at the facility. The following questions pertain to that analysis.

a. DESCRIBE the event which is postulated as the most severe NORMAL case of AR-41 release to the environment. (1.0)

b. LIST the alarm setpoint(s) for the AR-41 monitors in the ductwork. (0.5)

c. STATE the type of detector used for AR-41 this monitoring. (0.5)

QUESTION I.06 (1.00)

Which of the following is a 10 CFR 20 exposure limit?

a. 5 rem/year - whole body.

b. 1 rem/quarter - whole body.

c. 18.75 rem/quarter - hands.

d. 7 rem/quarter - skin of whole body.

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

QUESTION I.07 (1.00)

What would be the activity of 28 grams of Al-28? (Al-28 has a half-life of 2.24 minutes).

a. 1.95 E24 dps

b. 1.86 E23 dps

c. 3.25 E22 dps

d. 3.10 E21 dps

QUESTION I.08 (1.00)

If a point source of gamma radiation gives an exposure rate of 10 mR/hr at 1 meter, what would be the exposure rate a 5 meters?

a. 2.0 mR/hr

b. 1.0 mR/hr

c. 0.4 mR/hr

d. 0.2 mR/hr

QUESTION I.09 (2.00)

For the following radiation detector types, indicate whether the output intensity (current or pulse height) is proportional to the incident radiation energy; i.e., if the incident energy increases, will the output intensity increase? (Answer YES or NO to each part.)

a. Ion Chamber (0.5)

b. GM (0.5)

c. Proportional Counter (0.5)

d. Scintillation (0.5)

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

QUESTION I.10 (1.50)

Match the isotopes in Column A with the principal type of radiation exposure hazard in Column B.

COLUMN A	COLUMN B
a. Ar-41	1. Alpha
b. Tritium	2. Beta
c. N-16	3. Neutron
	4. Gamma
	5. Proton

QUESTION I.11 (1.00)

When frisking in the step-down area of the UVAR reactor room, at what level are you considered contaminated?

a. 10000 dpm (absolute)

b. 5000 dpm (absolute)

c. 10000 dpm (above background)

d. 5000 dpm (above background)

QUESTION I.12 (1.50)

Match the radiation detector in Column A to the detector type in Column B.

COLUMN A	COLUMN B
a. Control Room	1. Ion Chamber
b. ~~Stack Gaseous~~	2. Proportional Counter
c. ~~Stack Particulate~~	3. GM
	4. Scintillation

QUESTION I.13 (2.00)

List, in order of severity (from lowest to highest), the FOUR Emergency Action Levels (EAL's) specified in the Emergency Plan Implementing Procedures.

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

QUESTION I.14 (1.00)

DESCRIBE how exposure to a member of a TOUR GROUP is determined.

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

QUESTION J.01 (4.00)

Assume that the UVAR is being operated at 2 MW, when a TOTAL LOSS OF POWER (Electrical) to the Facility occurs. EXPLAIN the effect of this "blackout" on EACH of the following:

a. Shim Rod Position
b. Regulating Rod Position
c. Core Spray System
d. Reactor Room Containment
e. Catch Tank Level (Pool Makeup System)
f. Pool Water Temperature
g. Constant Air Monitors
h. Primary Coolant System (0.5 each)

QUESTION J.02 (1.00)

For the purpose of making required reactivity measurements, STATE how an operator would determine that:

a. The UVAR core is XENON FREE (0.5)

b. The UVAR core is COLD (0.5)

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

QUESTION J.03 (3.00)

Regarding UVAR Primary and Secondary Chemistry:

a. LIST the applicable LIMITS (or ranges) for Conductivity and/or pH for: (1.0)

(1) Primary Water
(2) Secondary Water

b. LIST the two (2) reasons stated in the Technical Specifications which necessitate Primary Water control. (1.0)

c. TRUE or FALSE

The necessity to regenerate the primary water system demineralizer resin is indicated to the CONSOLE OPERATOR by an alarm. (0.5)

d. STATE the reason for adding Chromate compounds and detergent chemicals to the secondary water system. (0.5)

QUESTION J.04 (1.50)

DESCRIBE how N-16 is formed during reactor operation and STATE what provisions are made to assure that the effects are minimized in the UVAR.

QUESTION J.05 (2.00)

Indicate whether the Actual Critical Position (ACP) would be HIGHER THAN, THE SAME AS, or LOWER THAN the Estimated Critical Position (ECP) for the following conditions. Consider each separately.

a. A Beam Tube is inadvertently filled after the ECP is calculated. (0.5)

b. The reactor is started up 10 hours after S/D for 4 hours at 1.0 MW instead of 2 hours after shutdown. (0.5)

c. The ACP is taken at 100 W instead of 10 W with other parameters as calculated on ECP. (0.5)

d. The primary pump is secured just prior to startup. Note: the reactor has been shutdown all weekend. (0.5)

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

QUESTION J.06 (1.00)

STATE the two (2) flow requirements which the UVAR Core Spray System meets to satisfy its design basis (Flow Rates and Timing).

QUESTION J.07 (2.00)

DESCRIBE how the maximum excess reactivity is achieved on the CAVALIER without exceeding the Shutdown Margin required by the Technical Specifications. Consider a fuel loading procedure where the reciprocal multiplication data indicates that the reactor will go critical with the next addition of a normal fuel element - thus a partial element has been loaded first.

QUESTION J.08 ~~(1.00)~~ DELETE

~~Concerning UNLOADING the CAVALIER core:~~

~~"Immediately after monitoring,, each fuel element shall be moved to the Fuel Storage Room ..."~~

~~WHO must be notified prior to the move and WHY must this person be notified?~~

QUESTION J.09 (.50)

STATE which annunciator comes in when the "temporary electric eye" system annunciates while it is being used as a Radiation Zone Entry Alarm.

QUESTION J.10 (1.50)

LIST three (3) symptoms (indications) which you could expect to see as a result of a Dropped Rod.

QUESTION J.11 (1.00)

Per the UVAR SOP, DESCRIBE what indications would constitute INCONSISTENT READINGS of the Reactor Power Monitors (for power operations).

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

QUESTION K.01 (1.00)

Shim rods were last inspected on April 30, 1984. Which of the following dates would be the latest date to inspect them again without violating a UVAR surveillance requirement?

a. December 15, 1984

b. April 30, 1985

c. May 30, 1985

d. August 31, 1985

QUESTION K.02 (1.50)

LIST the three (3) criteria which must be met in order to keep a Shim Rod in service, after an inspection.

QUESTION K.03 (2.00)

Assume the following data was obtained during a core loading:

Number of Fuel Elements	Count Rate (CPS) Rods In	Rods Out
0	20	20
4	25	27
6	29	32
8	35	40
10	43	53
12	55	79

a. Using the attached graph paper, PLOT a 1/M curve for the above data, and PREDICT when criticality will occur.
SHOW ALL CALCULATIONS (1.5)

b. Analytically PREDICT when criticality will occur. (0.5)

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

QUESTION K.04 (2.50)

MATCH the Fuel Element parameter listed in Column A with the type of Fuel Element listed in Column B. (ANSWERS FROM COLUMN B MAY BE USED MORE THAN ONCE)

COLUMN A	COLUMN B
a. 18 Fuel Plates	1) Standard Flat Plate
b. 165 grams of U-235	2) Standard Partial Element
c. 0.4 Metal to Water Ratio	3) Standard Control Rod Element
d. 6 Fuel Plates	4) MTR Curved Plate
e. 0.211" Water Gap between Plates	5) MTR Rod Element

QUESTION K.05 (2.50)

Concerning Refueling activities:

a. STATE the bases for the precaution that no reactor core shall be taken critical with Shim Rod positions below 10 inches and the Regulating Rod fully withdrawn. (1.0)

b. LIST the log entries which are required when unloading fuel. (1.5)

QUESTION K.06 (1.00)

Which of the following is NOT a reason for pressurizing the fuel rods with helium?

a. Minimize clad creeping inwards toward fuel pellets.

b. Increase gap (pellet to clad) thermal conductivity.

c. Allow detection of clad failure by helium analysis of the coolant.

d. Maintain lower fuel centerline temperature.

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

QUESTION K.07 (1.00)

Following a reactivity insertion of +50 pcm to a subcritical reactor, the new count rate will take longest to reach equilibrium if :

a. The new keff is .997 and source strength is 50 N/sec.

b. The new keff is .999 and source strength is 50 N/sec.

c. The new keff is .997 and source strength is 100 N/sec.

d. The new keff is .998 and source strength is 100 N/sec.

QUESTION K.08 (1.00)

The Shutdown Margin is correctly calculated by which of the following?

a. Total Rod Worth - Highest Rod Worth + Cold, Clean Excess

b. Highest Rod Worth - Cold, Clean Excess + Total Rod Worth

c. Cold, Clean Excess - Highest Rod Worth - Total Rod Worth

d. Total Rod Worth - Highest Rod Worth - Cold, Clean Excess

QUESTION K.09 (1.00)

The following are the boiling phases associated with nucleate boiling and departure from nucleate boiling.

1) Transition Boiling
2) Bulk Boiling
3) Film Boiling
4) Sub-cooled (Local) Boiling

Which of the following is the order in which they would occur in a channel with normal flow and high heat flux?

a. 2, 4, 3, 1

b. 2, 4, 1, 3

c. 4, 2, 3, 1

d. 4, 2, 1, 3

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

QUESTION K.10 (1.50)

In the event of an Evacuation signal during fuel movement, STATE what actions are to be taken by the fuel handling crew?

QUESTION K.11 (1.00)

LIST the TWO Technical Specification design limits for fuel storage locations at the UVAR.

QUESTION K.12 (1.50)

LIST the minimum radiation monitoring detectors that must be in operation during fuel handling evolutions on the UVAR, without entering into an LCO.

QUESTION K.13 (1.00)

EXPLAIN why the CAVALIER Log N Instrument uses a Compensated Ion Chamber (CIC) while the Gamma Ray Power Range Instrument uses an Ion Chamber (IC).

QUESTION K.14 (1.00)

LIST two (2) times when Control Rod CALIBRATION is required.

QUESTION K.15 (1.00)

STATE what action(s) must be taken prior to removing TWO (2) Control Rods from the core.

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

QUESTION L.01 (1.50)

LIST the three (3) conditions which must be satisfied, per the Technical Specifications concerning the Alternate Reactivity Insertion System (ARIS), for the CAVALIER to be operated.

QUESTION L.02 (2.00)

LIST four (4) of the forces which the Restraining Force on SECURED EQUIPMENT must be able to withstand.

QUESTION L.03 (3.50)

SKETCH the Thermal Power vs. Coolant Flow Rate operational curve (Safety Limit Curve) for the FORCED CONVECTION MODE of the UVAR. Be sure to annotate axes parameters, critical and end points, and all other applicable core parameter limitations.

QUESTION L.04 (1.00)

Which one of the following conditions is NOT REQUIRED to allow removing a jumper from the control console of the CAVALIER?

a. No Safety System is compromised.

b. Reactor Supervisor's approval.

c. Reactor Log Book entry.

d. Reactor shutdown.

QUESTION L.05 (1.00)

Answer TRUE or FALSE to the following.

a. The licensee (you) shall notify the NRC within 15 days after the occurrence of a disability. (0.5)

b. If a licensee (you) have not been actively performing the functions of a senior operator for a period of five months, you can NOT resume licensed activities without NRC concurrence. (0.5)

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

QUESTION L.06 (1.50)

Per the UVAR TS, LIST the minimum required operating crew with the reactor at 1.0 MW, steady state conditions. STATE whether each individual must be at the facility or may be on call.

QUESTION L.07 (1.00)

LIST the requirements which must be met to process "minor" procedural changes (Include in your response a definition of "minor").

QUESTION L.08 (1.00)

The Power Level LSSS for the CAVALIER is 100 W, much greater than the average of the Maximum Average Power Limit of 200 W-hr/day. STATE the basis for allowing this higher power (i.e., how was the limit determined?)

QUESTION L.09 (2.00)

You are told ot escort a visitor through the UVAR reactor room. The visitor is a reporter on a local newspaper, but personally unknown to you or your supervisor. DESCRIBE your responsibilities and required actions, per UVAR SOP 13.

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

QUESTION L.10 (1.00)

Given:

"A Qualitative verification of acceptable performance by observation of ... behavior. This verification should include comparison with other independent indications or methods of measuring the same variable, where this capability exists."

Which of the following does this statement most accurately DEFINE.

a. Channel Calibration

b. Channel Check

c. Functional Test

d. Functional Check

QUESTION L.11 (2.00)

With respect to the UVAR Natural Convection Safety Limit:

a. DEFINE "P" and STATE its SPECIFICATION. (1.0)

b. DEFINE "T_I" and STATE its SPECIFICATION. (1.0)

QUESTION L.12 (1.50)

Per the CAVALIER SOP, when maintenance is performed whereby operation of a system or component could result in personnel injury:

a. STATE what action must be taken on the controlling device(s) for that system. (1.0)

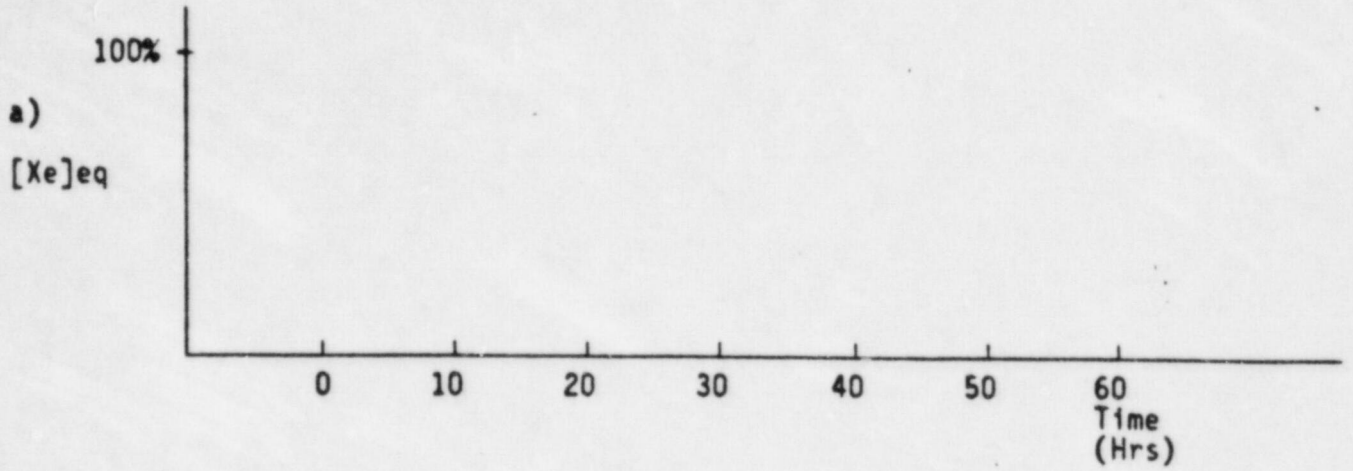
b. STATE who can "undo" the above action(s). (0.5)

QUESTION L.13 (1.50)

Per the UVAR TS, LIST the three (3) requirements which must be met when an individual is ON CALL.

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

(********** END OF EXAMINATION **********)


100%
a)
[Xe]eq
0
10
20
30
40
50
60
Time
(Hrs)

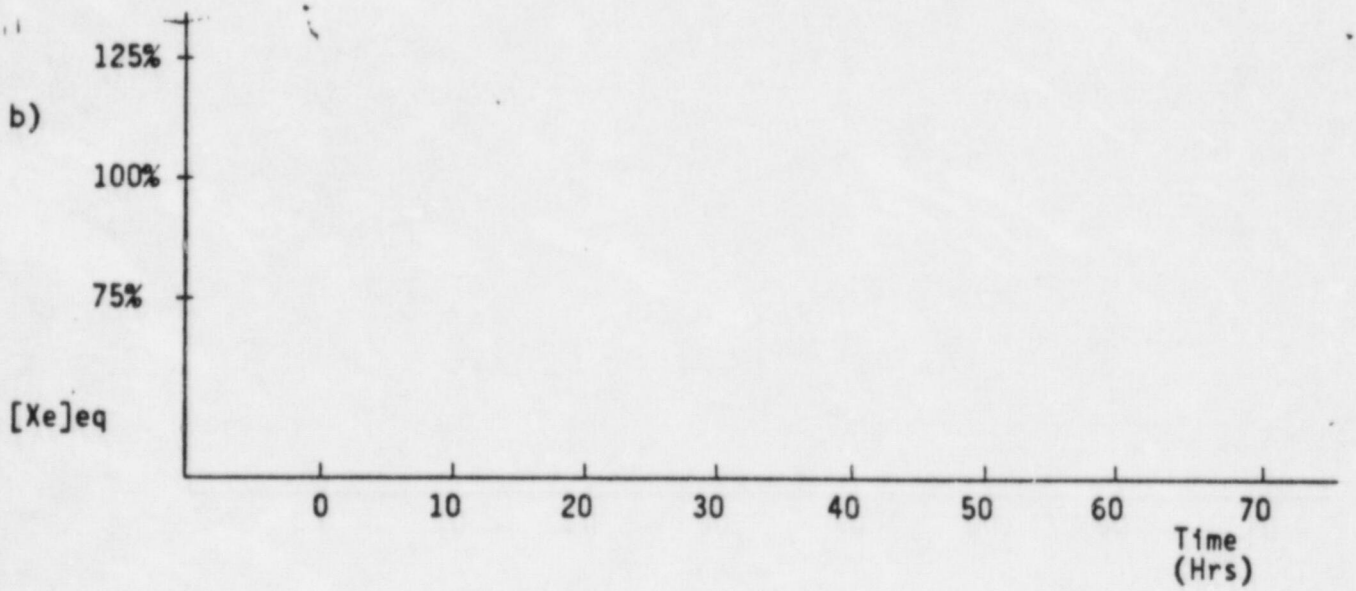

125%
b)
100%
75%
[Xe]eq
0
10
20
30
40
50
60
70
Time
(Hrs)

Figure #692

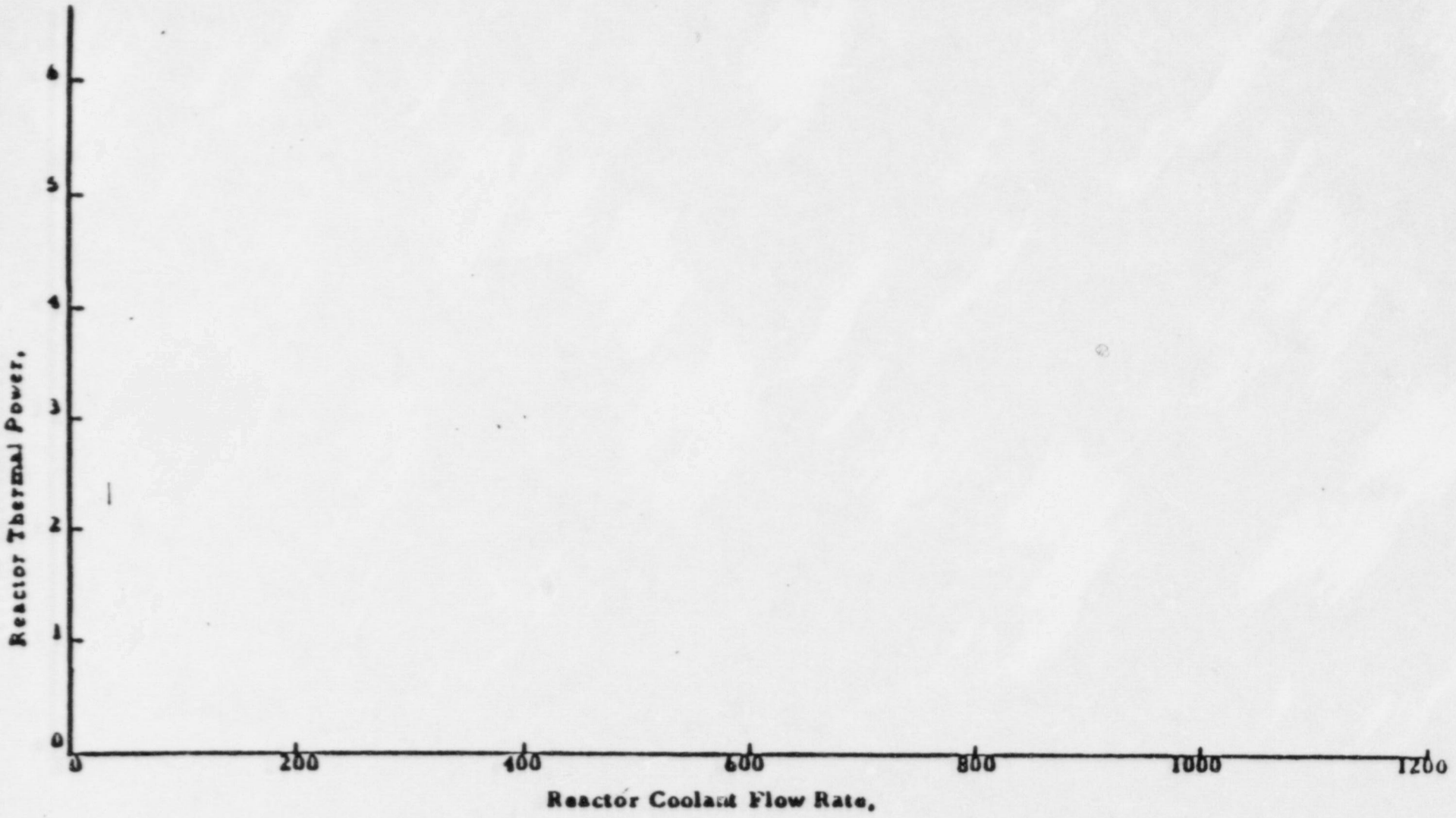
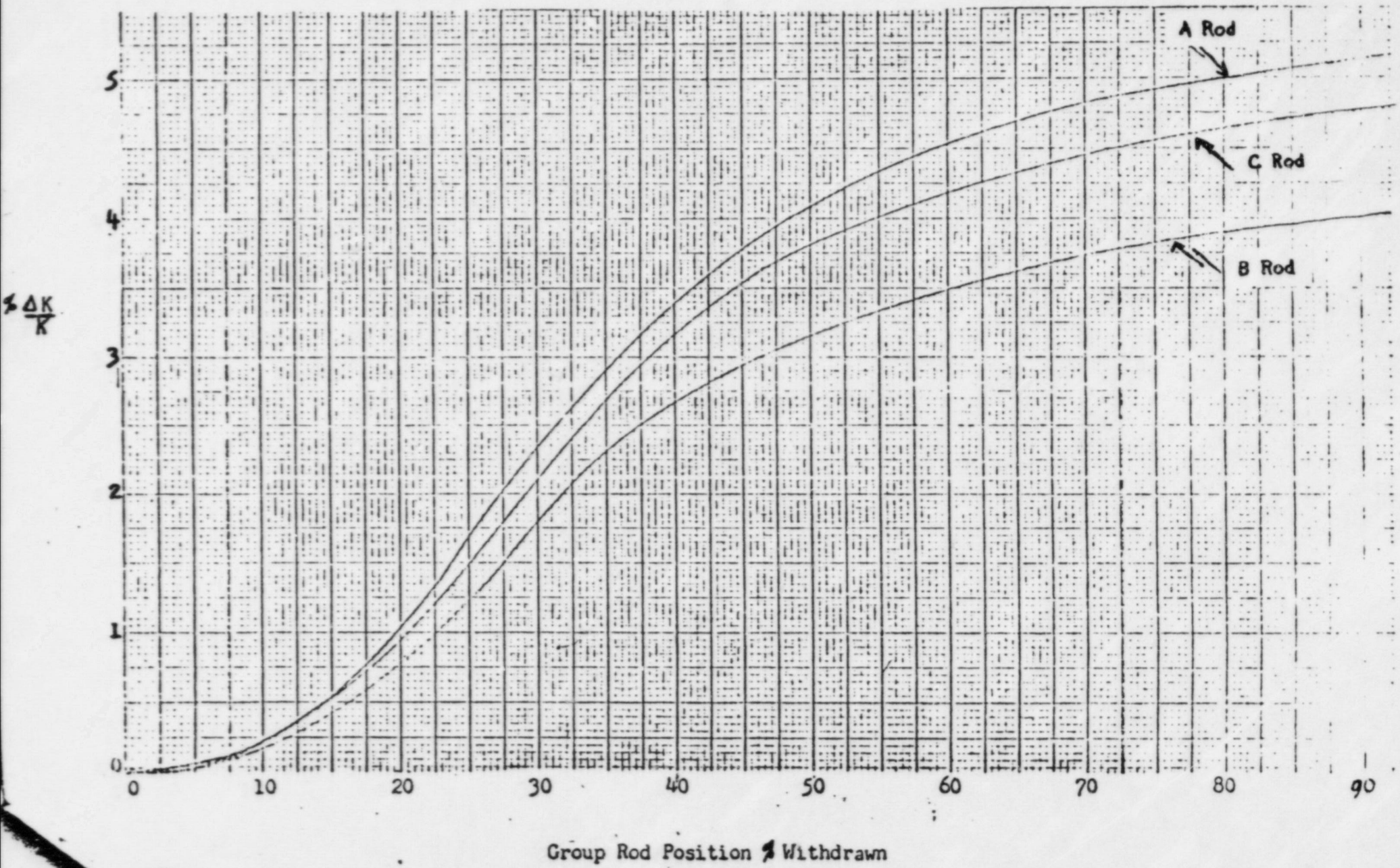

Reactor Thermal Power,
6
5
4
3
2
1
0
0
200
400
600
800
1000
1200
Reactor Coolant Flow Rate,

FIGURE 1.

INTEGRAL ROD WORTH



ANSWERS -- UNIVERSITY OF VIRGINIA -86/05/13-BROCKMAN, K.

ANSWER H.01 (1.00)

Critical loading is less for graphite (2.31 kg vs. 2.97 kg)

For same MW, if the amount of U-5 goes down, then the flux must go up to maintain the same fission rate

- OR -

More neutrons are reflected back into the core because water is a better neutron absorber. (1.0)

REFERENCE
UVA: UVAR SAR, pp 26 - 27; DPC, Section 3.3

ANSWER H.02 (1.00)

C

REFERENCE
UVA: UVA SAR, p 136

ANSWER H.03 (2.50)

See Attached Graphs

REFERENCE
UVA: DPC, pp 161 - 164; NUS, Module 3, pp 10.2-2/3, 10.3-1/3

ANSWERS -- UNIVERSITY OF VIRGINIA -86/05/13-BROCKMAN, K.

ANSWER H.04 (3.00)

a. Rod A - 5 % ^k/k
Rod B - 3.9 % ^k/k
Rod C - 3.55% ^k/k

12.45% ^k/k = Shutdown Reactivity (0.5)

(K-eff - 1)/K-eff = -.1245 -> k - 1 = -.1245 * k -> k = 0.89 (0.5)

b. Rod C Inserts = 0.45 ^k/k

T = (Beta-eff - rho)/lambda * rho = (.007 - .0045)/.08 * .0045
= 6.94 seconds (1.0)

c. C2/C1 = (1-k1)/(1-k2)
60/15 = (1 - .88)/(1 - k2) -> k2 = .97 -> 10.5% ^k/k (0.5)

Rod A w/d @ 90% = -5.15 % ^k/k
Rod B w/d @ 90% = -4 % ^k/k

Rod C needs 1.35% ^k/k (10.5% - 9.15%) = 24% Withdrawn (0.5)

REFERENCE
UVA: NUS, Module 3, Unit 6

ANSWER H.05 (1.00)

b

REFERENCE
CP&L, Nuclear Reactor Theory, p. 5-2

ANSWER H.06 (1.00)

c

REFERENCE
NUS, Reactor Theory

ANSWERS -- UNIVERSITY OF VIRGINIA -86/05/13-BROCKMAN, R.

ANSWER H.07 (1.00)

b

REFERENCE
NUS, Vol 3, pp 6.1-3

ANSWER H.08 (1.00)

a

REFERENCE
General Physics, HT & FF, Chapter 1

ANSWER H.09 (1.00)

a

REFERENCE
Basic Reactor Theory, Subcritical Multiplication

ANSWER H.10 (1.00)

a

REFERENCE
VEGP, Training Text, Vol. 9, p. 21-47
Westinghouse Reactor Physics, pp. I-3.17 & 19
DPC, Fundamentals of Nuclear Reactor Engineering, p. 106
001/000-K5.49 (2.9/3.4)

ANSWER H.11 (1.00)

c

REFERENCE
HBR, Reactor Theory, Session 42, pp. 3 & 4
DPC, Fundamentals of Nuclear Reactor Engineering
004/000-K5.08 (2.6/3.2)

ANSWERS -- UNIVERSITY OF VIRGINIA -86/05/13-BROCKMAN, R.

ANSWER H.12 (1.50)

a. FALSE (0.5)
b. FALSE (Power Reactor); TRUE (Research Reactor) (0.5)
c. FALSE (0.5)

REFERENCE
Westinghouse Nuclear Training Operations, pp. I-3.9 - 15

ANSWER H.13 (2.00)

a. DECREASE (0.5)
b. INCREASE (0.5)
c. DECREASE (0.5)
d. INCREASE (0.5)

REFERENCE
Westinghouse Nuclear Training Operations, pp. I-2.31 - 36

ANSWER H.14 ~~(1.50)~~ 1.00

a. Power Defect (~~-0.25 for power coefficient~~) DELETE ~~(0.5)~~
b. Reactivity (0.5)
c. Beta (minus) Decay (0.5)

REFERENCE
Westinghouse Reactor Physics, pp. I-5.26, I-3.2, and I-1.18
NSR, Reactor Theory, Session 32, p. 3 and Session 21, p. 2 and
Session 4, p. 2

ANSWERS -- UNIVERSITY OF VIRGINIA -86/05/13-BROCKMAN, K.

ANSWER I.01 (1.00)

b

REFERENCE
UVA: UVAR SOP 10-3

ANSWER I.02 (1.00)

d

REFERENCE
UVA: UVAR SOP, pp 10-9 & 10

ANSWER I.03 (2.50)

a. Specific activity from the Waste Hold-up Tank
Specific activity of the pond
Volumetric flow rate of the pond and tank
Calculated activity of the mixed release (0.5 each)

b. The Facility Staff or Environmental Health and Safety Office Staff (0.5)

REFERENCE
UVA: UVAR SOP, pp 10-10 - 12

ANSWER I.04 (2.00)

Reactor Health Physicist
Environmental Health and Safety Officer
Facility Director
Reactor Supervisor (0.5 each)

REFERENCE
UVA: UVAR SOP, p 10-19

ANSWERS -- UNIVERSITY OF VIRGINIA -86/05/13-BROCKMAN, K.

ANSWER I.05 (2.00)

a. Flooding a Beam Port after a long period of operation (0.5) due to the large volume of irradiated air released (0.5). (1.0)

b. 800 cpm (700 cpm + 100 cpm background). (0.5)

c. (Thin walled) G-M Tube. (0.5)

REFERENCE
UVA: UVAR SAR, Amendment 1, pp 54 - 56

ANSWER I.06 (1.00)

c

REFERENCE
10 CFR 20.101

000/060-K1.02 (2.5/3.1)

ANSWER I.07 (1.00)

d

REFERENCE
NUS-NET, Volume 2

ANSWER I.08 (1.00)

c

REFERENCE
Rad Health Handbook, USDHEW, p. 56

ANSWERS -- UNIVERSITY OF VIRGINIA -86/05/12 BROCKMAN, K.

ANSWER I.09 (2.00)

a. YES (0.5)
b. NO (0.5)
c. YES (0.5)
d. YES (0.5)

REFERENCE
FNP, Health Physics and Radiation Protection Lesson Plans, pp. 41-46
William J. Price, Nuclear Radiation Detection, pp. 43 - 46, 77, 138, and 196
VEGP, Training Text, Volume 9, pp. 23-39 - 42

072/00-K5.01 (2.7/3.0)

ANSWER I.10 (1.50)

a. 4 (0.5)
b. 2 (0.5)
c. 4 (0.5)

REFERENCE
Chart of the Nuclides

ANSWER I.11 (1.00)

c

REFERENCE
UVA: UVAR SOP 10-5

ANSWER I.12 (1.50)

a. 1 (0.5)
b. 3 (0.5)
c. 2/3 (0.5)

REFERENCE
NCSU, Ops Manual, Table 7-1
UVA: CAF

ANSWERS -- UNIVERSITY OF VIRGINIA -86/05/13-BROCKMAN, M.

ANSWER I.13 (2.00)

(0.3 for EAL, 0.2 for order)

1. Unusual Event (0.5)
2. Alert (0.5)
3. Site Emergency (0.5)
4. General Emergency (0.5)

REFERENCE
NCSU, Emergency Procedure 4.0, p. 1
UVA: CAF

ANSWER I.14 (1.00)

The tour guide will wear two dosimeters. The entire group is considered to be equally exposed to a level equal to the average of the two dosimeters.

REFERENCE
UVA: UVAR SOP 10-4

ANSWERS -- UNIVERSITY OF VIRGINIA -86/05/13-BROCKMAN, R.

ANSWER J.01 (4.00)

a. FULL IN (Loss of Magnet Current)
b. AS IS (Loss of Drive Moter Current)
c. Water Flow to Tanks STOPS
d. Ventilation Exhaust Duct Door & Personnel Access Door CLOSES
e. NO EFFECT (Mechanical Float Valve)
f. INCREASES (Decay Heat w/o Flow)
g. STOPS (Ceases to Function)
h. STOPS (Pump Stops -> No Flow nor Indication) (0.5 each)

REFERENCE
UVA: UVAR SAR, Various Sections

ANSWER J.02 (1.00)

a. The reactor has not been operated at a power greater than 1 kW (0.25) during the previous 96 hours (0.25) (0.5)

b. Pool Temperature less than 90 deg F. (0.5)

REFERENCE
UVA: UVAR SOP 5-24; UVAR TS, Definitions

ANSWER J.03 (3.00)

a. (1) Conductivity 1 - 2 umho/cm -OR- Poolwater < 5 umho/cm
pH 6 - 7 -OR- 5 - 7.5 (0.25 each)

(2) pH ONLY 6 - 7.4 (0.5)

b. Limit Corrosion of the Fuel Cladding
Limit Inventory of radioactive nuclides (0.5 each)

c. TRUE (0.5)

d. Chromates - Corrosion Control
Detergent - Algae Control (0.25 each)

ANSWERS -- UNIVERSITY OF VIRGINIA -86/05/13-BROCKMAN, K.

REFERENCE
UVA: UVAR SOP 8-1; TS 3-11

ANSWER J.04 (1.50)

$$^{16}_{8}O + ^{1}_{0}n \rightarrow ^{16}_{7}N + ^{1}_{1}p$$ (0.5)

Flow water directs returning primary water at wall furthest from the reactor, thus minimizing N-16 gamma activity. (0.5)

In forced convection, newly formed N-16 is drawn into the header instead of being allowed to rise to the pool surface. (0.5)

REFERENCE
UVA: UVAR SAR, p 65

ANSWER J.05 (2.00)

a. THE SAME AS (0.5)
b. HIGHER THAN (0.5)
c. THE SAME AS (0.5)
d. THE SAME AS (0.5)

REFERENCE
NCSU, PDS, Vol. II, p. 11

ANSWER J.06 (1.00)

1) 10 gpm (0.35) for the first 30 minutes (0.35) (0.7)

2) 7.5 gpm (0.15) for the next 60 minutes (0.15) (0.3)

REFERENCE
UVA: UVAR TS 3.1

ANSWER J.07 (2.00)

The partial element will be replaced by an experimental fuel element with the maximum number of fuel plates removed. Fuel plates will be added to the element, one at a time, and rod positions and shutdown margin checked after the addition of each fuel plate until the maximum excess reactivity is achieved without exceeding the shutdown margin requirements.

REFERENCE
UVA: CAVALIER SOP 5-1.a.h

ANSWER J.08 ~~(1.00)~~ DELETE

~~UVAR RO (0.3). Passing too close to the UVAR Face Monitor will result in a UVAR Scram and Hi Radiation Alarm (0.7)~~

REFERENCE
UVA: CAVALIER SAR 5-4.d

ANSWER J.09 (.50)

Heat Exchanger Radiation Zone Entry

REFERENCE
UVA: UVAR SOP 11-4

ANSWER J.10 (1.50)

Magnet Engaged Lites - OUT
Seating Lites - ON
Reactor Power - DECREASE

REFERENCE
UVA: UVAR SOP 11-5

ANSWER J.11 (1.00)

Power Range Channels 5% (100 kW) below the power level indicated by the Core Differential Temperature.

REFERENCE
UVA: UVAR SOP 11-7

ANSWERS -- UNIVERSITY OF VIRGINIA -06/05/13-BROCKMAN, K.

ANSWER K.01 (1.00)

C

REFERENCE
UVA: UVAR SOP 7-18 (TS allows 15 months)

ANSWER K.02 (1.50)

1) No crack greater than 1/4" in length.

2) No obvious deterioration.

3) Able to pass a 1" feeler gauge freely over the rod. (0.5 each)

REFERENCE
UVA: UVAR SOP 7-18

ANSWERS -- UNIVERSITY OF VIRGINIA -86/05/13-BROCKMAN, K.

ANSWER K.03 (2.00)

a. Calculate 1/M after each loading for the Rods Out Data

Number of Elements	CPS	1/M
0	20	1.00
4	27	0.80
6	32	0.69
8	40	0.50
10	53	0.38
12	79	0.25

(0.5)

Plot 1/M vs. # of Fuel Elements; Extrapolate the graph to 1/M = 0.00; You will get 16 Elements needed to go critical. (1.0)

b. Using the Rods Out Data, choose any two points and construct the mathematical analogy to predict criticality.

e.g., If 0 Elements and 8 Elements were chosen:

N/8 = 1.00 / 0.50 -> N = 16 for Criticality (0.5)

REFERENCE
UVA: UVAR SOP 5

ANSWER K.04 (2.50)

a. 4

b. 1

c. 1 & 2

d. 2 & 3

e. 1, 2, & 3 (0.5 each)

ANSWERS -- UNIVERSITY OF VIRGINIA -86/05/13-BROCKMAN, K.

REFERENCE
UVA: UVAR SAR, pp 2/26/32 - 33

ANSWER K.05 (2.50)

a. This ensures that the reactor will not go critical when pulling shim rods two at a time during a reactor startup. (1.0)

b. Name of the Senior Operator in charge

All operations and manipulations

Fuel element numbers and storage locations (0.5 each)

REFERENCE
UVA: UVAR SOP, pp 5-9/10, 5-14

ANSWER K.06 (1.00)

c

REFERENCE
General Physics, HT & FF, pp. 239 and 240

ANSWER K.07 (1.00)

b

REFERENCE
VLGP, Training Text, Vol. 9, p. 21-17

ANSWER K.08 (1.00)

d

REFERENCE
NCSU, Ops Manual, p. 3-36
UVA: TS 3.1(1)

ANSWERS -- UNIVERSITY OF VIRGINIA -86/05/13 BUCKMAN, K.

ANSWER K.09 (1.00)

d

REFERENCE
NUS, Vol 4, pp 3.3-2
Turkey Point, Thermal-Hydraulic Principles and Applications, pp. 13-17 - 20

ANSWER K.10 (1.50)

1. Fuel assembly in transit stored in recorded location (0.5)
2. Fuel handling tool disconnected from fuel (0.5)
3. Evacuate Reactor Bay (0.5)

- CAF -

REFERENCE
NSCU, Special Procedure 3.2, p. 1
UVA: CAF

ANSWER K.11 (1.00)

1. Keff less than 0.9 (0.5)
2. Temperature less than 100 degrees C (0.5)

REFERENCE
UVA: UVAR TS, 5.3

ANSWER K.12 (1.50)

Bridge Radiation Monitor
Core Gamma Monitor
Reactor Room Continuous Air Monitor (CAM) (0.5 each)

REFERENCE
UVA: UVAR TS 3.1, 3.2

ANSWER K.13 (1.00)

The CIC is needed to compensate for background and decay gammas which can distort indications at lower power levels; the IC does not discriminate for gammas, since at higher power levels the gamma signal is proportional to neutron power. (Also, the direct gamma signal is used in lieu of conducting reactor heat balances).

REFERENCE
Detector Theory
UVA: UVAR SOP 7-3; CAVALIER SAR 4.3.4.4

ANSWER K.14 (1.00)

1) Change in core configuration is made.

2) 1200 MW-hr since the last calibration. (0.5 each)

REFERENCE
UVA: UVAR SOP 7-4

ANSWER K.15 (1.00)

Remove at least four (4) Fuel Elements (0.5) from near the center of the core (0.5).

REFERENCE
UVA: UVAR SOP 5.4.2.D

ANSWERS -- UNIVERSITY OF VIRGINIA -86/05/13-BROCKMAN, K.

ANSWER L.01 (1.50)

1) Solution volume greater than 24 gallons
2) Boron Concentration greater than 0.129 lbm/gal
3) ARIS injection valve unlocked (0.5 each)

REFERENCE
UVA: CAVALIER TS, 3.8

ANSWER L.02 (2.00)

1) Hydraulic
2) Pneumatic
3) Buoyant
4) Other forces normal to the operating environment
5) Forces that can arise from credible malfunctions (4 @ 0.5 each)

REFERENCE
UVA: UVAR TS, Definitions

ANSWER L.03 (3.50)

See Attached Curve on the Next Page

REFERENCE
UVA: UVAR TS 2.1.2, Figure 2.1

ANSWER L.04 (1.00)

d

REFERENCE
UVA: CAVALIER SOP, p 1

ANSWERS -- UNIVERSITY OF VIRGINIA -86/05/19-BROCHMAN, R.

ANSWER L.05 (1.00)

a. TRUE (0.5)
b. TRUE (0.5)

REFERENCE
10CFR55.41 and 10CFR55.31(e)

ANSWER L.06 (1.50)

1. DSRO (or RO) (0.3) - At the Facility (0.2)
2. SRO (0.3) - On Call (0.2)
3. Anybody Else (0.3) - At the facility (0.2)

REFERENCE
UVA: UVAR TS 6.1

ANSWER L.07 (1.00)

Minor means that the original intent of the procedure is not changed (0.3). The change can be approved by the Facility Director (0.3), must be documented (0.2) and reviewed by the Reactor Safety Committee (0.2).

REFERENCE
UVA: UVAR and CAVALIER TS 6.3

ANSWER L.08 (1.00)

This was determined by the gamma radiation level above the Moderator Tank being minimal (< 1 mR/hr) and the neutron level being negligible, in those areas accessible to personnel. (This was based on calculations and measurements.)

REFERENCE
UVA: CAVALIER SAR, Section 3.2.3

ANSWERS -- UNIVERSITY OF VIRGINIA -86/05/13-BROCKMAN, K.

ANSWER L.09 (2.00)

People desiring entry into the reactor room who are not authorized to know the lock combination will require the assistance of someone authorized to know it. This authorized person is responsible for obtaining the identity of the person desiring entry, determining that they have a need to enter, and, if the identity of the person desiring entry is not known, searching any packages being taken into the reactor room and ensuring that he/she is escorted while in the reactor room.

Packages carried by visitors which are larger than small hand carried items will normally be left outside of the reactor room.

REFERENCE
UVA: UVAR SOP 13.3.2

ANSWER L.10 (1.00)

b

REFERENCE
UVA: UVAR TS, Definitions

ANSWER L.11 (2.00)

a. Reactor Thermal Power (0.5); 750 kWt (0.5)

b. Reactor Coolant Inlet Temperature (0.5); 111 deg F (0.5)

REFERENCE
UVA: UVAR TS 2.1

ANSWER L.12 (1.50)

a. Controlling device(s) secured (0.5) and Danger Tagged (0.5).

b. Person familiar with the maintenance and the danger asscoiated with it. (0.5)

REFERENCE
UVA: CAVALIER SOP, Section 7.0.A

ANSWERS -- UNIVERSITY OF VIRGINIA -86/05/13-BROCKMAN, K.

ANSWER L.13 (1.50)

1) Individual designated and DSRO informed.

2) DSRO kept informed on the persons location and Phone Number.

3) Capability of getting to the facility in a reasonable amount of time (~ 30 minutes). (0.5 each)

REFERENCE
UVA: UVAR TS, Definitions

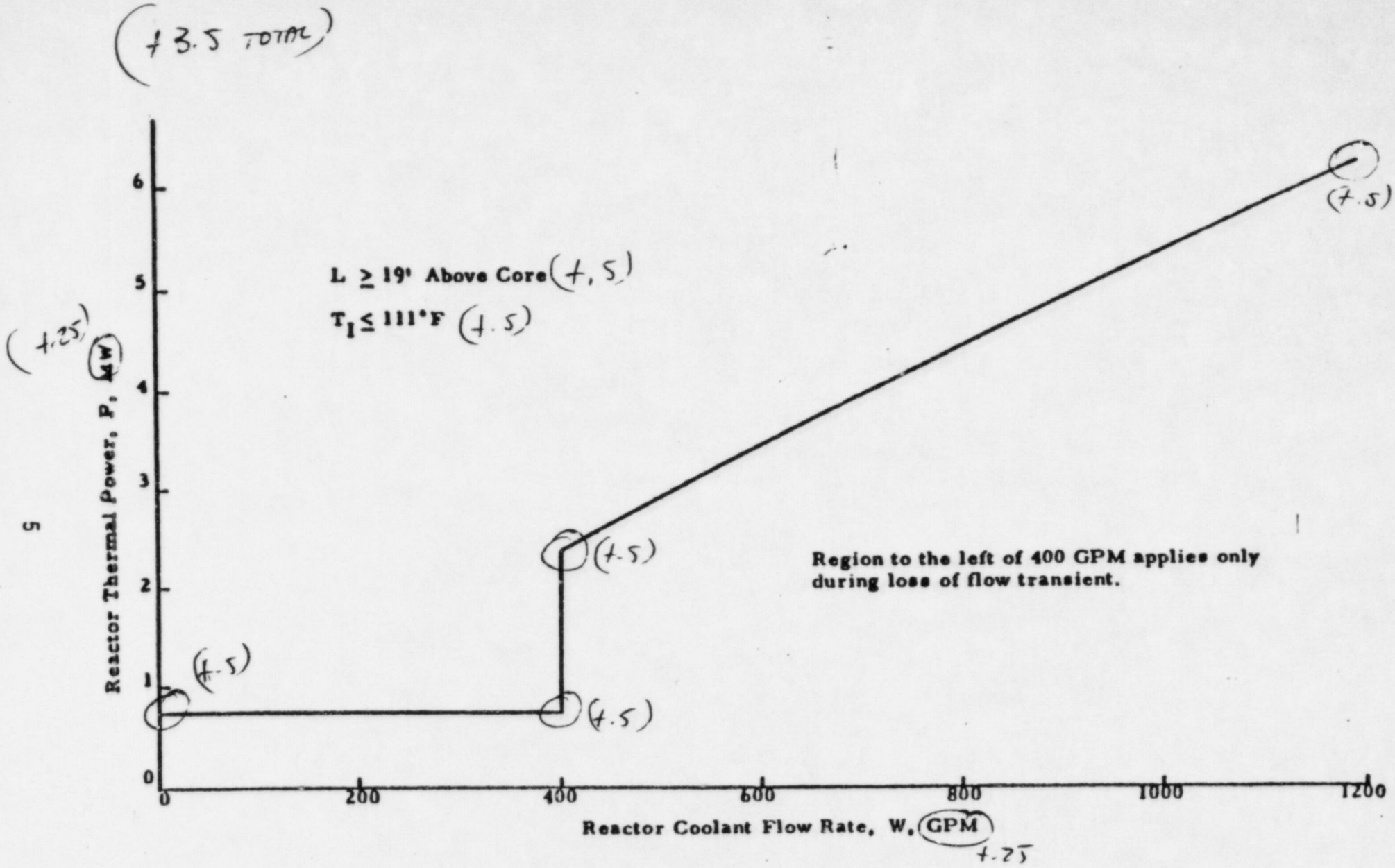
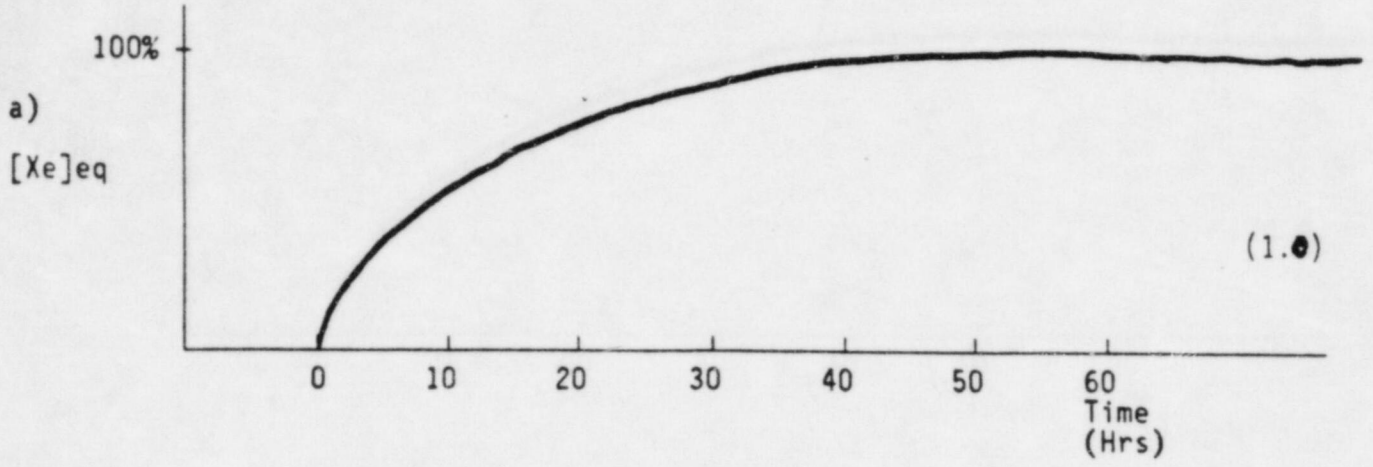
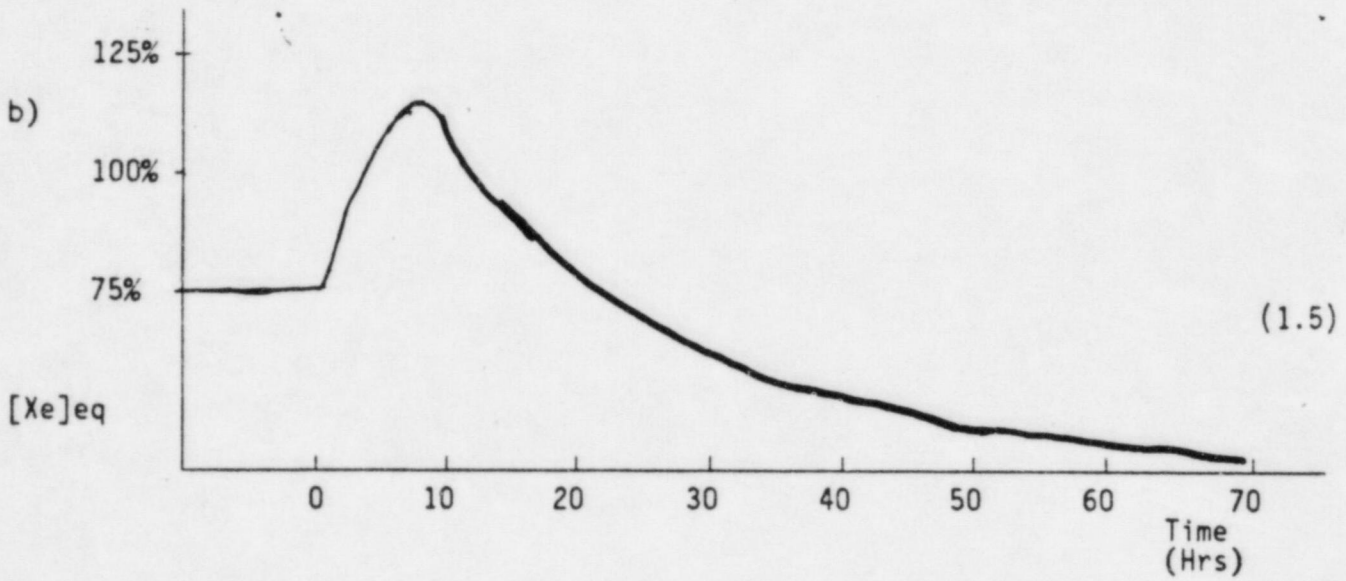


Figure 2.1 Safety limits with forced convection flow





Ref: DPC pp 161-164
NUS Module 3, pp 10.2-2/3, 10. 3-1/3

QUESTION	VALUE	REFERENCE
H.01	1.00	KEB0000690
H.02	1.00	KEB0000691
H.03	2.50	KEB0000692
H.04	3.00	KEB0000693
H.05	1.00	KEB0000712
H.06	1.00	KEB0000713
H.07	1.00	KEB0000714
H.08	1.00	KEB0000715
H.09	1.00	KEB0000716
H.10	1.00	KEB0000717
H.11	1.00	KEB0000718
H.12	1.50	KEB0000719
H.13	2.00	KEB0000720
H.14	1.50	KEB0000721
	19.50	
I.01	1.00	KEB0000694
I.02	1.00	KEB0000695
I.03	2.50	KEB0000696
I.04	2.00	KEB0000697
I.05	2.00	KEB0000698
I.06	1.00	KEB0000722
I.07	1.00	KEB0000723
I.08	1.00	KEB0000724
I.09	2.00	KEB0000726
I.10	1.50	KEB0000727
I.11	1.00	KEB0000728
I.12	1.50	KEB0000729
I.13	2.00	KEB0000730
I.14	1.00	KEB0000742
	20.50	
J.01	4.00	KEB0000699
J.02	1.00	KEB0000700
J.03	3.00	KEB0000701
J.04	1.50	KEB0000702
J.05	2.00	KEB0000731
J.06	1.00	KEB0000743
J.07	2.00	KEB0000744
J.08	1.00	KEB0000745
J.09	.50	KEB0000746
J.10	1.50	KEB0000747
J.11	1.00	KEB0000748
	18.50	
K.01	1.00	KEB0000703
K.02	1.50	KEB0000704

QUESTION	VALUE	REFERENCE
K.03	2.00	KEB0000705
K.04	2.50	KEB0000706
K.05	2.50	KEB0000707
K.06	1.00	KEB0000733
K.07	1.00	KEB0000734
K.08	1.00	KEB0000735
K.09	1.00	KEB0000736
K.10	1.50	KEB0000737
K.11	1.00	KEB0000738
K.12	1.50	KEB0000739
K.13	1.00	KEB0000749
K.14	1.00	KEB0000757
K.15	1.00	KEB0000758
	20.50	
L.01	1.50	KEB0000708
L.02	2.00	KEB0000709
L.03	3.50	KEB0000710
L.04	1.00	KEB0000711
L.05	1.00	KEB0000740
L.06	1.50	KEB0000741
L.07	1.00	KEB0000750
L.08	1.00	KEB0000751
L.09	2.00	KEB0000752
L.10	1.00	KEB0000753
L.11	2.00	KEB0000754
L.12	1.50	KEB0000755
L.13	1.50	KEB0000756
	20.50	
	99.50	