U.S. NUCLEAR REGULATORY COMMISSION REGION I
OPERATOR LICENSING EXAMINATION REPORT

EXAMINATION REPORT NO. 50-057/88-01(OL)

FACILITY DOCKET NO. 50-057

FACILITY LICENSE NO. R-77

LICENSEE: State University of New York at Buffalo
Rotary Road
Buffalo, New York 14214

FACILITY: Buffalo Materials Research Center

EXAMINATION DATES: February 9 and 10, 1988

CHIEF EXAMINER: *[signature]* 23 Mar 88
Barry S. Norris, Senior Operations Engineer — Date

APPROVED BY: *[signature]* 3-24-88
Peter W. Eselgroth, Chief, PWR Section, Operations Branch, Division of Reactor Safety, Region I — Date

SUMMARY: Written and operating examinations were administered to two Reactor Operator (RO) candidates. Both candidates passed these examinations.

REPORT DETAILS

TYPE OF EXAMINATIONS: Replacement

EXAMINATION RESULTS:

	RO Pass/Fail
Written	2/0
Operating	2/0
Overall	2/0

CHIEF EXAMINER AT SITE: B. S. Norris, USNRC

OTHER EXAMINERS: D. B. Jarrell, PNL

1. The following is a summary of generic deficiencies noted during the operating examinations. This information is being provided to aid the licensee in upgrading license and requalification training programs. No licensee response is required.

   a. Both candidates were weak with respect to evacuation procedures for a fire or radiological problem.

   b. Both candidates were weak on radiation detector operation and on calculations for shielding and distance from a radiation source.

2. The written examination questions and answer key were reviewed by L. G. Henry and P. M. Orlosky of your staff. The facility comments and the NRC resolution of those comments is enclosed.

Attachments:

1. RO Written Examination and Answer Key
2. Facility Comments on Written Examinations and NRC Resolution

ATTACHMENT 1

Master Answer Key

U. S. NUCLEAR REGULATORY COMMISSION
REACTOR OPERATOR LICENSE EXAMINATION

FACILITY: STATE UNIV. OF NEW YORK

REACTOR TYPE: TEST

DATE ADMINISTERED: 88/02/09

EXAMINER: JARRELL, D.

CANDIDATE: ANSWER KEY

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	CANDIDATE'S SCORE	% OF CATEGORY VALUE	CATEGORY
15.00	~~15.00~~ 15.23			A. PRINCIPLES OF REACTOR OPERATION
15.00	~~15.00~~ 15.23			B. FEATURES OF FACILITY DESIGN
~~14.50~~ 14.00	~~14.50~~ 14.21			C. GENERAL OPERATING CHARACTERISTICS
~~15.00~~ 14.00	~~15.00~~ 14.21			D. INSTRUMENTS AND CONTROLS
13.50	~~13.50~~ 13.71			E. SAFETY AND EMERGENCY SYSTEMS
13.50	~~13.50~~ 13.71			F. STANDARD AND EMERGENCY OPERATING PROCEDURES
13.50	~~13.50~~ 13.71			G. RADIATION CONTROL AND SAFETY
~~100.00~~ 98.50		Final Grade	%	Totals

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

Candidate's Signature

Category values reduced due reducing points or to deleting following questions:

C.06.a (0.50 points)

D.05 (0.50 points)

D.08 (0.50 points)

[signature]
2 Mar 88

NRC RULES AND GUIDELINES FOR LICENSE EXAMINATIONS

During the administration of this examination the following rules apply:

1. Cheating on the examination means an automatic denial of your application and could result in more severe penalties.

2. 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.

3. Use black ink or dark pencil only to facilitate legible reproductions.

4. Print your name in the blank provided on the cover sheet of the examination.

5. Fill in the date on the cover sheet of the examination (if necessary).

6. Use only the paper provided for answers.

7. Print your name in the upper right-hand corner of the first page of each section of the answer sheet.

8. Consecutively number each answer sheet, write "End of Category __" as appropriate, start each category on a new page, write only on one side of the paper, and write "Last Page" on the last answer sheet.

9. Number each answer as to category and number, for example, 1.4, 6.3.

10. Skip at least three 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 literature.

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 examiner 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.

18. 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.

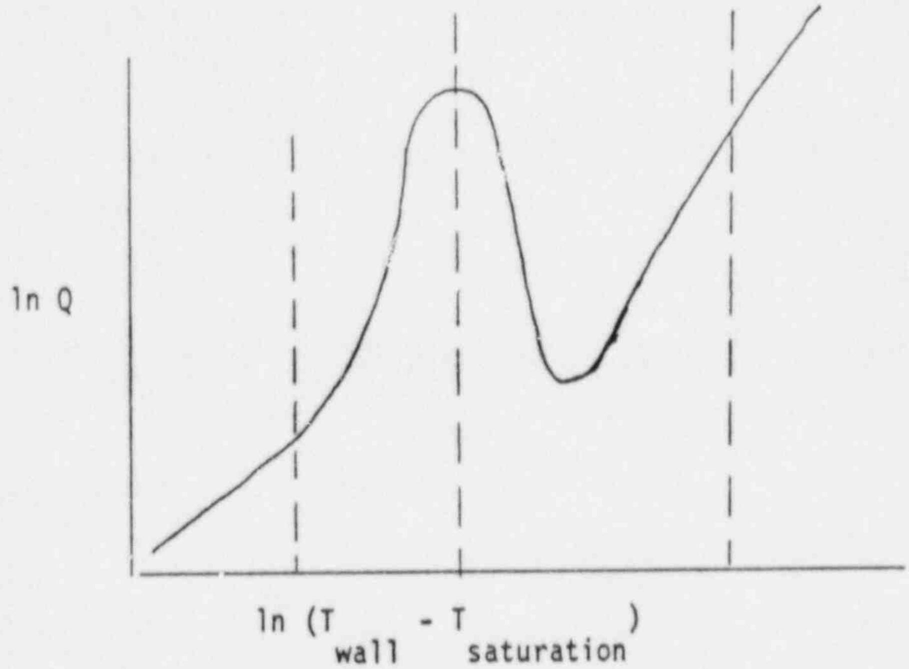
QUESTION A.01 (2.00)

On the curve of heat flux density versus temperature difference shown below,

a. LABEL each of the four (4) indicated segments of the curve with its associated heat transfer regime. (1.0)

b. LABEL the point of DNB (departure from nucleate boiling). (0.5)

c. INDICATE the portion of the curve where the SUNYAB reactor is allowed by Tech Specs to operate. (0.5)



QUESTION A.02 (2.00)

Fuel assemblies are shuffled to move some of the peripheral assemblies to the center and the central assemblies to the periphery. Assuming that only original fuel elements remain in the core, and no net fuel addition or subtraction took place, WOULD it be safe to assume that no change in core excess reactivity took place? EXPLAIN. (2.0)

QUESTION A.03 (1.00)

WHAT is responsible for the shape of a control rod's differential reactivity worth curve? (1.0)

QUESTION A.04 (2.50)

With the reactor operating at 2 MW, a moveable experiment with a positive reactivity worth equal to the maximum allowable is suddenly placed next to the core. Assuming that rho = 0.091/ tau

a. WHAT is the minimum period possible? (1.0)

b. WOULD any automatic actions occur, and if so, WHEN relative to the insertion? (1.5)

add for next exam

QUESTION A.05 (2.00) *(of a detector)*

a. WHAT is rod shadowing? (0.5)

b. WHAT is its potential significance to reactor safety? (0.5)

c. WHAT immediately available instrumentation can be used to verify a suspected shadowing problem and WHY is it reliable? (1.0)

QUESTION A.06 (1.50)

With increasing burnup, the amount of available U**235 decreases and the Pu**239 content in the core increases. Knowing that the delayed fraction for Pu**239 is approximately 0.0021, WOULD you expect the reactor transient response time to a given positive reactivity step to increase or decrease from BOL to EOL and WHY? (1.5)

QUESTION A.07 (2.00)

EXPLAIN the "prompt jump" phenomena resulting from of a small (<<beta) but rapid insertion of reactivity. (2.0)

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

QUESTION A.08 (1.00)

at 100w (given during exam)

A strong neutron source (= 1E13 n/cm**2/sec) is placed adjacent to an exactly critical reactor. DESCRIBE (words or a graph) the behavior of the neutron population as a function of time. (1.0)

QUESTION A.09 (1.00)

A step positive reactivity insertion is imposed on a critical reactor. WHAT is the first mechanism that will turn the power rise and HOW does it work? (1.0)

(***** END OF CATEGORY A *****)

QUESTION B.01 (2.00)

a. DRAW a simple cross-section diagram of the reactor including a fuel assembly, core support plate, lower plenum, flapper valve and plenum outlet pipe. (1.0)

b. SHOW the coolant flow path during forced and natural convection. (1.0)

QUESTION B.02 (2.00)

WHAT is the

a. minimum number of fuel assemblies necessary to achieve criticality? (0.5)

b. number of assemblies currently installed? (0.5)

c. maximum number of assemblies that could be accommodated (geometrically)? (1.0)

d. WHY are the excess holes plugged? (1.0)

QUESTION B.03 (1.50)

WHAT design feature(s) controls the release of Ar-41 from the beam tubes to the environment? HOW? (1.5)

QUESTION B.04 (2.00)

WHAT eight (8) parameters can cause a reactor scram? (setpoints are not required) (2.0)

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

QUESTION B.05 (2.00)

Regarding the purifica. on system:

a. WHY is the purification system needed? (0.5)

b. WHY is there a filter before and after the resin column? (0.5)

c. If during normal high power operation the demineralizer pump is deenergized, DOES flow through the demin unit cease? WHY? (1.0)

QUESTION B.06 (1.00)

HOW MANY air subsystems does the facility have, and HOW MANY of these can be cross-connected? (1.0)

QUESTION B.07 (1.50)

STATE the normal and emergency source of makeup water to the primary AND secondary loops, as appropriate. WHICH are manual and WHICH are automatic? (1.5)

QUESTION B.08 (2.00)

Following a power outage, the motor-generator functions as planned. WHICH of the following equipment would still be energized? (ANSWER YES or NO for each.) (2.0)

a. fume hood fans
b. evacuation alarm horn
c. bridge radiation monitor
d. reactor console instrumentation

QUESTION B.09 (1.00)

WHAT design feature associated with the pneumatic transfer systems helps to prevent inadvertent radiation exposure of the transfer system operator? (1.0)

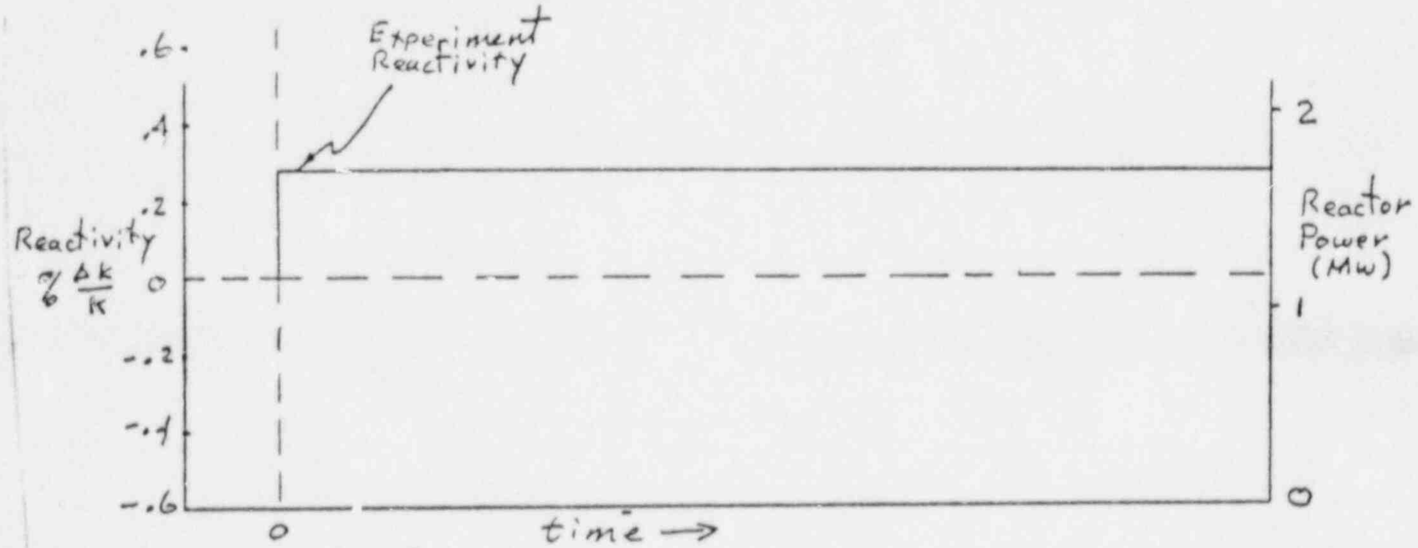
(***** END OF CATEGORY B *****)

QUESTION C.01 (2.50)

A moveable experiment with a worth of 0.28% delta-k/k is inserted in a single stepwise fashion with the reactor stable at a power level of 100 W. Given no operator or safety action, DRAW on the graph below the following parameters versus time:

1. moderator temperature reactivity
2. power reactivity
3. power level

STATE any assumptions made in drawing your graph. (2.5)



QUESTION C.02 (1.50)

WHAT is the primary (reference) method for determining reactor power? BRIEFLY EXPLAIN. (1.5)

QUESTION C.03 (1.00)

HOW LONG does it take to drive a control-safety rod full stroke? STATE all assumptions. (1.0)

QUESTION C.04 (1.00)

WHICH two (2) control blades (by number) have the greatest differential reactivity worth? (1.0)

QUESTION C.05 (1.00)

An IF with a small sample and a voided container is to be loaded into the reactor core. IS it preferable to do this at low (approximately 100 W) power OR high (1.8 MW) power? EXPLAIN WHY. (1.0)

QUESTION C.06 ~~(2.50)~~ (2.00)

a. Briefly DESCRIBE control rod worth calibration by the Inhour method. ~~(2.0)~~ (1.50)

b. WHY must the calibration be performed at low power? (0.5)

QUESTION C.07 (1.00)

About HOW long should it take from SCRAM initiation to full insertion of the scrammable control blades? (1.0)

QUESTION C.08 (1.00)

Approximately WHAT is the combined total worth of all six (6) control blades? (1.0)

QUESTION C.09 (1.00)

a. DOES secondary coolant flow on the shell side or on the tube side of the heat exchanger? (0.5)

b. DOES primary side pressure ever exceed secondary side pressure in the heat exchanger? (0.5)

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

QUESTION C.10 (2.00)

A very small sample of low cross section materials is to be exposed in an IF, positioned in an area of maximum flux. DESCRIBE the process by which the sample is suspended in the area of peak flux. (2.0)

(***** END OF CATEGORY C *****)

QUESTION D.01 (2.50)

a. DRAW the graph of the relationship between the voltage differential across the electrodes of a radiation detection chamber and the log of the resulting charge collection. Be sure to name your axes; numerical values are not required. (0.5)

b. NAME and INDICATE the regions where the detectors in your plant operate. (0.5)

c. NAME and INDICATE IN WHICH region each of the five channels of the NSTF nuclear instrumentation system operates. (1.5)

QUESTION D.02 (2.00)

WHICH detector(s) do (does) not have gamma compensation and WHY isn't it necessary for these channels? Give two (2) reasons. (2.0)

QUESTION D.03 (1.00)

HOW can you be sure that the startup (log count rate) channel is really seeing neutrons rather than noise or a test signal? (1.0)

QUESTION D.04 (2.00)

LIST the control blade withdrawal inhibit signals and WHAT each is designed to prevent. (2.0)

QUESTION D.05 ~~(1.50)~~ 1.0

HOW is the effect of N-16 produced in the primary coolant eliminated from the beta-gamma monitor? ~~(STATE two (2) methods.)~~ (1.5)

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

QUESTION D.06 (2.00)

a. WHAT do the low and high reference voltages correspond to in the rod position indication circuit? (1.0)

b. WHAT does the output of differential voltmeter measure and WHY is it required? (1.0)

QUESTION D.07 (2.00)

The Reactor Safety System provides two (2) types of SCRAMs. STATE these two (2) types of SCRAMS, and HOW the safety circuit causes each type of SCRAM. (2.0)

QUESTION D.08 ~~(2.00)~~ (1.50)

On a loss of commercial power, the emergency motor-generator functions normally. DESCRIBE HOW

a) the alarm(s) and
b) the function(s)

of the facility Engineered Safety Features are affected. ~~(2.0)~~ (1.50)

(***** END OF CATEGORY D *****)

QUESTION E.01 (1.00)

WHAT two (2) safety criteria are considered to be a compromise of clad integrity by the Safety Evaluation Report? (1.0)

QUESTION E.02 (1.00)

WHAT two (2) systems are considered engineered safety features in the Safety Evaluation Report? (1.0)

QUESTION E.03 (1.00)

WHAT mechanical system is the most important to reactor safety (per the SER)? (1.0)

QUESTION E.04 (1.50)

WHAT design feature allows operation of ventilation system dampers under power failure conditions? (1.5)

QUESTION E.05 (1.50)

WHAT signals are necessary to actuate the reactor building ventilation damper closure system? (setpoints not required) (1.5)

QUESTION E.06 (1.50)

STATE the automatic actions that will occur upon actuation of the reactor building ventilation damper closure system. (1.5)

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

QUESTION E.07 (1.50)

STATE the general locations of the fixed area radiation monitors. (1.5)

QUESTION E.08 (2.50)

STATE the location of five (5) of the nine fire alarm boxes. (2.5)

QUESTION E.09 (2.00)

Drain lines from the containment building are constructed with a 24 inch loop seal (dip leg) to maintain containment integrity. Assuming that due to evaporation only 14 inches of water remained, HOW MUCH internal pressure (in PSIG) would be necessary to cause "blow-by" of this seal? STATE all assumptions and SHOW all work. (2.0)

(***** END OF CATEGORY E *****)

QUESTION F.01 (1.00)

WHAT are the two (2) immediate operator actions following indications of an automatic reactor scram? (1.0)

QUESTION F.02 (2.50)

It is a hot Sunday August evening with imminent rain. Your duty is to perform a startup to a power of 2 MW following the reactor being secured at the end of a full-power run the previous Friday. PLACE in proper order the following startup steps: (2.5)

1. energize the secondary circulation pump
2. withdraw the fission counter to its upper limit
3. announce your intention to start up the reactor
4. complete and sign the reactor checkout form
5. energize the primary circulation pump
6. position the neutron detectors to the low residual xenon position
7. take the reactor critical and commence the power increase
8. stabilize the reactor at near full power and approach 2 MW by your most conservative indication
9. adjust the linear-N recorder to correspond to delta-T and N-16 indicators
10. record the appropriate information and announce the reactor condition

QUESTION F.03 (1.00)

DEFINE the word OPERABLE in a Technical Specification context. (1.0)

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

QUESTION F.04 (2.00)

Of the items listed below, WHICH MUST be noted in the Reactor Log? (ANSWER Yes or No) (2.0)

1. changing power from 1.5 MW to 1.7 MW
2. completion of a reactor startup checklist
3. water addition to the reactor pool
4. operator relief to go to the lavatory
5. routine transfer of liquid to the 10,000 gal holding tank
6. changing the chart paper in a Log-N chart recorder
7. opening a valve which was previously logged as open
8. a check of the building radiation fields by visiting Russian scientists

QUESTION F.05 (2.50)

You are the reactor operator on backshift with the reactor at full power for isotope production. The fire alarm Klaxon sounds, followed five seconds later by the building air radiation alarm. WHAT are your five (5) required actions? (2.5)

QUESTION F.06 (2.50)

During normal dayshift operation at 2 MW, a loss-of-flow scram is annunciated, followed by a report from the pump room that the primary pump casing has disintegrated. WHAT are your immediate actions? (LIST ten (10) items) (2.5)

QUESTION F.07 (1.00)

Do you normally expect high contamination levels in primary coolant? WHY? Give two (2) reasons. (1.0)

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

QUESTION F.08 (1.00)

With reactor power at 1 MW, and a workman troubleshooting the bridge radiation monitor (temporarily removed from service), an experiment is energized which causes a 5% increase in reactor power. WHAT action do you take and WHY? (1.0)

(***** END OF CATEGORY F *****)

QUESTION G.01 (1.00)

With the minimum amount of water covering the core per Tech Specs, WHAT is the neutron flux at the water surface due to attenuation only if you assume one-tenth thickness to be 2 feet of water and neutron flux at the core top to be 10**10 n/sec/cm**2? STATE all assumptions. (1.0)

QUESTION G.02 (2.00)

A valve must be repaired in a 1 rem radiation field. Two alternative methods are to be considered:

1. Two men working on the job can complete it in 45 min.

2. Placing and removing shielding around the job, a one-man, 40-min. procedure, will reduce the radiation field to 300 mrem/hr.

WHICH procedure is better and WHY (state principle involved)? (SHOW all work) (2.0)

QUESTION G.03 (2.00)

During full power operation, a fuel pin fails and releases several curies of radioactivity into the pool water. Assuming that this contamination was restricted to liquid form, WHAT systems (subsystems) are in place to warn or protect the reactor staff and general public from radiation dangers? NAME at least four (4). (2.0)

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

QUESTION G.04 (2.00)

An undergraduate student is working in the dry irradiation chamber when the reactor is operating. The following radiation fields exist:

gamma radiation - 200 rad
beta radiation - 50 rad
thermal neutrons - 800 rad

If his job lasts for 15 min, WHAT would be the total radiation dose in rem? WHAT are his chances for survival (better or worse than 50/30)? (2.0)

QUESTION G.05 (2.50)

An undergraduate student, hurrying to finish his experiment, trips while running across the reactor bay and the shielded flask containing 0.5 Ci of radioactive liquid that he was carrying runs into the floor drain.

a. WHERE does the liquid go from there? (0.5)

b. WHAT detection and hold-up barriers lie between the spill and its release from the facility? (1.5)

c. If release limits are met, HOW does it leave the site boundary? (0.5)

QUESTION G.06 (2.00)

A 3 Ci point source of Co60 is 21 ft from man A and 24 ft from man B. Man A, however, has positioned one HVL of lead between himself and the source. WHICH man is receiving the greater dose rate? STATE all assumptions and SHOW all work. (2.0)

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

QUESTION G.07 (2.00)

FILL in the table below with Federal Exposure Limit values for radiation workers: (2.0)

rem per calendar quarter

	Quarterly Average	Quarterly Maximum
Whole body		
Skin		X
Extremities		X

(***** END OF CATEGORY G *****)
(************* END OF EXAMINATION ***************)

IMPORTANT MATHEMATICAL RELATIONSHIPS

The following equations may appear on a reactor operator's examination. In the pages that follow, a brief explanation of each equation is given.

$\frac{dN}{dt} = -\lambda N$

$N_t = N_o e^{-\lambda t}$

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

$A = \lambda N$

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

$\text{Stay time} = \frac{\text{limit}}{\text{dose rate}}$

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

R/hr @ 1 foot = 6 CE

$I = I_o e^{\text{[illegible]}}$

$S.U.R. = 26/\tau$

$HVL = 0.693/\mu$

$N = S/1-K_{eff}$

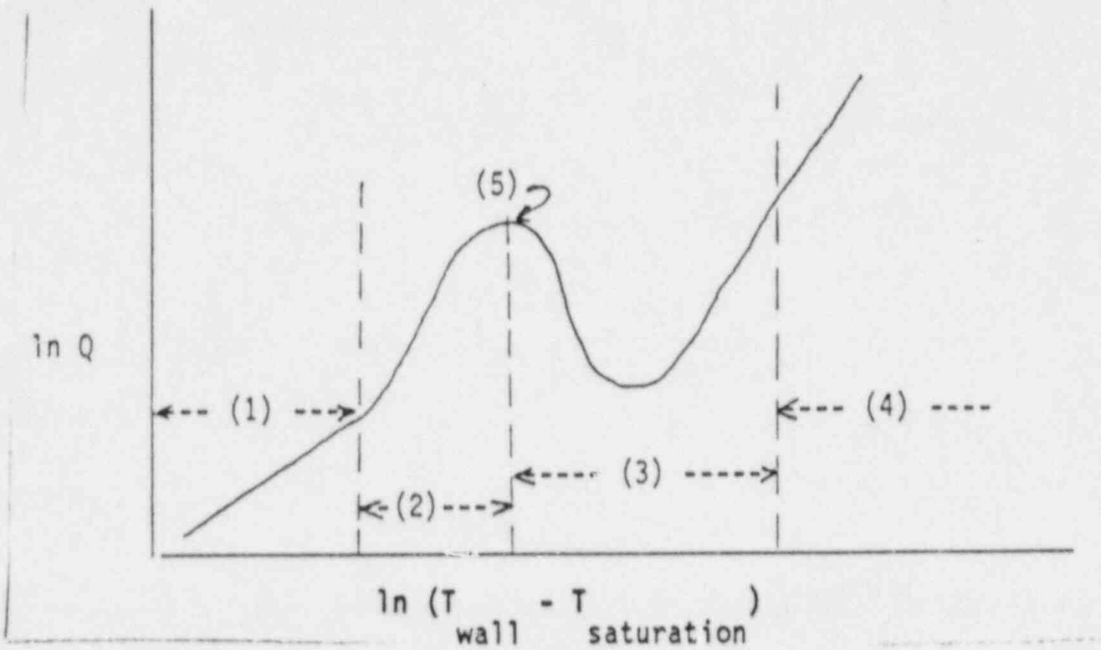
$P = P_o e^{t/\tau}$

$P = P_o(10^{t \cdot SUR})$

$\rho = \frac{\ell^*}{\tau} + \sum_{i=1}^{5} \left(\frac{\beta i}{1+\lambda_i \tau}\right)$

(The important equations are boxed in the following explanations). Since there are many R.P.D. equations, that part of this material is sectioned according to topic.

ANSWER A.01 (2.00)



a. The segments are:

1. (natural) convection [+0.25]
2. ~~nucleate~~ boiling [+0.25]
3. transition boiling [+0.25]
4. film boiling [+0.25]

b. (5) point of DNB [+0.5]

c. Region 1 is the allowable operating segment [+0.5]

REFERENCE

1. SUNY: Training Outline Definitions.

2. SUNY: Technical Specifications, p. 5.

ANSWER A.02 (2.00)

No [+0.5]. Moving the fuel elements around might significantly affect core excess reactivity [+0.5]. This is because there may have been a net change in the macroscopic cross section for uranium, i.e., net fuel may have been shifted toward or away from regions of higher potential neutron flux [+1.0].

REFERENCE

1. SUNY: OP No. 4, p. 5.

ANSWER A.03 (1.00)

The shape of the (local) axial neutron flux [+1.0].

(Discussion of reaction rate; rate = flux x cross section x number density)

REFERENCE

1. SUNY: Handouts, ANL 7291, p. 385.

ANSWER A.04 (2.50)

a. rho = 0.091/tau => tau = 0.091/rho and per Tech Specs, rho_{max} = 0.003 delta-k/k [+0.5] for a moveable experiment

Then tau = 0.091/0.003 which is approximately equal to 30 sec. period [+0.5].

b. Yes [+0.5], scram setpoint is 2.4 MW and assuming no temperature coefficient effects, the time to reactor scram would be

$P = P_o$ e**t/tau [+0.5] P/P_o = 2.4/2.0 = exp (t/30s)

ln 1.2 = t/30s
30(0.182) = t
t = 5.47 sec [+0.5] (accept 5.5 +- 0.5 seconds)

REFERENCE

1. SUNY: Technical Specifications, pp. 6 and 8.

2. SUNY: Training Outline, Equations, pp. 11 and 8.

ANSWER A.05 (2.00)

a. A local suppression of neutron flux incident on an ion chamber [+0.5].

b. It causes the shadowed chamber to read low relative to true thermal power [+0.5].

c. Two temperature channels (core delta T and primary temp) [+0.25] and the N-16 channel [+0.25] can be used since they are not directly dependent on neutron level [+0.5].

Question did not ask for two channels (either answer worth full 0.5)

REFERENCE

1. SUNY: Tech Specs, p. 21.

ANSWER A.06 (1.50)

Decrease [+0.5]. Since the effective delayed neutron fraction is decreased, the time one must wait for completion of the previous neutron generation has decreased (smaller mean generation time), yielding a quicker response time. (Alternatively, showing that the right hand term of the in-hour equation becomes less effective in determining reactivity response is acceptable.) [+1.0]

REFERENCE

1. SUNY: Handouts, ANL 6701, Section 1.12.
2. SUNY: Training Outline, Equations, p. 10.
3. SUNY: Handouts, Physics, p. III-16-18.

ANSWER A.07 (2.00)

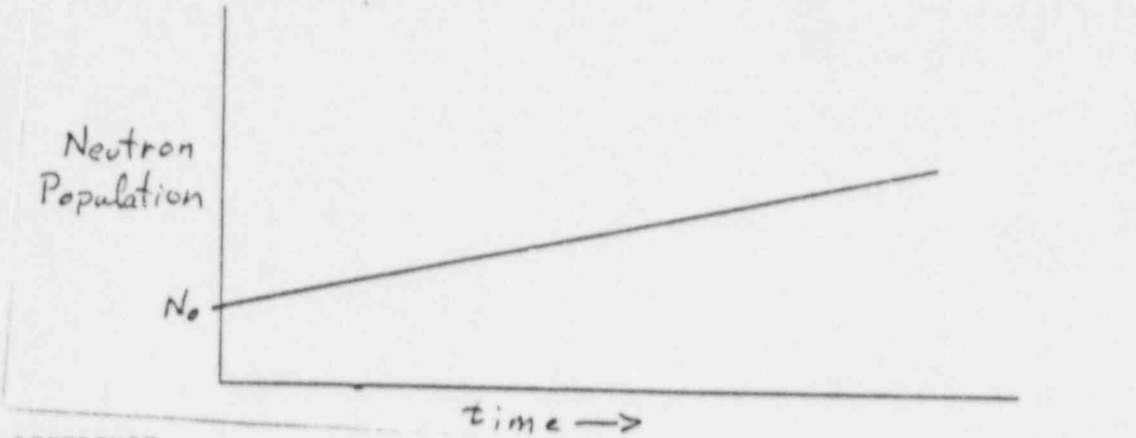
Following a small rapid reactivity insertion, the fission rate increases generating additional prompt neutrons, and causing the reaction rate to begin to increase (diverge) on prompt neutrons alone [+1.0]. Since the system is actually subcritical on prompt neutrons [+0.5], it must wait for the delayed neutron groups to contribute their necessary fraction to continue the power rise [+0.5].

REFERENCE

1. SUNY: Handouts, Physics, p. III-16.
2. Lamarsh, J. R., "Introduction to Nuclear Reactor Theory," p. 427.

ANSWER A.08 (1.00)

The neutron population will increase [+0.5] in a linear fashion with time [+0.5] (the rate of increase is dependent on the source strength). ~~Alternately (N = S*1/1-keff)~~



REFERENCE

1. SUNY: ANL-6701, "Approach to Critical," p. 18.

ANSWER A.09 (1.00)

The first (and only) mechanism will be the doppler or fuel temperature coefficient [+0.5]. By increasing the temperature of the fuel, the resonance absorption peaks are effective over a wider energy range (broadened) resulting in a larger macroscopic absorption cross section and hence resulting in a negative reactivity effect [+0.5].

(Discussions of resonance escape probability would be acceptable.)

Since initial power level was not stated and protective system action was not dis-allowed, accept CR reversal at 110% [+0.5] initiated by the (2.2 MW) high level run-in setpoint [+0.5]

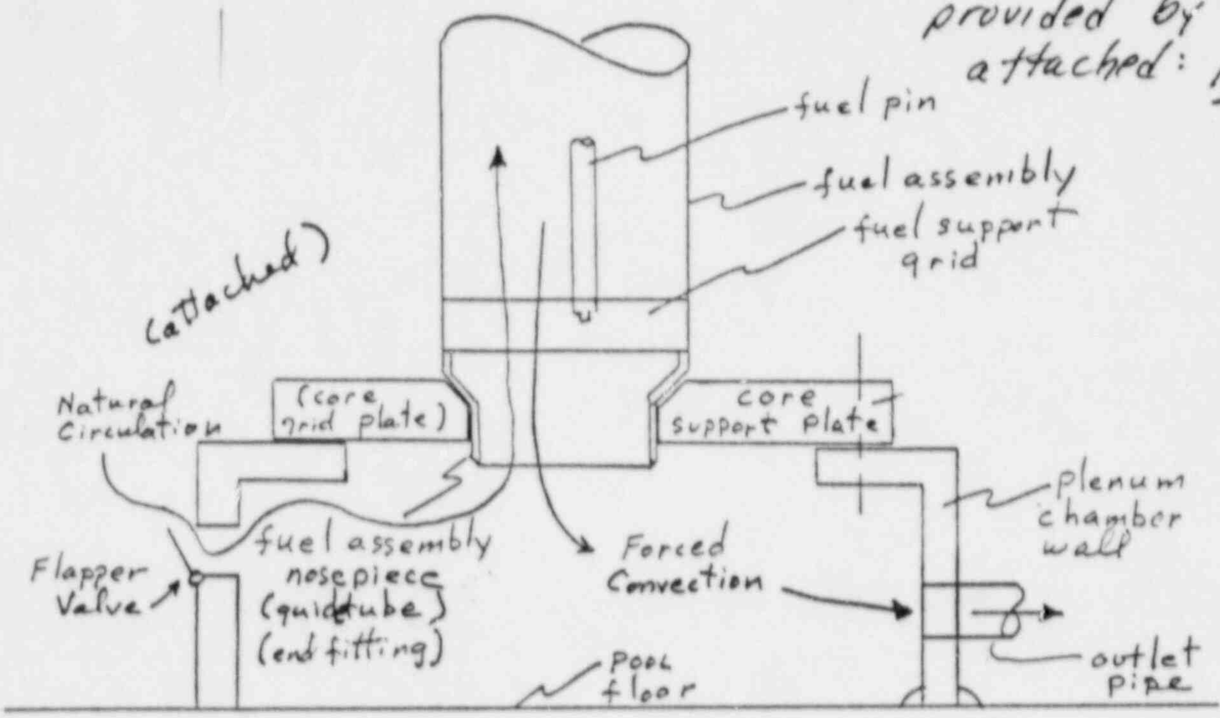
REFERENCE

1. SUNY: Handouts, Physics, p. III-31, four factor formula.

ANSWERS -- STATE UNIV. OF NEW YORK -88/02/09-JARRELL, D.

ANSWER B.01 (2.00)

alternate drwg provided by facility attached: pg 25a



Grading: [+0.2] each for each cross-section element, [+0.5] for each correct flow path

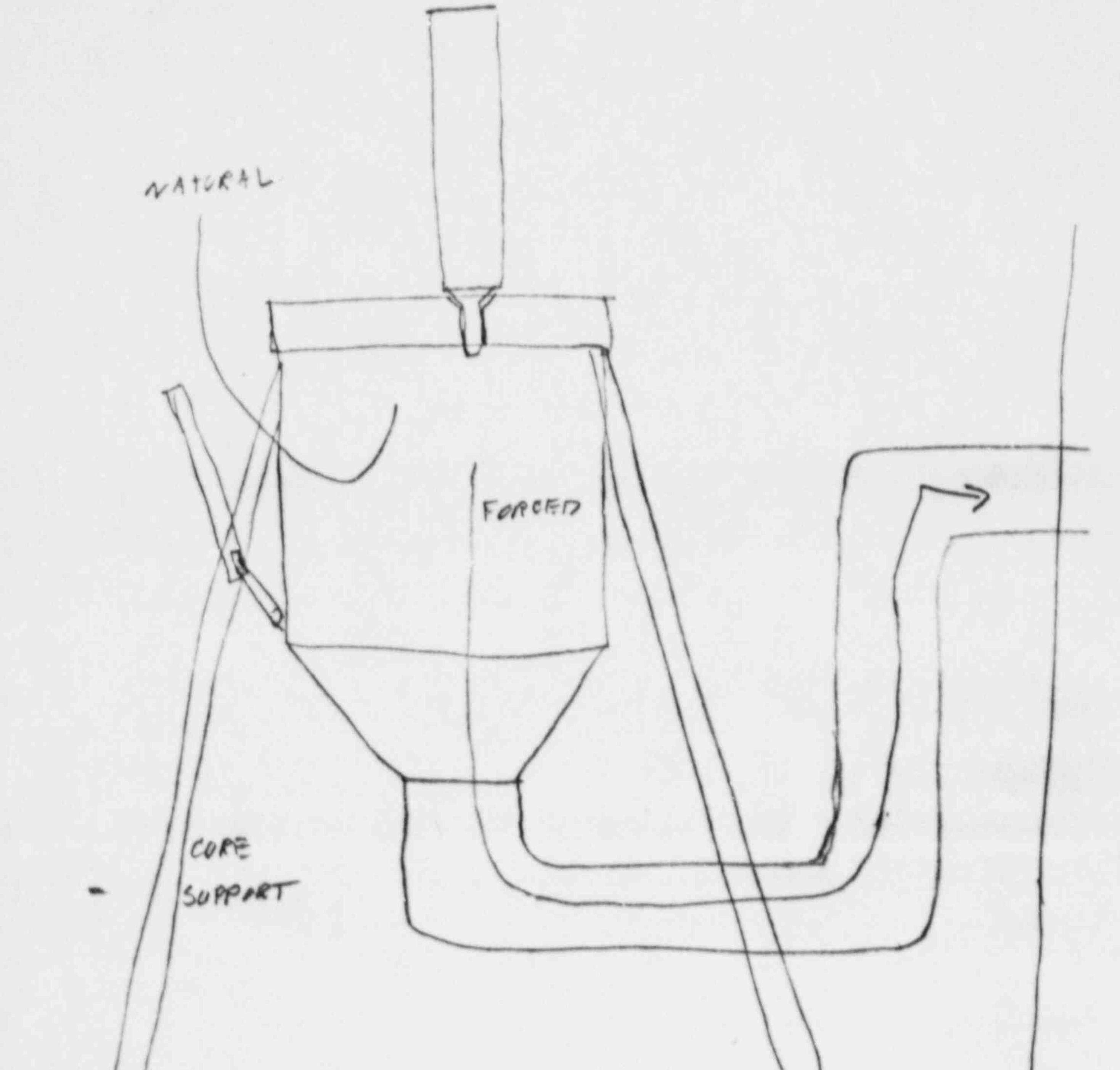
REFERENCE

1. SUNY: SER, pp. 4-16, 4-4.

SUNY 88/02/09- Jarrell, D.

Facility provided drawing
2/10/88 DBJ

B01



ANSWERS -- STATE UNIV. OF NEW YORK -88/02/09-JARRELL, D.

ANSWER B.02 (2.00)

a. 17 [+0.5]

b. 32 [+0.5]

c. 36 [+0.5]

d. holes are plugged to confine coolant flow to core assemblies and experiment positions [+0.5]

REFERENCE

1. SUNY: SER, pp. 4-2, 4-4.

2. SUNY: Handouts; Reactivity Summary, Loading #140.

ANSWER B.03 (1.50)

The ventilation system [+0.5] maintains the beam tubes under a slight negative pressure [+0.5] exhausting (through a filter) to the exhaust stack [+0.5].

REFERENCE

1. SUNY: SER, p. 10-2.

ANSWER B.04 (2.00)

1. high reactor power
2. low coolant flow
3. low pool water level
4. flapper valve open
5. high pool/core inlet temperature
6. dry chamber door not fully closed (limit switch)
7. loss of safety chamber high voltage (B- failure)
8. operator (manual)

[+0.25] each

REFERENCE

1. SUNY: SER, p. 4-10.

ANSWER B.05 (2.00)

a. Minimize contamination (due to corrosion products and foreign matter) in the reactor pool [+0.5].

b. The inlet filter removes large debris prior to the demin bed preventing clogging; the outlet filter prevents possible resin discharge to the reactor pool [+0.5].

c. No [+0.5]; primary coolant pump pressure drop causes (about a 6 gpm) flow through the demineralizer [+0.5].

REFERENCE

1. SUNY: OP-24, p. 1, System Print.

2. SUNY: OP-21, System Print.

ANSWER B.06 (1.00)

three (3) [+0.5]
all [+0.5]

REFERENCE

1. SUNY: SER, p. 9-1.

ANSWER B.07 (1.50) ECCS

Primary
normal - demin water tank, manual [+0.5]
emergency - city water, manual [+0.5]
Secondary
normal - city water, automatic [+0.5]
(emergency - none)

REFERENCE

1. SUNY: SER, pp. 5-4, 5-2, 6-1.

ANSWERS -- STATE UNIV. OF NEW YORK -88/02/09-JARRELL, D.

ANSWER B.08 (2.00)

a. No
b. Yes
c. Yes
d. No

[+0.5] each

REFERENCE

1. SUNY: SER, p. 8-1.

ANSWER B.09 (1.00)

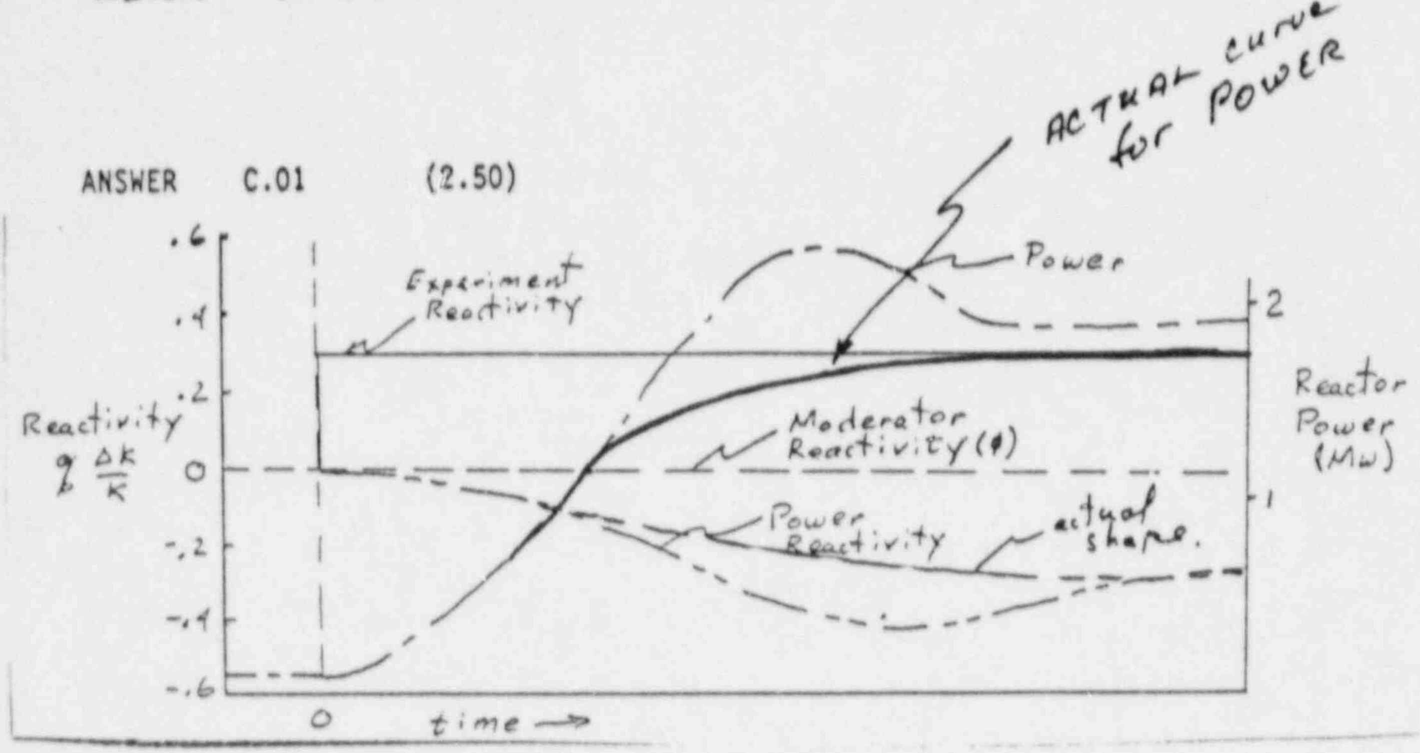
The transfer systems are equipped with shielded containers for receiving irradiated specimens. [+1.0]

REFERENCE

1. SUNY: SER, NUREG-0982, p. 10-1.

ANSWERS -- STATE UNIV. OF NEW YORK -88/02/09-JARRELL, D.

ANSWER C.01 (2.50)



Key assumptions: 1. power defect = 0.35% delta k/k for 2 MW change [+0.25]
2. temperature reactivity is approximately equal to 0 [+0.25]

Grading Key

POWER REACTIVITY - starts at approximately 0 (-0.017% delta-k/k) [+0.5] and winds up compensating for the 0.28% insertion [+0.5].

POWER - starts at 100 W (approximately 0), overshoots [+0.5], then returns to slightly less than 2 MW [+0.5].

(2 MW/0.35% delta k/k * 0.3% delta k/k + 0.1 MW = 1.8 MW final power)

REFERENCE

1. SUNY: SER, p. 4-8.

2. Telecon with P. Orlosky on 1/15/88 (clarification of SER values).

ANSWER C.02 (1.50)

Calorimetric on reactor primary coolant flow [+0.5]. Basically a heat balance on temperature rise of a known flow media using Power = mCp (delta-T) [+1.0].

REFERENCE

1. SUNY: OP-6, p. 1.

2. SUNY: OP-78, p.1.

ANSWER C.03 (1.00)

Rod speed is 3 in./min [+0.3] and full stroke is 26 in. [+0.3] therefore stroke travel time is 8.7 min [+0.4].

REFERENCE

1. SUNY: Technical Specifications, p. 27.

ANSWER C.04 (1.00)

1. blade 3 [+0.5]
2. blade 4 [+0.5]

REFERENCE

1. SUNY: Reactivity Loading Report #140.

ANSWER C.05 (1.00)

High power [+0.5]; doppler reactivity will be immediately available to counteract the expected positive ~~void~~ reactivity [+0.5].

REFERENCE

1. SUNY: OP-49, p. 4.

ANSWERS -- STATE UNIV. OF NEW YORK -88/02/09-JARRELL, D.

ANSWER C.06 2.00 ~~(2.50)~~

a. Attain a low power, stable critical position, then withdraw the rod to be measured to achieve a slow (long; approximately 30 sec) period [+0.5]. Measure the time it takes power to change a specific amount [+0.5]. By recording the new position of the rod being calibrated (and relating that to the period produced, (period = power change/2.3), then reactivity can be read from the decade time versus % delta k/k plot (or calculated from Inhour equation) [+0.5]. (The % delta k/k per inch of rod travel for the entire rod can be determined from a sequence of measurements [+0.5].) not required by the question

b. To avoid temperature effects [+0.5].

REFERENCE

1. SUNY: OP-61, pp. 1 and 2.

ANSWER C.07 (1.00)

less than one second (0.65 seconds) [+1.0]

REFERENCE

1. SUNY: SER, NUREG-0982, p. 4-3.

ANSWER C.08 (1.00)

10% delta k/k (9.932 delta k/k) [+1.0]

REFERENCE

1. SUNY: Reactivity loading report, No. 140.

ANSWER C.09 (1.00)

a. tube side [+0.5]
b. yes [+0.5]

REFERENCE

1. SUNY: SER, NUREG-0982, p. 5-2.

ANSWER C.10 (2.00)

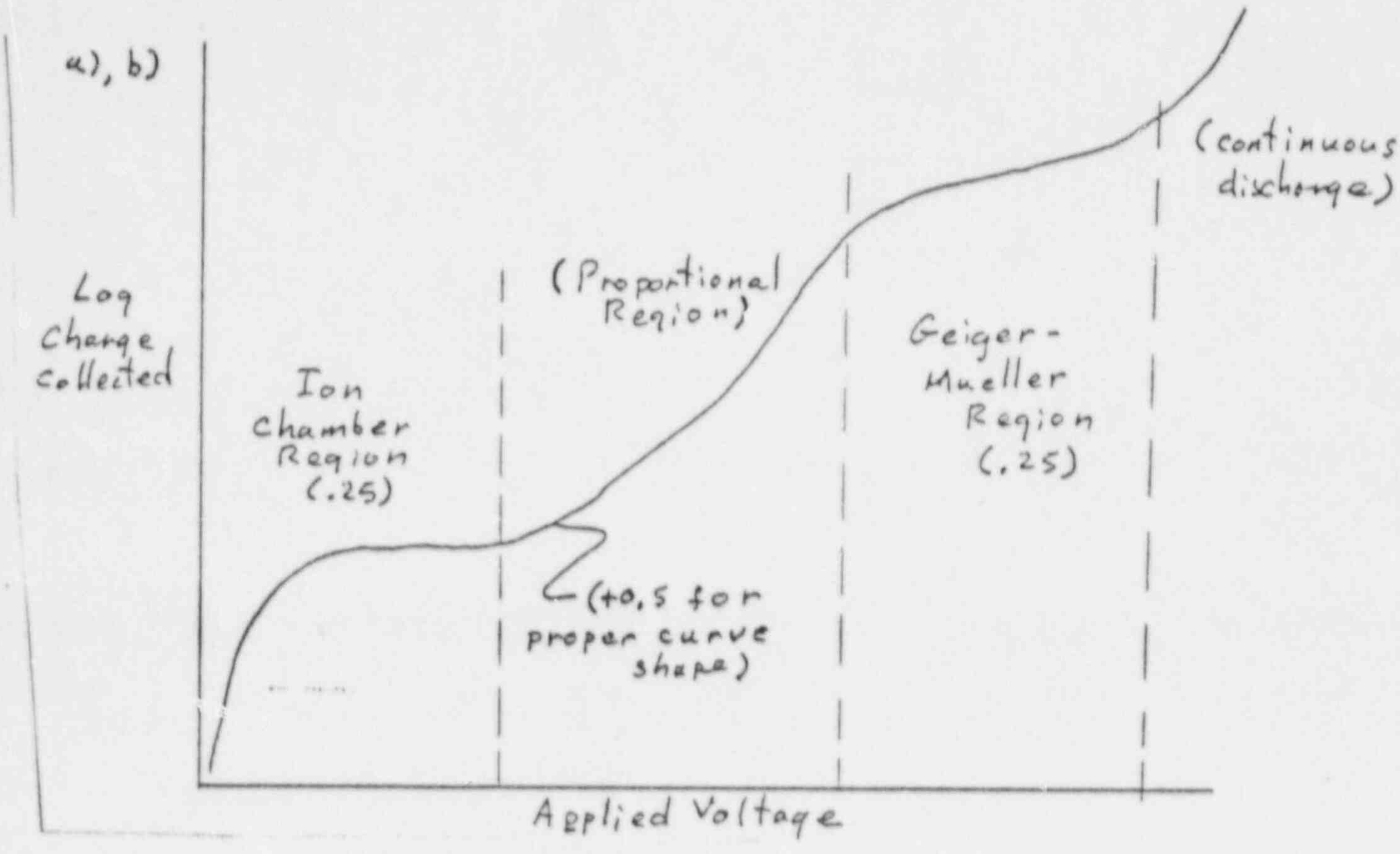
The sample will exhibit positive reactivity. Reactor power should be lowered by about 20% before insertion [+0.5]. During insertion the power will increase, being compensated for by Doppler, so no rod motion should be necessary [+0.5]. As the IF presses through the peak flux, power will start to drop [+0.5]. The IF is then pulled back through and suspended at the position corresponding to the highest power level on the chart recorder [+0.5].

REFERENCE

1. SUNY: OP 49, p. 3.

ANSWERS -- STATE UNIV. OF NEW YORK -88/02/09-JARRELL, D.

ANSWER D.01 (2.50)



c. 1. linear power (linear-N)
2. log power (log-N)
3. safety channels
4. N-16 p.wer
5. log count rate (startup)

All detectors operate in Ion Chamber Region

[+0.3] each

REFERENCE

1. SUNY: SER, p. 7-2.

2. SUNY: OP-71, 72, and 74.

3. SUNY: Training Outline, Definitions.

ANSWERS -- STATE UNIV. OF NEW YORK -88/02/09-JARRELL, D.

ANSWER D.02 (2.00)

The two safety channels [+0.5] are uncompensated because they only function at high power levels [+0.5] where 1) gamma power is proportional to neutron power [+0.5] and 2) the gamma signal is small compared to the neutron signal [+0.5].

REFERENCE

1. SUNY: SER, p. 7-2.

2. SUNY: OP-74, p. 1.

ANSWER D.03 (1.00)

Move the ex-core neutron source (and verify instrument response) [+1.0].

REFERENCE

1. SUNY: OP-74, p. 3.

/high

ANSWER D.04 (2.00)

Low neutron count rate (startup channel) [+0.5]; prevent startup without a visible neutron level [+0.5].

inoperable chart recorders (startup, Log-N, Linear-N channels) [+0.5]; to prevent startup or power escalation without on-line monitoring and recording of reactor power (and period) [+0.5].

REFERENCE

1. SUNY: OP-74, pp. 1 and 2.

2. SUNY: SER, p. 7-2.

3. SUNY: OP-6, p. 2.

ANSWERS -- STATE UNIV. OF NEW YORK -88/02/09-JARRELL, D.

ANSWER D.05 1.0 ~~(1.50)~~

1. by locating the detector downstream (after) the holdup tank (N-16 decay) ~~[+0.75]~~ 1.0
2. ~~by varying the alarm setpoint based on ambient (background) conditions [+0.75]~~

REFERENCE

1. SUNY: SER, p. 7-3.

ANSWER D.06 (2.00)

a. Low ref voltage => corresponds to rod full in potentiometer position (voltage) [+0.5]

   High ref voltage => rod full out potentiometer position (voltage) [+0.5]

b. Differential voltmeter subtracts the position potentiometer output voltage from low reference voltage to give a position analog [+0.5]. This arrangement allows accurate measurement over the entire range (especially extremes) of rod travel [+0.5].

REFERENCE

1. SUNY: OP-73, pp. 1 and 2.

ANSWER D.07 (2.00)

1. fast SCRAM - by decreasing the DC holding current [+1.0]
2. slow SCRAM - by turning off the AC power supply [+1.0]

REFERENCE

1. SUNY: SER, NUREG-0982, p. 7-2.

ANSWERS -- STATE UNIV. OF NEW YORK -88/02/09-JARRELL, D.

ANSWER D.08 ~~(2.00)~~ 1.5

~~Coolant replacement [+0.5]~~
~~a) no electrical power to pool low level alarm [+0.25]~~

~~b) manual system so no effect on function [+0.25] (electrical components deactivated)~~

not per tech specs.

Ventilation system [+0.5]
a) building exhaust fan power is lost (exhaust blowers shutdown, but the stack fan has its own generator and would continue to operate) ~~[+0.25]~~ .5

b) actuation of alarms; auto shift to emergency ventilation lineup would be operative (for 10-15 min) since the (bridge and exhaust stack) radiation monitors are powered from the M-G and air bladders provide damper hydraulic power ~~[+0.25]~~ .5

full credit allowed for containment only

REFERENCE

1. SUNY: SER, pp. 6-1, 6-2, 8-1, and 9-1.

ANSWERS -- STATE UNIV. OF NEW YORK -83/02/09-JARRELL, D.

ANSWER E.01 (1.00)

1. ~~fuel centerline melting~~
2. departure from nucleate boiling (DNB)

REFERENCE

1. SUNY: SER, p. 4-5.

ANSWER E.02 (1.00)

1. ~~Emergency Coolant Replacement (pool fill system) (no longer covered by Technical Specifications) [+0.5]~~
2. (containment) Building ventilation system [~~+0.5~~] 1.0

Removed from Tech Specs.

REFERENCE

1. SUNY: SER, p. 6-1.

ANSWER E.03 (1.00)

The (neutron-absorbing) control blades (rods) (and their associated reactivity insertion scram devices). [+1.0]

REFERENCE

1. SUNY: SER, p. 3-1.

ANSWER E.04 (1.50)

Hydraulic system pressure is sustained for several minutes by air bladders in the hydraulic system accumulators. [+1.5]

REFERENCE

1. SUNY: SER, p. 11-3.

ANSWER E.05 (1.50)

Coincident alarms [+0.5] from the reactor bridge fixed area monitor [+0.5] and the building air exhaust effluent monitor [+0.5].

REFERENCE

1. SUNY: SER, NUREG-0982, p. 7-3.

ANSWER E.06 (1.50)

the two inlet ducts and the two exhaust ducts will close

the two exhaust blowers stop (the 6000 ft cubed per minute blower at the base of the stack remains in operation)

the damper in the 6" emergency exhaust duct opens

[+0.5] each

REFERENCE

1. SUNY: SER, NUREG-0982, p. 6-2.

ANSWER E.07 (1.50)

Three are on the neutron deck, one is under the bridge, and one is in the hot cell. [+1.5]

REFERENCE

1. SUNY: SER, NUREG-0982, p. 7-3.

ANSWER E.08 (2.50)

1. control room (behind console)
2. control deck (near airlock)
3. gamma deck (near airlock)
4. neutron deck (at base of stairs)
5. office wing lower hall (near machine shop)
6. office wing upper hall (near conference room)
7. fan room (basement)
8. general building evacuation (in elec equip room)
9. outside, on side of office wing

Any five (5) [+0.5] each, +2.5 maximum.

REFERENCE

1. SUNY: EP No. 6, p. 1.

ANSWER E.09 (2.00)

Assuming ρ_{H2O} = 62.4 lbm/ft**3 [+0.5]

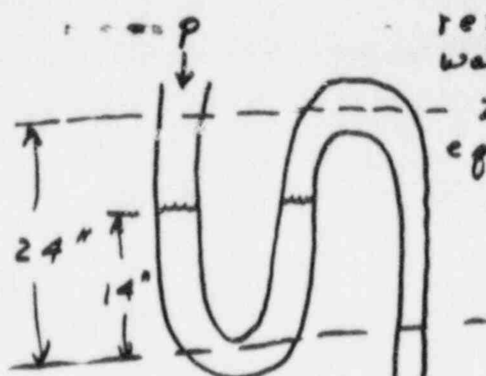
Pressure = rho h = (62.4 lbm/ft**3)(~~14~~ 24 in.)(1 ft**3/1728 in.**3)
= ~~0.505~~ 0.87 psi

~~(0.4 to 0.6 psig acceptable)~~ [+1.5]
0.8 to 1.0 psi acceptable

REFERENCE

1. SUNY: Technical Specifications, p. 25.

Depression of high pressure side will result in a total water column of 24" until the equilibrium manometer height is < 12".



ANSWER F.01 (1.00)

Backup the automatic scram by pressing the console SCRAM button [+0.5] and verifying that all control blades indicate fully inserted [+0.5].

REFERENCE

1. SUNY: OP-6, p. 2.

ANSWER F.02 (2.50)

4.
6.
5.
1. NOTE: Steps 5. and 1. may be reversed without loss of points.
3.
7.
2.
8. [+0.25] each
10.
9.

REFERENCE

1. SUNY: OP-5, pp. 1, 2, and 3.

ANSWER F.03 (1.00)

A component is OPERABLE if it is capable of performing its intended function in a normal manner. [+1.0]

REFERENCE

1. SUNY: Technical Specifications, p. 2.

ANSWER F.04 (2.00)

1. yes
2. NO ~~yes~~
3. no (primary coolant log)
4. No ~~yes~~
5. no (waste water log)
6. no
7. yes
8. no

[+0.25] each

REFERENCE

1. SUNY: OP-8; pp. 1, 2, and 3.

ANSWER F.05 (2.50)

1. SCRAM the reactor (and perform follow-up).
2. Announce the reactor scram and the requirement to evacuate the reactor building.
3. Monitor egress of personnel from the building.
4. Notify staff supervision and go to Howe Research Building.
5. Stand by to assist (possible) firemen reentry.

[+0.5] for each action.

acceptable { take reactor log
evacuate containment

REFERENCE

1. SUNY: EP-6, pp. 2 and 3.
2. SUNY: EP-1, pp. 3, 4, and 6.
3. SUNY: Emergency Plan, p. 6.

ANSWER F.06 (2.50)

1. scram the reactor - take the key
2. turn off the primary pump
3. turn off the secondary pump
4. turn off the demineralizer pump
5. close pool isolation valves
6. announce the situation over the PA and evacuate unnecessary personnel, if appropriate
7. survey radiation levels in proximity to the reactor pool
8. if necessary, activate the EPF system; or do not allow the pool to overflow
9. post-off the airlocks and/or the machine room door, as appropriate
10. notify the highest available Emergency Director candidate

[+0.25] each

REFERENCE

1. SUNY: EP-4, pp. 1, 3, and 4.

ANSWER F.07 (1.00)

No [+0.5]; primary coolant has a very low level of radioactivity due to no fuel leakage [+0.25] and primary system demineralizer [+0.25]

REFERENCE

1. SUNY: EP-4, pp. 1, 3, and 4.

ANSWER F.08 (1.00)

Immediately reduce power to 1 MW (or scram) [+0.5] since personnel are working in a potentially high radiation area without known radiation protection [+0.5].

REFERENCE

1. SUNY: OP-26A, p. 3.

ANSWERS -- STATE UNIV. OF NEW YORK -88/02/09-JARRELL, D.

ANSWER G.01 (1.00)

Minimum Technical Specification water level is 20 feet above the core top [+0.5], so ten tenth thicknesses would mean an attenuation factor of 10**10, therefore the neutron flux is 10**10/10**10 = 1 n/sec/cm**2 [+0.5].

REFERENCE

1. SUNY: Technical Specifications, p. 6.

ANSWER G.02 (2.00)

1. The first method requires 2 men x 1 rem/hr x 3/4 hr = 1.5 man-rem [+0.5]

2. Method 2 requires 1 man x 1 rem/hr x 40/60 hr = 0.667 man-rem (removal and replacement) AND

```
                                    0.45 man-rem
2 men x 0.3 rem/hr x 3/4 hr = --------------------      [+0.5]
                                total = 1.11 man-rem
```

Method 2 [+0.5]; less radiation exposure [+0.5] (consistent with ALARA guidelines).

REFERENCE

1. SUNY: Radiation Protection Manual, pp. 52 and 78.

ANSWER G.03 (2.00)

1. area radiation monitors
2. primary coolant monitors
3. effluent monitors
4. primary loop components (leak tight integrity)
5. installed shielding
6. containment
7. primary purification (demineralizer)

[+0.5] each, +2.0 maximum.

REFERENCE

1. SUNY: SER, pp. 4-2, 4-3, 5-1, 5-3, 6-2, and 12-3.

ANSWER G.04 (2.00)

gamma rem = 200 rad x 1 rem/rad x 1/4 hr = 50 rem [+0.5]

beta rem = 50 rad x 1 rem/rad x 1/4 hr = 12.5 rem [+0.5]

$^{1}_{0}n$ rem = 800 rad x 3 rem/rad x 1/4 hr = 600 rem
[+0.5]

total = 662.5 man-rem

Chances are less than 50/30 [+0.5] (L/D 50 less than or equal to 450 rem)

REFERENCE

1. SUNY: Radiation Protection Manual, pp. 12 and 35.

ANSWER G.05 (2.50)

a. A liquid entering the floor drain is routed to a (250 gal stainless steel) underground storage tank [+0.5].

b. The liquid in this tank will be sampled for activity [+0.5] then if requirements are met, the contents are pumped to an above-ground (10,000 gal) holding tank [+0.5]. Again this tank is (stirred and) sampled [+0.5].

c. If release limits are met the contents are pumped to the (SUNYAB) sanitary sewer system [+0.5].

REFERENCE

1. SUNY: SER, p. 11-3.

ANSWER G.06 (2.00)

The dose rate to each due to distance alone is:

at 1 meter (3 ft) the dose rate = 3.96 rem (gamma value from Appendix IV)

I1 = 4 rem D1 = 1 meter [+0.5]

for man A then I1/I2 = d2**2/d1**2

so I2 = 4 rem (1**2/7**2)
= 4 (1/49) = 81.6 mrem/hr [+0.5]

For man B

I2 = 4 (1/8**2) = 62.5 mrem/hr [+0.5]

Man A however has reduced this by shielding to 81.6 mR/hr divided by 2 = 40.8 mR/hr ~~[+0.5]~~ 0.25

So man B is receiving the greater dose rate ~~[+0.5]~~ .25

REFERENCE

1. SUNY: Training Handout, Equations, p. 5.

2. SUNY: Radiation Protection Training Manual, Appendix IV.

ANSWER G.07 (2.00)

rem per calendar quarter

	Quarterly Average	Quarterly Maximum
Whole body	1.25	3
Skin	7.5	X
Extremities	18.75	X

[+0.5] for each answer

REFERENCE

1. SUNY: Radiation Protection Manual, p. 40.

APPENDIX IV

REFERENCE DATA FOR SELECTED RADIOISOTOPES

NUCLIDE	HALF LIFE	BETA: MAX ENERGY MeV (I %)	BETA: RANGE IN INCHES AIR	BETA: RANGE IN INCHES PLASTIC	GAMMA: ENERGY MeV (I %)	GAMMA: Γ	GAMMA: HVL (cm Pb)	GAMMA: ATTN. COEF. cm^2/gm Pb	CRITICAL ORGAN, BODY BURDEN (uCi)	EFFECTIVE HALF-LIFE (d)
Calcium-45	163 d	0.257 (100)	20	.02	---	---	---	---	Bone, 30	17
Carbon-14	5730 y	0.156 (100)	10	.01	---	---	---	---	Whole Body, 400	10
Cesium-137	30.17 y	1.173 (5.4)	150	.15	0.6616 (89.9)	0.33	0.536	0.114	Whole Body, 30	113.8
Chromium-51	27.7 d	---	---	---	0.3201 (9.8)	0.016	0.165	0.369	Lower Large Intestine, 800	26.6
Cobalt-60	5.27 y	0.318 (99.9)	25	.03	1.17 (99.9) 1.33 (99.98)	1.32	1.035	0.059	Whole Body, 10	9.5
Copper-64	12.71 h	0.578 (37.2)	60	.06	1.346 (0.49)	0.12	1.11	0.055	Whole Body, 80	0.529
Hydrogen-3	12.33 y	0.0186 (100)	0.5	0.00	---	---	---	---	Whole Body, 1000	10
Iodine-125	60.14 d	---	---	---	0.0355 (6.67)	0.07	0.0029	21.0	Thyroid, 0.325	42
Iodine-131	8.04 d	0.606 (89.4)	60	.06	0.364 (81.2) 0.636 (7.27)	0.22	0.178	0.342	Thyroid, 0.140	7.6
otassium-42	12.36 h	3.521 (82) 1.996 (17.5)	600 300	0.6 0.3	1.524 (17.9)	0.14	1.174	0.052	*	*
hosphorous-32	14.28 d	1.71 (100)	250	.25	---	---	---	---	Bone, 6	13.5
odium-22	2.60 y	0.546 β+ (89.8)	55	0.05	1.274 (99.9)	1.2	1.00	0.061	Whole Body, 10	11
ulfur-35	87.4 d	0.1675 (100)	11	.01	---	---	---	---	Whole Body, 400 Testis, 90	44.3
inc-65	243.9 d	0.329 β+ (1.5)	30	.03	1.115 (50.8)	0.27	0.925	0.066	Whole Body, 60	193.2

= Intensity h = hours Γ = Roentgens per hour at one meter per Curie

= days y = years * Data not available

APPENDIX IV

REFERENCE DATA FOR SELECTED RADIOISOTOPES

NUCLIDE	HALF LIFE	BETA: MAX ENERGY MeV	BETA: I %	BETA: RANGE IN INCHES AIR	BETA: RANGE IN INCHES PLASTIC	GAMMA: ENERGY MeV	GAMMA: I %	GAMMA: Γ	GAMMA: HVL (cm Pb)	GAMMA: ATTN. COEF. cm^2/gm Pb	CRITICAL ORGAN, BODY BURDEN (uCi)	EFFECTIVE HALF-LIFE (d)
Calcium-45	163 d	0.257	(100)	20	.02	---		---	---	---	Bone, 30	17
Carbon-14	5730 y	0.156	(100)	10	.01	---		---	---	---	Whole Body, 400	10
Cesium-137	30.17 y	1.173	(5.4)	150	.15	0.6616	(89.9)	0.33	0.536	0.114	Whole Body, 30	113.8
Chromium-51	27.7 d	---		---	---	0.3201	(9.8)	0.016	0.165	0.369	Lower Large Intestine, 800	26.6
Cobalt-60	5.27 y	0.318	(99.9)	25	.03	1.17 1.33	(99.9) (99.98)	1.32	1.035	0.059	Whole Body, 10	9.5
Copper-64	12.71 h	0.578	(37.2)	60	.06	1.346	(0.49)	0.12	1.11	0.055	Whole Body, 80	0.529
Hydrogen-3	12.33 y	0.0186	(100)	0.5	0.00	---		---	---	---	Whole Body, 1000	10
Iodine-125	60.14 d	---		---	---	0.0355	(6.67)	0.07	0.0029	21.0	Thyroid, 0.325	42
Iodine-131	8.04 d	0.606	(89.4)	60	.06	0.364 0.636	(81.2) (7.27)	0.22	0.178	0.342	Thyroid, 0.140	7.6
Potassium-42	12.36 h	3.521 1.996	(82) (17.5)	600 300	0.6 0.3	1.524	(17.9)	0.14	1.174	0.052	*	*
Phosphorous-32	14.28 d	1.71	(100)	250	.25	---		---	---	---	Bone, 6	13.5
Sodium-22	2.60 y	0.546$^{\beta+}$	(89.8)	55	0.05	1.274	(99.9)	1.2	1.00	0.061	Whole Body, 10	11
Sulfur-35	87.4 d	0.1675	(100)	11	.01	---		---	---	---	Whole Body, 400 Testis, 90	44.3
Zinc-65	243.9 d	0.329$^{\beta+}$	(1.5)	30	.03	1.115	(50.8)	0.27	0.925	0.066	Whole Body, 60	193.2

I = Intensity
d = days
h = hours
y = years
Γ = Roentgens per hour at one meter per Curie
* Data not available

ATTACHMENT 2

SUNY 2/9/88

RESOLUTION OF FACILITY COMMENTS

COMMENTS ON QUESTIONS

A.01 The answer should reflect the candidates' knowledge rather than require the specific terms given.

RESPONSE: Any adequate definition of the phenomena at hand is acceptable for full credit.

A.02 The answer does not allow for possible absorption effects overriding positive reactivity from shuffling U-235.

RESPONSE: The answer specifically states movement may be "toward or away from" higher neutron flux. Both options are allowed - no change required.

A.04b The answer is incorrect in that a control rod run-in would occur at 110% power yielding a time of 2.85 seconds.

RESPONSE: The facility is correct, full credit will be given for the run-in response.

A.05c The question did not ask for two responses. In the answer, change the word "level" to "core spatial distribution" since the instruments in question do in fact respond to changes in neutron level.

RESPONSE: Either channel will receive full credit. The answer states "directly" dependent on level (like the fission chamber) - no change required.

A.08 The question should be posed regarding a subcritical reactor, since a critical reactor would exhibit exponential behavior rather than linear response.

RESPONSE: Not accepted. The definition of criticality requires that a constant neutron level (power) shall be maintained from one generation to the next. The question then superimposes a constant source term on the critical condition resulting in the addition of the source strength to the constant neutron level for each generation. This would result in $N = N_0 + S$ neutrons for each generation, clearly a linear progression. The equation given parenthetically is, as was pointed out, incorrect for the critical condition since it "blows up" (does not apply) to a critical reactor.

.A.09 If initial power is close to a protective system setpoint, a run-in might be the first thing to turn power.

RESPONSE: Since initial power level was not stated, and protective system response was not disallowed, control rod reverse through activation of a control system setpoint is an acceptable answer.

B.01 An improved drawing for the answer key was provided by the facility.

B.02c Accept 35 since a fission chamber is permanently mounted in one grid position.

RESPONSE: The question asks for the geometrical maximum which is 36. No change.

B.04 An alternate term for loss of safety chamber high voltage is B- failure.

RESPONSE: Accepted.

B.09 In addition to the stated answer, a permanently installed radiation monitor serves to prevent inadvertent exposure of personnel.

RESPONSE: Not accepted. The question asks for design features of the transfer system. The monitor is desireable, but is not considered a design feature of the system by the SER.

C.01 The question should be restated to " draw the reactivity associated with moderator temperature" rather than draw the moderator temperature reactivity. Additionally, the curve in the answer key is wrong in that the power curve is critically damped, i.e. it does not overshoot in response to step inputs as indicated.

RESPONSE: The semantics are clear as stated, no change in wording is required. Based on your testing data, the curve shape given in the answer key for power and corresponding doppler reactivity were corrected.

C.05 This question should refer to loading an IF target; to load an actual IF (isotope facility) tube, the reactor must be shut down by procedure.

RESPONSE: The facility statement is correct. If a candidate knows the procedure well enough to state that to load an IF tube a shutdown condition is required, full credit will be given.

C.06 The concept of sequential measurements to obtain worth over the rod length is not required by the question.

RESPONSE: Accepted. This portion of the answer is deleted and the point value was reduced accordingly.

D.01 The charge collection versus voltage curve is discussed in training, but is not stressed. Also, there are proportional counters in the isotope labs.

RESPONSE: The question is considered basic to personnel safety in a potential radiation environment since it is the foundation of all active detection devices. If proportional counters are listed in candidate's answers, appropriate credit will be given.

D.05 Alarm setpoint bias is set because the N-16 detector is near the demineralizer and does not reflect any elimination of N-16 gamma radiation.

RESPONSE: The question did not ask for anything but N-16 elimination, so the point value will be reduced to 1.0 and full credit will be given for the holdup tank.

D.08 Emergency Coolant Replacement (ECR) is no longer addressed by tech specs as an Engineered Safety Feature (ESF). This portion of the answer will be deleted.

RESPONSE: Accepted. Since the RO is bound to observe tech specs, the ECR portion of the answer will be deleted, and the point value adjusted accordingly.

E.01
E.02 Similarly to D.08, E.01 and E.02 require knowledge that is no longer required per tech specs.

RESPONSE: Accepted. Answer key and point valuation changed to reflect tech spec knowledge only.

E.09 A 24" loop seal will develop a 24" water column if the equilibrium (static no differential pressure) water height is 12" or greater. The correct answer to this question is 0.87" not the 0.5" indicated on the answer key.

RESPONSE: Accepted. The answer key was changed to reflect the larger water column.

F.02 Since several operators generally perform the startup checkout, steps 5 & 6 should precede step 4.

RESPONSE: Accepted. Per OP-5, Routine Startup Procedure, step # 1 of this procedure states:

"Complete and sign the reactor checkout form."

To accomplish this task requires steps 5 and 6 to be performed.

It should be noted, however, that the "reactor checkout form" (OP-2) is actually the "reactor pre-operation checklist" and needs to have correct terminology and be cross referenced by number. Also, as the facility was aware, step 57 of OP-2 cannot be accomplished until performing step 4 of OP-5. One of these procedures needs modification to resolve this conflict.

F.04 Per facility common practice the following answers should be changed:

2 YES to NO
4 YES to NO
7 YES to NO

RESPONSE:

#2 Accepted. The S/U stamp effectively serves this function.

#4 Accepted. The reactor will not be left unattended because the "last out" rule will administratively prohibit it. This practice does leave the relieved operator liable for any mistakes committed by the relief operator in his (her) absence, and, in the case of a casualty, does not leave a single clear coordinator in charge of the control room.

#7 Rejected. This would clearly violate OP-8 section II.A.4.

F.05 Per EP-1 section IV.A.3 "take the reactor log book and evacuate the containment" are acceptable actions.

RESPONSE: Accepted.

G.04 The question states radiation field, then gives gamma, beta, and neutron doses, not dose rates. The units should be in RAD/HR, not RAD.

RESPONSE: ~~Not~~ accepted. The comment is correct, but candidates should not be confused, since <u>radiation field</u> was explicitly stated, and <u>job duration</u> was given.

2 Mar 88

G.05 A new radwaste system has been installed, which replaces the old system completely. A 1000 gal. aluminum lined tank in the primary pump room collects all drains. Following sampling this is pumped to a new 10,000 gal. carbon steel tank located in a water-tight vault. This tank is recirculated, sampled and, if below required limits, pumped to the SUNYAB sewer system.

RESPONSE: Grading will be adjusted to account for this new system.

G.06 Per PNL internal review, grading changed to explicitly allow credit for correct use of Appendix IV of radcon manual.