ENCLOSURE 1

EXAMINATION REPORT - 50-327/OL-86-02

Facility Licensee: Tennessee Valley Authority
ATTN: Mr. S. A. White
Manager of Nuclear Power
6N 38A Lookout Place
1101 Market Street
Chattanooga, TN 37402-2801

Facility Name: Sequoyah Nuclear Plant

Facility Docket No.: 50-327, 50-328

Written, oral and simulator examinations were administered at Sequoyah Nuclear Plant near Soddy-Daisy, Tennessee.

Chief Examiner: William M. Dean — 10/24/86
William M. Dean — Date Signed

Approved by: for John F. Munro, Acting Section Chief — 10/27/86
Date Signed

Summary:

Examinations: May 26-30, 1986

Written examinations were administered to 15 candidates, including two re-examinations; 12 passed, including one re-examination. Oral and simulator examinations were administered to 13 candidates, 11 of whom passed; one candidate failed the simulator exam and one candidate failed both the simulator and oral exams.

Based on these results, 4 of 5 ROs passed and 6 of 10 SROs passed.

REPORT DETAILS

1. Facility Employees Contacted:

*L. M. Nobles, Superintendent of Operations
*J. M. Anthony, Operations Supervisor
*R. Joe Johnson, Director of Nuclear Training
*C. H. Noe, Supervisor Operator Training
*C. T. Benton, Simulator Training Supervisor
*Clyde Brewer, Section Supervisor
*W. J. Glasser, Unit Supervisor, Audit, Surveillance, Training Unit
*Don Conner, Chief, E&TT Branch
*R. L. Merring, Engineering Training Section Supervisor
*B. E. Rodgers, TVA Corporate QA Branch
*R. C. Birchell, Compliance Engineer
*B. C. Lake, Training Shift Engineer
*Ed Keyser, Simulator Instructor
*W. G. Payne, Simulator Instructor

*Attended Exit Meeting

2. Examiners:

*Bill Dean
Barry Norris
Dave Nelson
John Munro
Dave Graves

*Chief Examiner

3. Examination Review Meeting

At the conclusion of the written examinations, the examiners provided a copy of the written examination and answer key for review. The comments made by the facility reviewers are included as Enclosure 3 to this report. The NRC Resolutions to these comments are given below.

NRC Resolution of Facility Comments to Written Exam

a. RO Exam

(1) Question 2.13

NRC Resolution: Agree. The answer key has been modified based on revised system description provided the NRC.

(2) Question 2.14

NRC Resolution: Agree. The answer key has been expanded to include reasonable radiation alarms indicative of a leak.

(3) Question 2.21

NRC Resolution: No action required. The question does not ask for specific mechanisms of instituting spray flow.

(4) Question 2.25

NRC Resolution: Agree. The answer key has been modified to correct error in answer key generation.

(5) Question 3.09

NRC Resolution: Agree. A dropped rod is a special case of a misaligned rod and may be substituted for either response #4 or #5.

(6) Question 3.11

NRC Resolution: No action required. Candidates were instructed by proctor that increasing severity of the same function would be acceptable provided that unique protective/control outputs occurred.

(7) Question 3.14

NRC Resolution: Agree. Based on revised procedure not held by the NRC, the answer key has been modified to allow answers in the range of 70% - 80% for full credit. The previous answer of 85% is no longer an acceptable answer.

b. SRO Exam

(1) Question 5.12

NRC Resolution: Agree. The answer key has been modified to reflect correct unit designation.

(2) Question 5.20b

NRC Resolution: Disagree. Referring to the curves given with the exam, nuclear power is not at the C-2 rod stop setpoint at the time outward rod motion stops. Due to steam dumps being open, Tc decreases causing dT to increase. As the dT increases, the OPdT setpoint decreases causing a runback and the rod stop.

(3) Question 5.20c

NRC Resolution: Agree. The answer key has been modified to add an additional correct answer.

(4) Question 6.18

NRC Resolution: Agree. The answer key has been modified based on additional material provided by the facility.

(5) Question 7.09

NRC Resolution: Agree. The answer key has been modified based on additional information not originally supplied by the facility and the answer key has been modified to accept Plant Manager (or authorized representative); however, Plant Superintendent is no longer an acceptable answer.

(6) Question 7.15a

NRC Resolution: The question instructs the candidates that a tube rupture has occurred. However, consideration will be given to candidates who made the assumption that a steam line break occurred.

(7) Question 7.15b

NRC Resolution: Disagree. The question asks the candidates to explain the bases for tripping the RCP's, not for the trip criteria as given in the facility comments.

(8) Question 7.21

NRC Resolution: Agree. The answer key has been modified to reflect the current CSF status trees.

(9) Question 8.13

NRC Resolution: Disagree. Mode 6 is entered any time the vessel head bolts are less than fully tensioned. The facility comments support this position.

(10) Question 8.14

NRC Resolution: Agree. Information in parenthesis is given for purposes of clarity and not required for full credit.

(11) Question 8.15

NRC Resolution: Agree. The question has been deleted based on revised procedures and the sectional point value adjusted.

(12) Question 8.16

NRC Resolution: Disagree. The question does not ask for the DRPI operability requirements, only for the TS requirements related to Hot Channel Factors. No change to the answer key made.

(13) Question 8.17

NRC Resolution: Disagree. The candidates should know TS 1.0 definitions; however verbatim response is not required for full credit. The point value of the question is in accordance with the Examiner Standards.

(14) Question 8.20

NRC Resolution: Disagree. The question asks candidates how to ensure the charging motor circuits will energize, not to determine if already energized. The charging motor circuits will not energize if the toggle switch on the breaker cabinet is in the OFF position. No change made to the answer key.

c. RO/SRO Exam

(1) Question 1.20/5.16

NRC Resolution: Agree. The answer key has been modified to accept <55F as the answer required for full credit.

(2) Question 2.12/6.11

NRC Resolution: Agree. The answer key has been modified to accept either answer for full credit.

(3) Question 2.11/6.12f

NRC Resolution: Agree. This part has been deleted based on the possible confusion regarding which valve is being referred to, and the point value adjusted.

(4) Question 2.11/6.12j

NRC Resolution: Agree. The answer key has been modified to accept CLOSE as the full credit answer.

(5) Question 2.16/6.14

NRC Resolution: Agree. The answer key has been modified to allow the inclusion of the high current command to the stationary gripper coil based on the facility's comments. For full credit, however, the candidate must specifically state that the high current command is removed upon completion of rod motion.

(6) Question 3.15/6.21

NRC Resolution: Disagree. The question asks for control or protective signals. RCS Subcooling meter and RVLIS are for indication only. COPS, however, does provide control/protection and the answer key has been modified to accept COPS.

(7) Question 4.05/7.05

NRC Resolution: Agree that OPdT is more likely to cause a trip for the given situation. The answer key has been modified to accept OPdT as the full credit answer.

(8) Question 4.18/7.19

NRC Resolution: Agree. This question has been deleted based on revised procedures and the sectional point value adjusted.

4. Exit Meeting

At the conclusion of the site visit the examiners met with representatives of the plant staff to discuss the results of the examination.

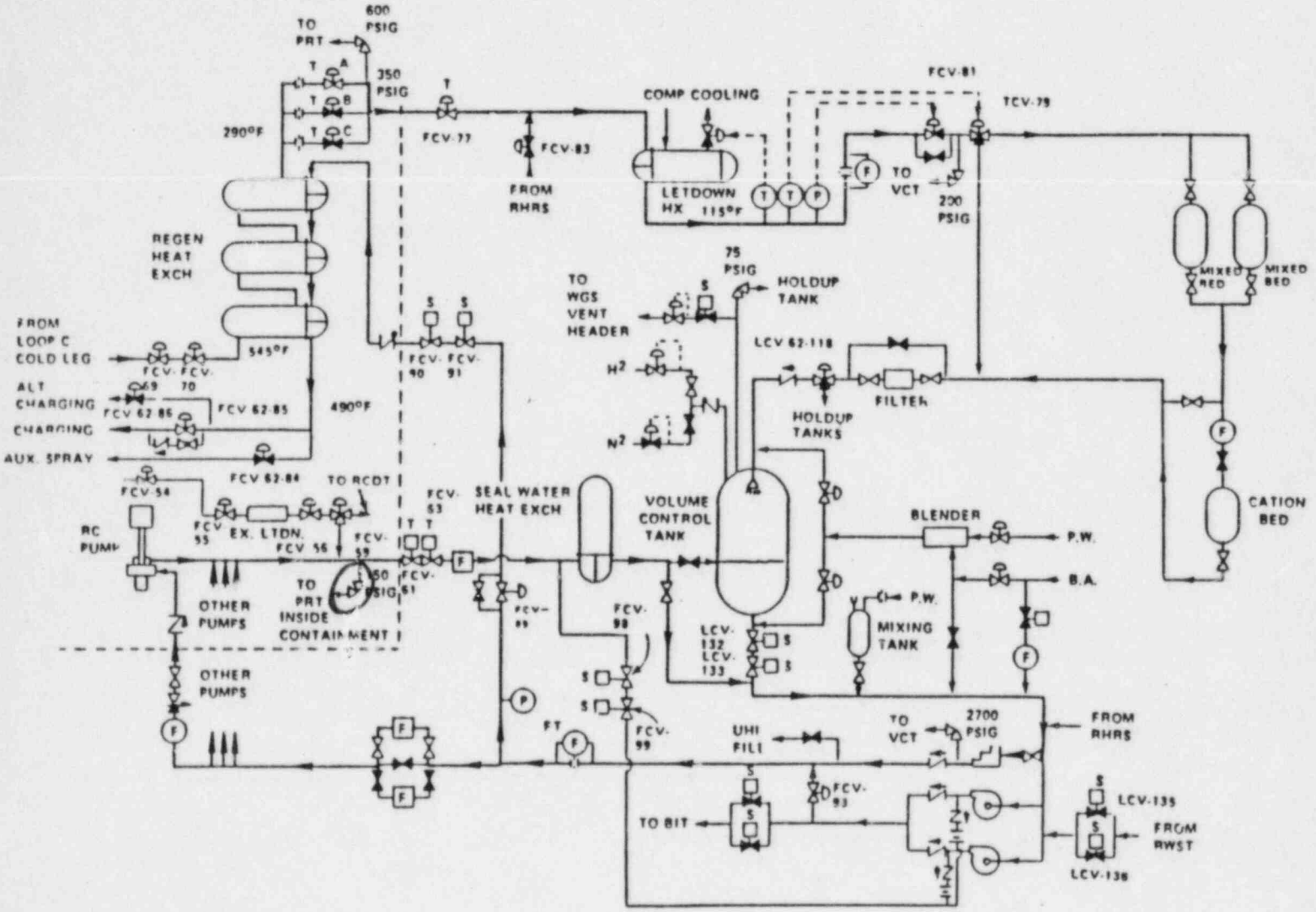
There were no generic weaknesses noted during the oral and simulator examinations; however, it was noted that some Senior Reactor Operator candidates had a tendency to move too rapidly through Emergency Procedures, resulting in required steps not being accomplished.

The cooperation given to the examiners and the effort to ensure an atmosphere in the control room conducive to oral examinations was also noted and appreciated.

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

SECTION 2

QUESTIONS	COMMENTS
2.13	RCP seal water return relief valves should be added to the answer key. -See Attached
2.14	Condenser vacuum exhaust radiation monitoring should be added to the answer key.
2.21	There are two correct ways to initiate spray flow - See Attached
2.25	Part 1 - Answer is reversed. a. Spring and Steam Pressure b. Air



UNLESS OTHERWISE NOTED
ALL VALVE NUMBERS ARE
PROCEEDED BY 62-
FCV-93 is FCV 62-93

OIT-62-2 CVCS FLOW DIAGRAM

III. PREREQUISITES (Continued)

10. _____ Select the highest reading source range channel and one intermediate range channel to be recorded on NR 45.

11. _____ Verify that the audio count rate channel is in operation and selected to the highest reading source range channel.

12. _____ Notify chem lab that impending mode change from 3 to 2 requires sampling per SI-407 and SI-415 for startup conditional requirements.

13. _____ Shift Engineer verification that limiting conditions for operation are met without reliance on provisions in ACTION statement unless otherwise excepted.

14. _____ If a prolonged hot standby is evident.

    a. _____ Borate the reactor coolant to the hot standby Xenon-free value according to SOI-62.2 boron concentration control.

       CAUTION: The boron concentration differential between the pressurizer and reactor coolant system shall not be greater than 50 ppm. When the difference is $\geq$ 50 ppm, turn on the pressurizer backup heaters to initiate automatic spray until concentrations are equalized.

    b. _____ Insert control banks, if withdrawn, and establish hot standby conditions.

    c. _____ Calculate S.D. margin and determine to be $\geq$ 1.6%.

Unit _____
Date _____

III. PRECAUTIONS

B. Anticipated changes in reactivity due to power variation or xenon changes will be compensated by programmed gradual changes in the loop boron concentrations to minimize deviations from target flux maintaining an axial flux difference per TI-28, A.2.

C. The boron concentration difference between the pressurizer and the reactor coolant system must not exceed 50 ppm.

D. If the loop boron concentration is changed by 10 ppm or greater, pressurizer sprays will be actuated by manual operation of sprays, causing B/U heaters to come on until the pressurizer concentration is within 10 ppm of the loop concentration.

CAUTION: Monitor pressurizer pressure closely during manual spray operation to prevent dropping pressurizer pressure excessively.

* E. In the event of a change in the rated thermal power level exceeding 15% in one hour, notify the chem lab to initiate the conditional portions of * SI-407 and SI-415 due to the thermal power change.

VI. INSTRUCTIONS

* A. _____ Drop turbine load from 100% to 80% power over one hour period so average load drop rate is about 1/3 %/min.

NOTE: This can be done by starting and stopping load drop on EHC system.

B. _____ Borate the amount according to Appendix A of this instruction during the load drop period to maintain control rods high in core.

NOTE: The amount of boration may be varied to maintain flux within limits.

NOTE: Borate or dilute according to SOI-62.2.

*

Lesson Outline	Instructor Notes
A bistable is set to open the valve at 1025 psig regardless of the controller setpoint. A pressure transmitter on each tee-header is used as the pressure reference	
4. Main Steam Isolation Valve and Check Valve	Objective F
a. Purpose - Isolates steam flow to the turbine in event of:	
(1) Break upstream	
(2) Break downstream	
(3) Tube rupture	
b. Isolation signals for above accidents	
(1) High steam flow, 2/4 loops	
(2) Phase B containment isolation	
c. Closing time: 5 seconds or less (limits containment pressure rise)	
d. Type - 32 inch globe wye, air to open, spring to close with flow assist (angle). Air accumulator slows down valve to prevent its slamming shut.	
e. Check valve - prevents reverse flow of steam into faulted line from upstream break	
5. Bypass Valve - Used to warm and pressurize steam lines upon startup. When ΔP across the MSIV $\approx$25 psid, the MSIV may be opened	
6. Piping	
a. 36"	
b. Supplies turbine via cross connection (36" header) which guarantees pressure ($\leq$ 10 psid) equalization to all steam dumps. Also seals and MSR reheat tap off this line	

SECTION 3

QUESTIONS COMMENTS

3.09 A dropped rod will bring in the alarm and should be considered as a correct answer.

3.11 The statement, "increasing severity of the same function like Lo and Lo-Lo level count as one response", is misleading.

The Answer Key list Lo and Lo-Lo as separate responses.

Lo T_{avg} is 554°F and initiates feed water isolation.

Lo-Lo T_{avg} is 540°F and allows block of steam line high flow SI.

3.14 The runback setpoint has been changed. The current revision of SOI-5.1 & 6.1 states the turbine will runback to ~75%. The candidates could give either answer. See Attached

B. Continued

4. Open No. 3 heater drain pumps discharge header isolation valves to heater strings "A," "B," and "C" and place their control switches in the "P-auto" position.

   a. FCV 6-108 for "A" heater string

   b. FCV 6-109 for "B" heater string

   c. FCV 6-110 for "C" heater string

5. At ≅40% power start 2nd #3 heater drain tank pump.

6. At ≅ 80 percent power start the 3rd #3 heater drain tank pump.

   CAUTION: If the level in the No. 3 heater drain tank goes high enough to open the dump to condenser valves and turbine load is ≥ 80 percent, the turbine is run back to ∿ 75 percent power.

   CAUTION: LCV 6-106B will close if the ΔP across the No. 3 heater drain pumps suction and discharge headers drops to 490 psi when one or more heater drain pumps are running.

   CAUTION: LCV 6-106B will have to be manually reset with local "Reset" pushbutton before the valve can be reopened. Close the air supply valve to LCV 6-106B before reseting the valve. After the PCV is reset open air supply valve slowly while monitoring the No. 3 heater drain tank level to prevent low level trip.

C. No. 7 heater drain pump operation

1. Check each No. 7 heater drain pump ready for operation by:

   a. Verify injection water flow to seals.

   b. Verify oil levels normal.

   c. Verify raw cooling water to oil coolers.

   d. Place local "Test-Reset-Safe Stop" switch to "Reset" position.

2. Place each No. 7 heater drain pump auxiliary oil pump local "Test-Reset-Safe Stop" switch to "Reset" position.

SECTIONS 5 & 1

QUESTIONS		COMMENTS
5.12		The answer key addresses units 3 and 4; however, it should be: a. 2 b. 1
5.16 1.20		Less than full load ΔT is not in our procedures. See attachment.
5.20	b.	Answer key states outward rod motion stops due to OPΔT. The OPΔT rod stop/runback is at 3% below the OPΔT trip setpoint ~109% - 3% = ~106% power. Because the NIS power range rod step is at 103% power (lower than OPΔT). The correct answer is NIS C-2 rod stop prevented outward rod motion. Answer key should allow NIS rod stop or the OPΔT rod stop.
5.20	c.	Answer key states the SF indication decreases due to P steam decrease. However, because the S/G press is decreasing, the steam flow should decrease because flow is proportional to the $\sqrt{\Delta P}$ Answer key should be revised to accept statement that there is less driving force in S/G (lower S/G press); therefore SF decreases.

NATURAL CIRCULATION GUIDELINES

A. Guidelines to determine if natural circulation is taking place in primary system under subcooled condition.

____ 1. Relatively stable Δ T with < 55°F with gradual decrease.

____ 2. Determine core Δ T as follows:

____ (a). Wide range RTD's (hot and cold legs) OR

____ (b). Wide range RTD's (cold legs) and incore T/C's.

____ 3. Incore T/C's temperature indicating below saturation temperature for the existing primary system pressure.

____ 4. RCS heat being removed by secondary system:

____ (a). S/G's steaming and water being added to S/G's.
____ (b). Steam pressure near saturation for RCS temperature

B. Instructions to enhance natural circulation.

* * ____ 1. Keep S/G levels in narrow range (tubes covered), between 25% and 50% for post accident instrument error.

NOTE: (Unit 1) When cooling down during natural circulation and it becomes desirable to depressurize the RCS; use the 5 relocated incore T/C's to determine the upper head temperature. Then base the RCS pressure reduction on the highest operable T/C of the 5 to prevent reaching saturation in the upper head area.

NOTE: (Unit 2) At this time U-2 does not have the 5 relocated incore T/C's. Therefore use the existing 65 incore T/C's to determine the highest temperature in the Upper Head. Base reduction of RCS pressure on the highest operable of the 65 T/C's.

____ 2. Keep RCS pressure above saturation pressure for the existing hot leg (W.R.) or incore T/C temperature.

____ 3. Use S/G PORV's to steam off and cool RCS.

* ____ 4. Initiate SI if RCS pressure drops below 2000 psi unexpectedly then evaluate condition and refer to emergency instructions.

NATURAL CIRCULATION COOLDOWN

STEP	ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED
	CAUTION: If SI actuation occurs, then E-0, Reactor Trip Or Safety Injection, should be used.	
	Note: If at any time an RCP can be restarted, then go to appropriate normal cooldown instruction	
1	Try To Restart An RCP a. Loop 2 preferred b. Refer to SOI-68.2 c. Start an RCP and go to appropriate plant instruction	IF an RCP can NOT be started, THEN verify natural circulation RCS subcooling S/G press stable or decreasing T-hot stable or decreasing Core exit T/C stable or decreasing T-cold at saturation temp for S/G press IF natural circulation NOT verified, THEN increase dumping steam

SECTIONS 7 & 4

QUESTIONS	COMMENTS
7.5 4.5	Answer key should accept OPΔT as well at OTΔT. OPΔT should occur first (~109%) and OTΔT second (~114%) (The reason AOI-3 states OTΔT as the trip function is because OPΔT is not taken credit for in the FSAR accident analysis. Ref. TS bases for OPΔT pg. B-2-4 - attached)
7.9	b. Answer key should accept Site Emergency Director - See Attached IP-15 Answer Key states Plant Superintendent; however, title has been changed to Plant Manager, should accept either as correct answer.
7.15	a. The words "Faulted Steam Generator" is misleading and implies that a steam line break is present. b. The RCPs are not tripped on a SGTR unless the pressure decreases uncontrollable to less than 1250 PSI. The question is based on outdated procedures. The answer key is confusing.
7.19 4.18	The question is misleading because it is based on outdated procedures. Any answer that verifies safety injection should be accepted.
7.21	The answer is based on outdated EOIs - It should reflect current status trees. - See attached.

Intermediate and Source Range, Nuclear Flux (Continued)

Range Channels will initiate a reactor trip at a current level proportional to approximately 25 percent of RATED THERMAL POWER unless manually blocked when P-10 becomes active. No credit was taken for operation of the trips associated with either the Intermediate or Source Range Channels in the accident analyses; however, their functional capability at the specified trip settings is required by this specification to enhance the overall reliability of the Reactor Protection System.

Overtemperature ΔT

The Overtemperature delta T trip provides core protection to prevent DNB for all combinations of pressure, power, coolant temperature, and axial power distribution, provided that the transient is slow with respect to piping transit delays from the core to the temperature detectors (about 4 seconds), and pressure is within the range between the High and Low Pressure reactor trips. This setpoint includes corrections for axial power distribution, changes in density and heat capacity of water with temperature and dynamic compensation for piping delays from the core to the loop temperature detectors. With normal axial power distribution, this reactor trip limit is always below the core safety limit as shown in Figure 2.1-1. If axial peaks are greater than design, as indicated by the difference between top and bottom power range nuclear detectors, the reactor trip is automatically reduced according to the notations in Table 2.2-1.

Operation with a reactor coolant loop out of service below the 4 loop P-8 setpoint does not require reactor protection system set point modification because the P-8 setpoint and associated trip will prevent DNB during 3 loop operation exclusive of the Overtemperature delta T setpoint. Three loop operation above the 4 loop P-8 setpoint is permissible after resetting the K1, K2, and K3 inputs to the Overtemperature delta T channels and raising the P-8 setpoint to its 3 loop value. In this mode of operation, the P-8 interlock and trip functions as a High Neutron Flux trip at the reduced power level.

Overpower ΔT

The Overpower delta T reactor trip provides assurance of fuel integrity, e.g., no melting, under all possible overpower conditions, limits the required range for Overtemperature delta T protection, and provides a backup to the High Neutron Flux trip. The setpoint includes corrections for changes in density and heat capacity of water with temperature, and dynamic compensation for piping delays from the core to the loop temperature detectors. No credit was taken for operation of this trip in the accident analyses; however, its functional capability at the specified trip setting is required by this specification to enhance the overall reliability of the Reactor Protection System.

EMERGENCY EXPOSURE GUIDELINES

1.0 PURPOSE

This procedure provides guidance as to the amount of radiation exposure that is acceptable for various types of activity.

2.0 PROCEDURE

2.1 Life Saving Actions (75 rems)

This applies to lifesaving actions for individuals or to prevent serious injuries to a large number of persons.

2.1.1 Rescue personnel must be aware of possible consequences of such an exposure and selected on a voluntary basis unless they are members of an emergency team and have previously consented to receive this exposure. Following the exposure, these individuals must be removed from areas where they could receive another emergency dose.

2.1.2 Women capable of reproduction should not take part in these actions.

2.1.3 Other things being equal, the oldest volunteer preferably should be selected.

2.1.4 Planned dose to the whole body shall not exceed 75 rems.

2.1.5 Hands and forearms may receive an additional dose of up to 200 rems (i.e., a total of 275 rems).

2.1.6 Internal exposure should be minimized by the use of respiratory protection equipment. Respiratory protection factors are given in attachment 1 of this procedure.

2.1.7 Contamination should be controlled by the use of available protective clothing.

2.1.8 Normally, exposure under these conditions shall be limited to once in a lifetime.

NOTE: The Site Emergency Director will determine the amount of exposure that will be permitted in order to perform the emergency mission.

IV. RADIATION PROTECTION STANDARDS (continued)

A. Maximum Permissible Exposure to Radiation (continued)

Non-TVA personnel shall be limited to the following maximum whole body exposures:

(1) 300 mrem/calendar quarter, or

(2) 1,250 mrem/calendar quarter (up to 5 rem per year with lifetime occupational radiation exposure considered) if dose records are supplied for the individual(s) for the present calendar quarter. The exposure permitted shall be adjusted so that the total dose received shall not exceed the 1,250 mrem/calendar quarter limit, or

(3) 3,000 mrem/calendar quarter (up to 12 rem per year with lifetime occupational radiation exposure considered) if the requirements of item (2) above and 10CFR20.101(b) are met and the written authorization of the individual's employer is obtained.

2. Exposure Exceeding Limits of 10CFR20

Any individual who receives an exposure to radiation in excess of the limits shall be removed from further exposure for the remainder of the applicable period. A report shall be completed by the HP Supervisor and an investigation with a written report of its findings and recommendations shall be conducted by the Plant Operations Review Committee (PORC).

Reports of the incident shall be made to the NRC per applicable parts of 10CFR20, Section 20.405, and AI-18, "Plant Reporting Requirements".

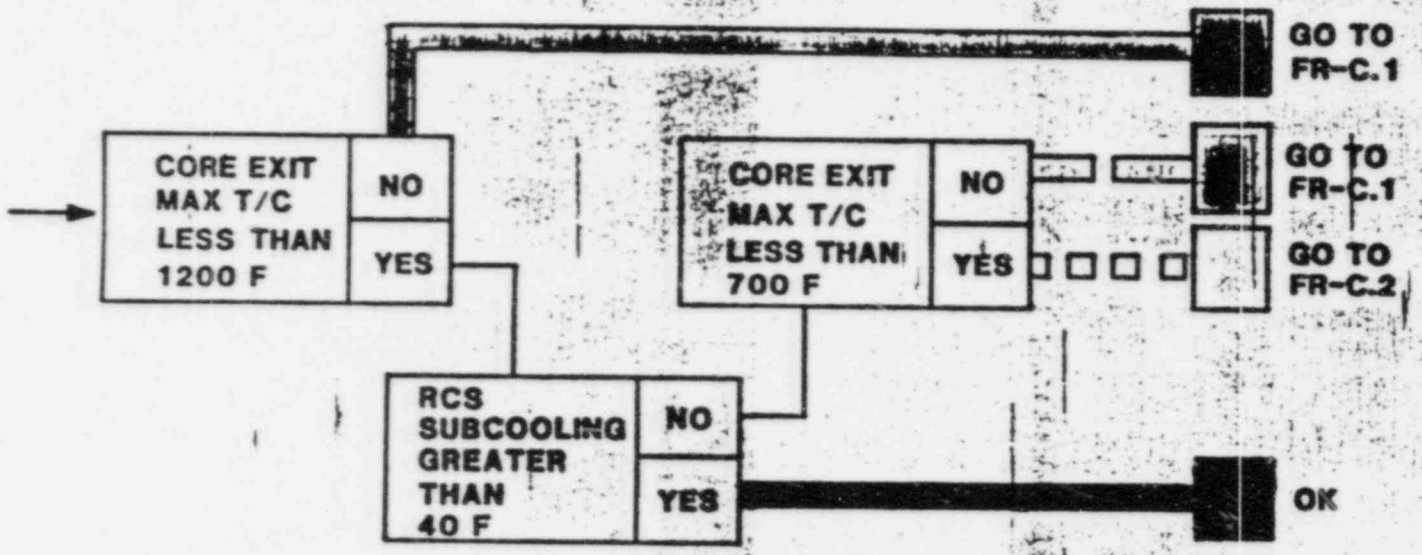
3. Emergency Exposure

In emergency situations, normal exposure limits may be exceeded. Guidelines for limiting emergency exposures are set forth in Sequoyah Implementing Procedures, IP-15.

These guidelines shall not be used without the knowledge and consent of the Plant Manager, or his duly authorized representative.

CORE COOLING

1FRC F-0.2



QUESTIONS COMMENTS

6.11 Air or Air Solenoid Valve should be accepted.
2.12

6.12 Part f. - RWST to SI Pump Suction
2.11

Answer key states these valves receive an "Open" signal. If the question is referring to FCV-63-5, then the answer should be "No Change".

If the interpretation for "SI Pump" is used for the CCP Suction [Sometimes called High-Head SI Pumps], then the answer would be open (FCV-62-135/136)

Request that both answers be accepted due to 2 different interpretations of SI Pump. Question could be referring to FCV-63-5 or FCV-62-135/136.

Ref. 47W611-63

Part j. - Steam Supply Valve To Main Feed Pump

Answer key states these valves receive "No Signal". However SIS→MFW Isolation→Closes MFP steam supply.

Request answer key accept <u>CLOSE</u>

6.18 Liquid Space RTD is used when a bubble is being drawn in the PZR. - See Attachments

6.14 The stationary gripper will receive a high current signal first;
2.16 therefore, the correct answer is:

b, c, f, e, b, d, a

QUESTIONS COMMENTS

6.21 3.15 The question asks what control or protection SIGNAL is generated by the pressure instrument on T-hot leg.

In addition to the answer given on the key any one of the following should also be accepted:

1) Cold over press input
2) RCS Subcooling meter input
3) RVLIS Input

} indications, not control or protection

4) RHR interlock 380# and 700# → only answer.

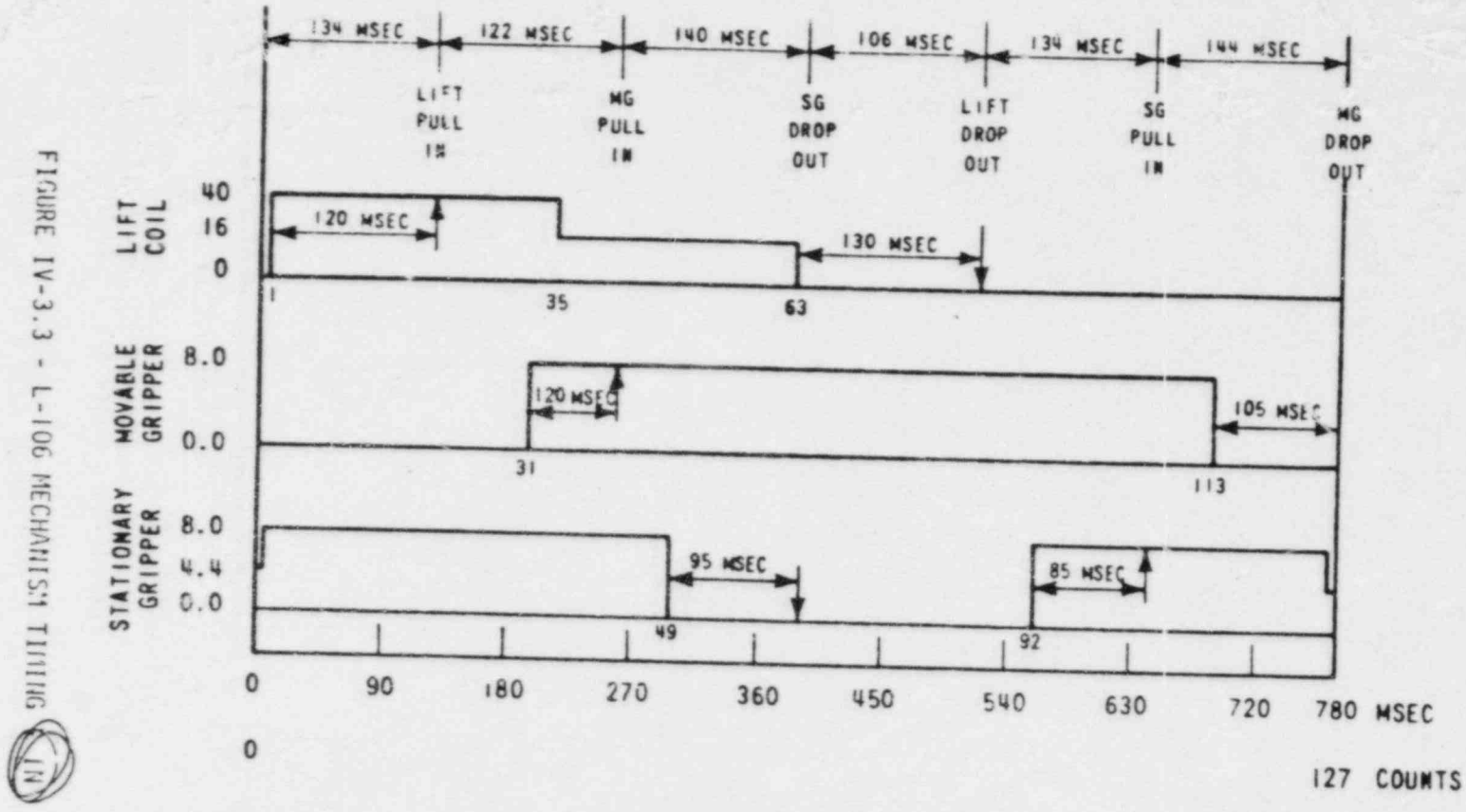
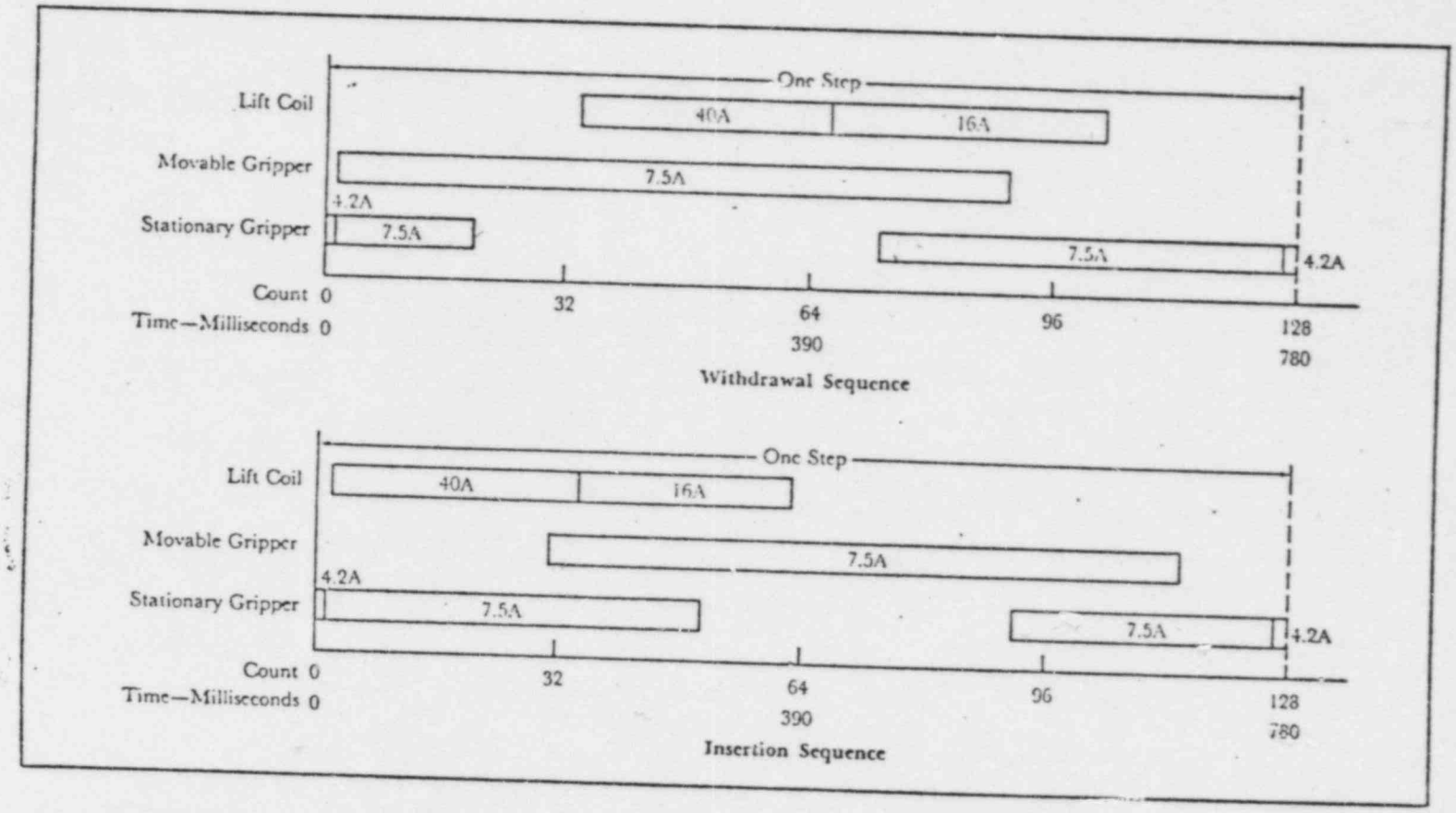


FIGURE IV-3.3 - L-106 MECHANISM TIMING


One Step
Lift Coil
40A
16A
Movable Gripper
7.5A
4.2A
Stationary Gripper
7.5A
7.5A
4.2A
Count 0
32
64
96
128
Time—Milliseconds 0
390
780
Withdrawal Sequence
One Step
Lift Coil
40A
16A
Movable Gripper
7.5A
4.2A
Stationary Gripper
7.5A
7.5A
4.2A
Count 0
32
64
96
128
Time—Milliseconds 0
390
780
Insertion Sequence

g. _____ Initiate SI-127 "RCS and Pressurizer Temperature and Pressure Limits."

h. _____ As the pressurizer temperature increases, water vapor and gas will be forced over to the PRT through the power relief valves. Monitor the PRT tank pressure and temperature as the pressurizer is heated. The pressurizer relief line temperature indicator should start increasing as soon as steaming is initiated in the pressurizer.

i. _____ Cool the PRT by spray and drain operation as required to maintain the temperature below the high temperature alarm. Vent the PRT if the gas pressure rises to near 3 psig through PCV-68-301.

j. _____ When the water and vapor temperatures are within about 5°F of each other, close the power relief valves to allow the pressurizer pressure to increase by action of the pressurizer heaters.

18. _____ Maintain the RCS temperature < 160°F by adjusting flow through the RHR heat exchangers (do not stop and start RHR pumps for temperature control).

19. _____ Continue pressurizer heatup to 430°F. Allow RCS pressure to increase to 325 psig.

20. _____ Gradually reduce pressurizer level to program (24.7%). Place level control in AUTO when level is normal. This is to limit temperature transients on loop 2 hotleg.

21. _____ Start the reactor coolant pumps (SOI-68.2). After five minutes running, sample the RC for chemistry specifications (limits in SI-50 and 51). Partially open pressurizer sprays for mixing and turn on backup heater for pressure control.

22. _____ Stop residual heat removal system cooling operation by closing HIC-74-16 and HIC-74-28 while maintaing flow thru HIC-74-32.

23. _____ Allow RC temperature to increase to 180°F. Continue SI--127.

CAUTION: Do not exceed 180°F on RCS until water chemistry is within specifications. (TI-27, Table 48, or SI-50 and SI-51).

Heatup ______________

Cooldown ______________

Leak/Hydrostatic Test ______________

Unit ______________

Date ______________

4.1 Time (Record every 30 min)	4.2 RCS press psig	4.3 RCS Temp °F	4.4 PZR Liq. Temp °F	4.5 PZR Vapor Temp °F	4.6 Spray Temp °F	4.7 RCS ΔT for 30 min °F	4.8 PZR ΔT for 30 °F	4.9 PZR/spray ΔT °F	4.10 RCS T/P within curves (√ for yes & X for No)
Instrument No.						N/A	N/A	N/A	
						Initial	Readings		

Data by: ______________________________ Date ______________

NOTE: For instruments to use and acceptance criteria - See Section 3.0 and 4.0

QUESTIONS COMMENTS

6.21
3.15 The question asks what control or protection SIGNAL is generated by the pressure instrument on T-hot leg.

In addition to the answer given on the key any one of the following should also be accepted:

1) Cold over press input

2) RCS Subcooling meter input

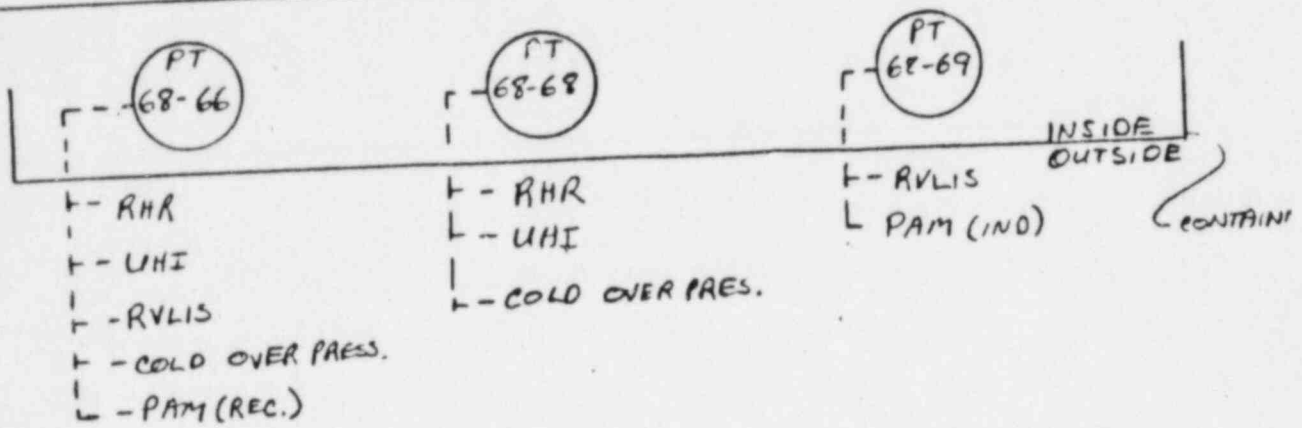
3) RVLIS Input

4) RHR interlock 380# and 700#

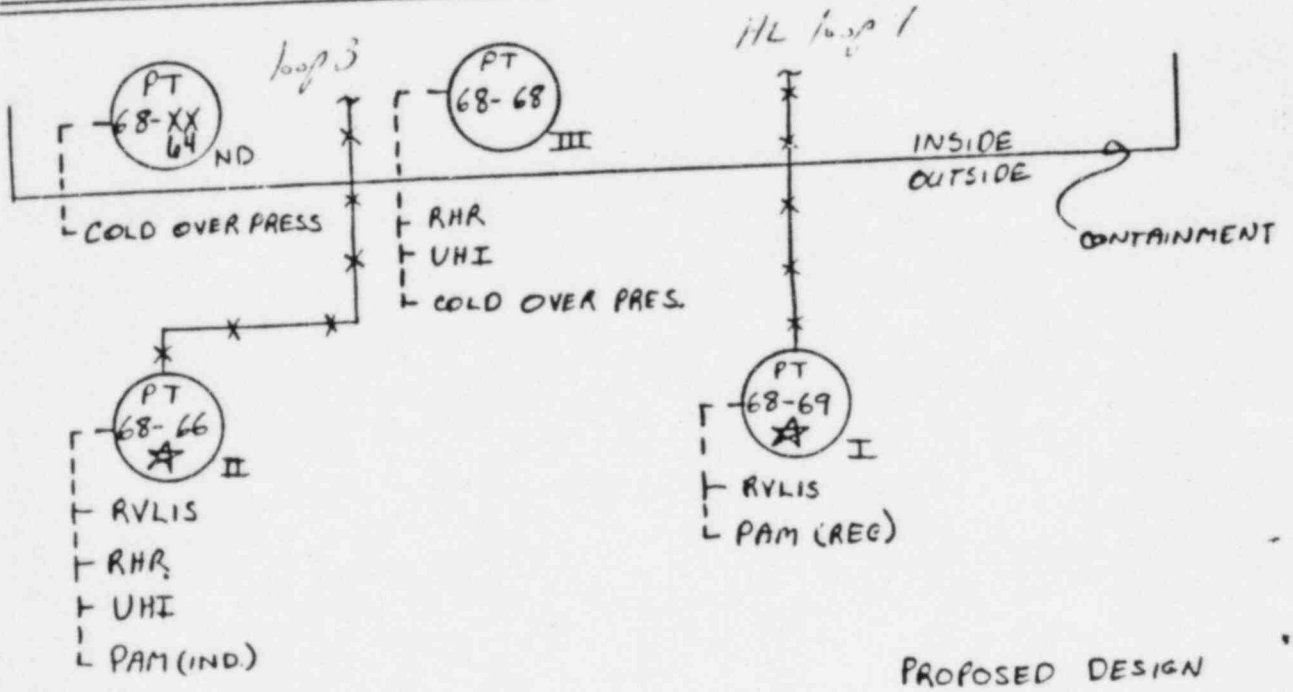
LOOP 2

COMPUTED AS DATE 12-20-8

CHECKED _____ DATE _____



PRESENT DESIGN



PROPOSED DESIGN

☆ THESE INSTR. TEE MECHANICALLY INTO RVLIS BETWEEN THE HYDRAULIC ISOLATORS (XIS) AND LEVEL XMTR (LT)

ref 47W610-68-7

WP 11174

PAGE III-8 OF 12

Data Sheets

B.14 SATURATION MONITORING

INTRODUCTION

The plant process computer is utilized to continuously monitor pressure and temperature margins-to-saturation of the primary coolant system, and to give early warning when any of these margins reaches preset limits. The following description is provided to familiarize the operator with the methods used for this monitoring, as an aid in the evaluation of saturation data to be used for trend or display, and in recognizing the type of abnormal indication that can result when certain computer inputs are unavailable or unreliable.

DESCRIPTION

Saturation pressures, temperatures (U0901 thru U0905), and their associated margins-to-saturation (U0984 thru U0989), are calculated based on the following primary system inputs:

1. System pressure (lowest pressurizer or wide-range)
2. Hot leg temperature (hottest)
3. Average incore T/C temperature
4. Hottest incore T/C temperature

The single pressure input used in the calculations is selected from the lowest of the four narrow-range pressurizer pressures when system pressure is above 1700 psig. Wide-range pressure is used below 1700 psig and when there are no narrow-range inputs available and reliable. If the wide-range pressure also is unavailable or unreliable, a minimum pressure value is used (unreliable zero). This causes all margin values to be indicated as unreliable and removed from limit checking. Use of this minimum pressure in the calculations also causes the margin values to go low (usually negative), which results in a sudden zero scale pen indication for any margin being trended. Alarm printout and annunciation are suppressed under these conditions.

The hottest wide-range loop temperature is selected from the four hot leg inputs on the basis of availability and reliability also. However, only those outputs associated with this temperature are affected (pen movement, alarm suppression) if none of the four inputs are usable. (700 degf unreliable is used.)

Average incore temperature and hottest incore temperature are calculated by a standard W program. This program uses temperature values for any thermocouple that is reliable and not in alarm; scan removed status is not checked. Therefore, during normal operation, if an incore thermocouple is removed from scan, a value of zero should be entered. This will cause it to be in low alarm and not be used in the average or selected as the hottest.

SUMMARY OF INPUTS AND OUTPUTS

A list of all program inputs and outputs can be obtained from the operator's console using the DATA DUMP function. This listing should be requested when initially selecting a value for trend, and periodically thereafter to check data quality and verify pen recorder indication. Analog inputs that are scan removed or have been out of range will be marked with a letter 'S' or an asterisk. Unreliable calculated values (program outputs) are marked with an asterisk and should not be used for trend. If there are no reliable outputs, a check of computer hardware and/or plant instrumentation should be requested.

PEN RECORDER TREND

Operator Procedure No. 1 (from W manual TP044)

1. Push ANALOG TREND Function Button
2. Select Address on Alphanumeric Keyboard
3. Push ADDRESS Button
4. Select Pen Number (1 to 12) on Keyboard (see note)
5. Push Value 1 Button
6. Select Pen Position on Keyboard
7. Push Value 2 Button
8. Select Range on Keyboard
9. Push Value 3 Button
10. Push START Button

Pen Position is the minimum scale value, Range is the maximum scale minus the minimum scale.

After the pen recorder is started, verify that the pen moves to the per cent of scale that corresponds to the value shown in the printout.

Example:

Pen Position = 0 (step 6)
Range = 100 (step 8)
TSAT Margin = 37.5 degf (from printout)
Pen Indication = 37.5 per cent

Note: It is suggested that Pen No. 1 be used as Pen No. 2 thru 12 are used for post accident monitoring, and are set up automatically by the PAM program.

SATURATION MONITORING

TABLE A

PROGRAM INPUTS

AP Sym	Instrument		Range	Units
P0480A	PT-68-340	Pressurizer 1 press	1700-2500	psig
P0481A	PT-68-334	Pressurizer 2 press	1700-2500	psig
P0482A	PT-68-323	Pressurizer 3 press	1700-2500	psig
P0483A	PT-68-322	Pressurizer 4 press	1700-2500	psig
P0499A	PT-68-68A	RCL System press	0-3000	psig
T0419A	TE-68-1	RCLA Hot temp	0-700	degf
T0439A	TE-68-24	RCLB Hot temp	0-700	degf
T0459A	TE-68-43	RCLC Hot temp	0-700	degf
T0479A	TE-68-65	RCLD Hot temp	0-700	degf
U0090		Inst Value of Hottest Incore T/C	0-2500	degf
U0091		Inst Value of Average Incore T/C	0-2500	degf
K5502		PSAT Margin Annunc Alarm Setpt	200	psi
K5503		TSAT Margin Annunc Alarm Setpt	15	degf

PROGRAM OUTPUTS

U0900	Press Value Used for Sat Calc	psig
U0901	Sat Press for Hottest RCL Temp	psig
U0902	Sat Press for Hottest T/C	psig
U0903	Sat Press for Avg Incore Temp	psig
U0904	Hot Leg Temp Used for Sat Calc	degf
U0905	Sat Temp for System Pressure	degf
U0984	PSAT Margin for Hottest RCL Temp	psi
U0985	PSAT Margin for Hottest T/C	psi
U0986	PSAT Margin for Avg Incore Temp	psi
U0987	TSAT Margin for (RCL T) for Sys Press	degf
U0988	TSAT Margin for (U0090) for Sys Press	degf
U0989	TSAT Margin for (U0091) for Sys Press	degf

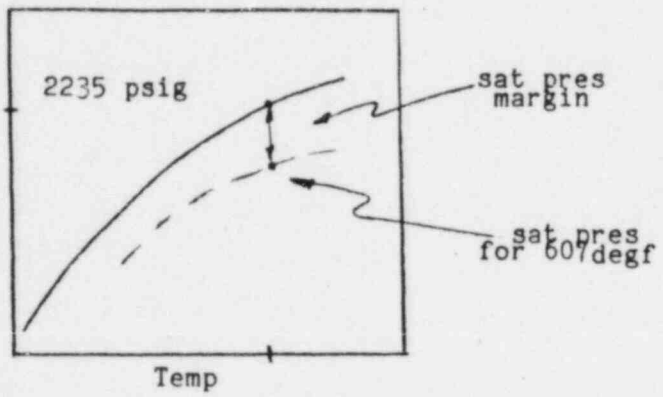
TABLE B

CALCULATIONS AND GRAPHICAL REPRESENTATION

Pressure Margin to Sat. = System Pressure - Saturation Pressure (fig. 1)

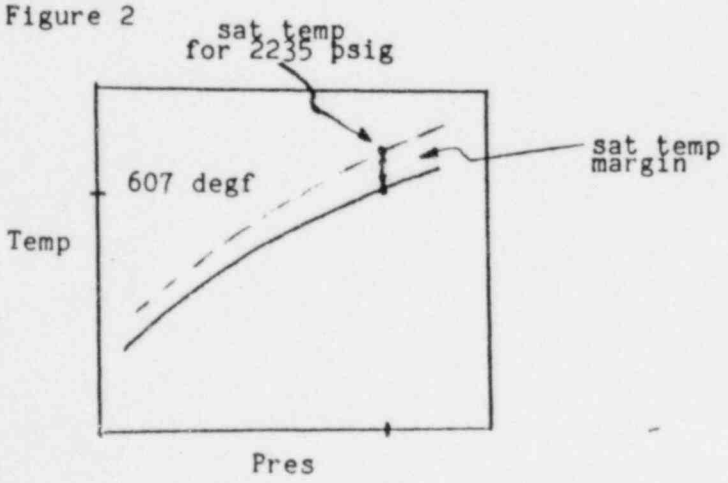
Temperature Margin to Sat. = Saturation Temp. - Measured Temp. (fig. 2)

Figure 1



The saturation pressure indicated is the pressure at which saturation will occur at the current temperature of 607 degf.

Figure 2



The saturation temperature indicated is the temperature at which saturation will occur at the current pressure of 2235 psig

SECTION 8

QUESTIONS COMMENTS

8.13 Mode 5 should also be accepted because of RCS T>140°F.

Definition of Mode 5: K_{eff} <.99 0% pwr RCS T<200°F

The Mode 5 condition does not footnote the "Fuel in the R_x vessel w/the vessel head closure bolts less than fully tensioned or head removed".

Both Mode 5 & Mode 6 should be accepted.

8.14 Answer Key reference is wrong. It should be AI-8.

AI-8 does not mention the storage area being lead shields.
See Attached

8.15 The question and answer is based on a old revision of OSLA-73.

The present revision does not designate a Stationary Fire Watch.

8.16 The Answer Key is based on bases for entholpy rise hot channel factor; however, LCO 3.1.3.2 states that rod position indication system shall be capable of determining the rod position within ±12 steps; therefore ±12 steps or ±13 steps should be accepted. - See Attached

8.17 This question's point value is too high.

Implies that the entire definition section of T.S. needs to be committed to memory.

8.20 a. You cannot determine that the charging motor is energized prior to racking the breaker in.

2.0 PROCEDURE (continued)

2.2.3 Prior to closing containment and/or the annulus (and including fuel handling areas), after an outage/refueling or major maintenance, the SE in coordination with the Public Safety Shift Supervisor, will require a search for explosives, incendaries and other devices. Two teams will conduct the search if necessary, one in upper containment and fuel handling areas, and one in lower containment and annulus(2). The teams will consist of a Public Safety Officer, an operator and HP representative. HP participation will be based on radiological conditions. Documentation of this requirement shall occur on the attached containment entry checklist data sheet.

2.3 The SE shall approve the number of personnel required for all initial entries to containment.

2.4 Prior to entry into lower containment or the annulus the incore flux detectors shall be verified to be in the storage position or inserted to within ten (10) feet of the core. The SE shall initiate a hold order clearance on the incore flux drive motors control power. This hold order shall remain in affect until the SE is assured all personnel have been cleared from containment and the personnel access is locked. Prior to issuing a radiation work permit (RWP) for lower containment or annulus, HP shall verify incore detector system is tagged with a hold order. The SE will issue incore detector system hold order clearance to HP Shift Supervisor by title.

The incore detector hold order clearance will remain issued to HP Shift Supervisor by title at all times except when running core maps or performing incore detector system maintenance that requires the detector system to be operated while persons are in the incore instrument room.

(2) Fuel handling areas is defined as that area on the fuel floor that will be within control zones delineated in AI-26.

0027A/mbs

SEQUOYAH NUCLEAR PLANT
OPERATIONS GROUP

OPERATIONS FIREWATCHES

References:
1. SQO37, Fire Protection Manual N82FP-1, FP-3
2. Memorandum from C. R. Brimer to P. R. Wallace dated June 14, 1985 (SOI-850614-957)
3. * CATS 85-409
4. * Memorandum from C. R. Brimer to P. R. Wallace dated February 18, 1986 (SOI 860218 818)

Firewatch personnel are under the supervision of the Operations Supervisor and his subordinates whose responsibility is to ensure the watches are manned, tours are made according to the established routes and times, journals are kept, and to evaluate any problems reported by the firewatch personnel including initiating corrective action deemed necessary as a result of reports from them.

There are two (2) designated firewatch patrol routes. Each route should be completed within forty-five minutes and shall be completed each hour. The designated routes are:

A. Control Building - all elevations
Auxiliary Building - elevations 759, 749, and 734
East Main Steam Valve Rooms - elevation 763 roof

B. Auxiliary Building - elevations 714, 690, 669, and 653
Additional Equipment Buildings - elevation 706
West Main Steam Valve Rooms - elevation 714

Checklists to be completed by the firewatch each shift are provided in Appendix A. These checklists shall be turned in to the shift engineer for review then forwarded to the Operations Supervisor's office through the morning mail pickup. Throughout the route, the firewatch shall observe and inspect the general area for substandard fire protection and detection systems, open or breached firestops, seals, fire doors, or fire dampers and transient fire loads or any other fire safety threats, perform hourly checks or PFBBP in their area (Penetration Fire Barrier Breaching Permits), and shall promptly inform the SE of any detrimental conditions encountered in his duties.

*
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*
*
*
*

*Revised (UCB)

* The Route B firewatch shall immediately notify Operations (shift engineer, assistant shift engineer, unit operator) upon indication of a rapid rise in temperature or temperatures in excess of 130°F
* in the U1 or U2 690 Pipe Chase or U1 side ERCW pipe tunnel.

* Firewatch personnel assigned to Appendix "R" Routes A and B shall maintain a daily journal to record all abnormal conditions or actions observed by the firewatch. The logs shall be turned in to the shift engineer for review then forwarded through the morning mail pickup to the Operations Supervisor's office.

The SE shall update the firewatch as necessary to meet the requirements of Tech Specs and Physi 13 by adding and/or deleting firestop breaching and fire protection inoperability or other substandard equipment.

*

* Stationary firewatches will relieve at their assigned watch stations. Do not leave firewatch stations (routes) unmanned. All relief shall be by direct face-to-face communication with the person assuming responsibility for the watch.

* Firewatch patrol personnel shift relief stations are as follows:

Route A.	Control Building at AUO sign in desk
Route B.	Auxiliary Building el. 669 at AUO station

Any problems encountered in supervising this program shall be brought to the attention of the Operations Supervisor for resolution.

Supv., Operations Group

* Revised

Each of these is measurable but will normally only be determined periodically as specified in Specifications 4.2.2 and 4.2.3. This periodic surveillance is sufficient to insure that the limits are maintained provided:

a. Control rods in a single group move together with no individual rod insertion differing by more than ± 13 steps from the group demand position.

b. Control rod groups are sequenced with overlapping groups as described in Specification 3.1.3.6.

c. The control rod insertion limits of Specifications 3.1.3.5 and 3.1.3.6 are maintained.

d. The axial power distribution, expressed in terms of AXIAL FLUX DIFFERENCE, is maintained within the limits.

$F^N_{\Delta H}$ will be maintained within its limits provided conditions a. through d. above are maintained. As noted on Figures 3.2-3 and 3.2-4, RCS flow and $F^N_{\Delta H}$ may be "traded off" against one another to ensure that the calculated DNBR will not be below the design DNBR value. The relaxation of $F^N_{\Delta H}$ as a function of THERMAL POWER allows changes in the radial power shape for all permissible rod insertion limits.

When RCS flow rate and $F^N_{\Delta H}$ are measured, no additional allowances are necessary prior to comparison with the limits of Figures 3.2-3 and 3.2-4. Measurement errors of 3.5 percent for RCS total flow rate and 4 percent for $F^N_{\Delta H}$ have been allowed for in determination of the design DNBR value.

R_1, as calculated in Specification 3.2.3 and used in Figure 3.2-3, accounts for $F^N_{\Delta H}$ less than or equal to 1.49. This value is the value used in the various safety analyses where $F^N_{\Delta H}$ influences parameters other than DNBR, e.g. peak clad temperature, and thus is the maximum "as measured" value allowed. R_2, as defined, allows for the inclusion of a penalty for Rod Bow on DNBR only. Thus, knowing the "as measured" values of $F^N_{\Delta H}$ and RCS flow allow for "trade off" in excess of R equal to 1.0 for the purpose of offsetting the Rod Bow DNBR penalty.

SEP 2 9 1983

POSITION INDICATION SYSTEMS-OPERATING

LIMITING CONDITION FOR OPERATION

3.1.3.2 The shutdown and control rod position indication system and the demand position indication system shall be OPERABLE and capable of determining the control rod positions within ± 12 steps.

APPLICABILITY: MODES 1 and 2.

ACTION:

a. With a maximum of one rod position indicator per bank inoperable either:

   1. Determine the position of the non-indicating rod(s) indirectly by the movable incore detectors at least once per 8 hours and immediately after any motion of the non-indicating rod which exceeds 24 steps in one direction since the last determination of the rod's position, or

   2. Reduce THERMAL POWER TO less than 50% of RATED THERMAL POWER within 8 hours.

b. With a maximum of one demand position indicator per bank inoperable either:

   1. Verify that all rod position indicators for the affected bank are OPERABLE and that the most withdrawn rod and the least withdrawn rod of the bank are within a maximum of 12 steps of each other at least once per 8 hours, or

   2. Reduce THERMAL POWER to less than 50% of RATED THERMAL POWER within 8 hours.

SURVEILLANCE REQUIREMENTS

4.1.3.2 Each rod position indicator shall be determined to be OPERABLE by verifying that the demand position indication system and the rod position indication system agree within 12 steps at least once per 12 hours except during time intervals when the Rod Position Deviation Monitor is inoperable, then compare the demand position indication system and the rod position indication system at least once per 4 hours.

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

FACILITY: SEQUOYAH 1&2

REACTOR TYPE: PWR-WEC4

DATE ADMINISTERED: 86/05/26

EXAMINER: D.J. NELSON

APPLICANT: Master and Key

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
30.00	25.53			5. THEORY OF NUCLEAR POWER PLANT OPERATION, FLUIDS, AND THERMODYNAMICS
~~30.00~~ 29.8	25.53			6. PLANT SYSTEMS DESIGN, CONTROL, AND INSTRUMENTATION
~~30.00~~ 28.0	25.53			7. PROCEDURES - NORMAL, ABNORMAL, EMERGENCY AND RADIOLOGICAL CONTROL
~~27.50~~ 27.0	23.40			8. ADMINISTRATIVE PROCEDURES, CONDITIONS, AND LIMITATIONS
~~117.50~~ 114.8	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 5.01 (1.00)

Which of the following will cause the fuel temperature coefficient (pcm/degree) to become less negative?

a. fuel temperature increase
b. boron concentration decrease
c. control rod insertion (at constant power)
d. increase in the ratio of Pu-240 to U-238

QUESTION 5.02 (1.00)

Select the statement about single speed, motor driven, centrifugal pumps that is correct.

a. Upon throttling open the discharge valve to increase flow, discharge pressure decreases and therefore motor amps decreases.

b. Upon throttling open the discharge valve to increase flow, net positive suction head required increases and differential pressure across the pump decreases.

c. Upon throttling open the discharge valve, flow increases, total developed head increases and net positive suction head available decreases.

d. Pump cavitation can be reduced by throttling open the discharge valve thereby reducing total developed head.

QUESTION 5.03 (1.00)

Of the following, which must the main condenser remove the most heat from to condense? (assume steam is of equal quality)

a. one pound of steam at 0 psia.

b. one pound of steam at 300 psia.

c. two pounds of steam at 600 psia.

d. two pounds of steam at 1200 psia.

(***** CATEGORY 05 CONTINUED ON NEXT PAGE *****)

UNITED STATES
NUCLEAR REGULATORY COMMISSION
REGION II
101 MARIETTA STREET, N.W., SUITE 2900
ATLANTA, GEORGIA 30323

QUESTION 5.04 (1.00)

Which expression below describes the heat flux hot channel factor Fq(z)?

a. Maximum fuel assembly $\dot{Q}$ at height Z/ Avg $\dot{Q}$ at height Z

b. Maximum fuel assembly $\dot{Q}$ at height Z/ Avg $\dot{Q}$ in core

c. Average fuel assembly $\dot{Q}$/ Maximum $\dot{Q}$ at height Z

d. Average $\dot{Q}$ at height Z/ Avg $\dot{Q}$ in core

QUESTION 5.05 (1.00)

Which of the following would cause an inadvertant dilution accident?

a) Overfilling a S/G while in hot standby.

b) A Regenerative heat exchanger leak.

c) Valving in a demineralizer that was not saturated.

d) A VCT Lo-Lo level resulting in the RWST being used for charging.

QUESTION 5.06 (1.00)

Attached Figure # 220 shows a power history and four possible samarium traces (reactivity vs time). Select (a, b, c, or d) the curve that correctly displays the expected samarium transient for the given power history.

QUESTION 5.07 (1.00)

Attached Figure # 219 shows a power history and four possible xenon traces (reactivity vs time). Select (a, b, c, or d) the curve that correctly displays the expected xenon transient for the given power history.

(***** CATEGORY 05 CONTINUED ON NEXT PAGE *****)

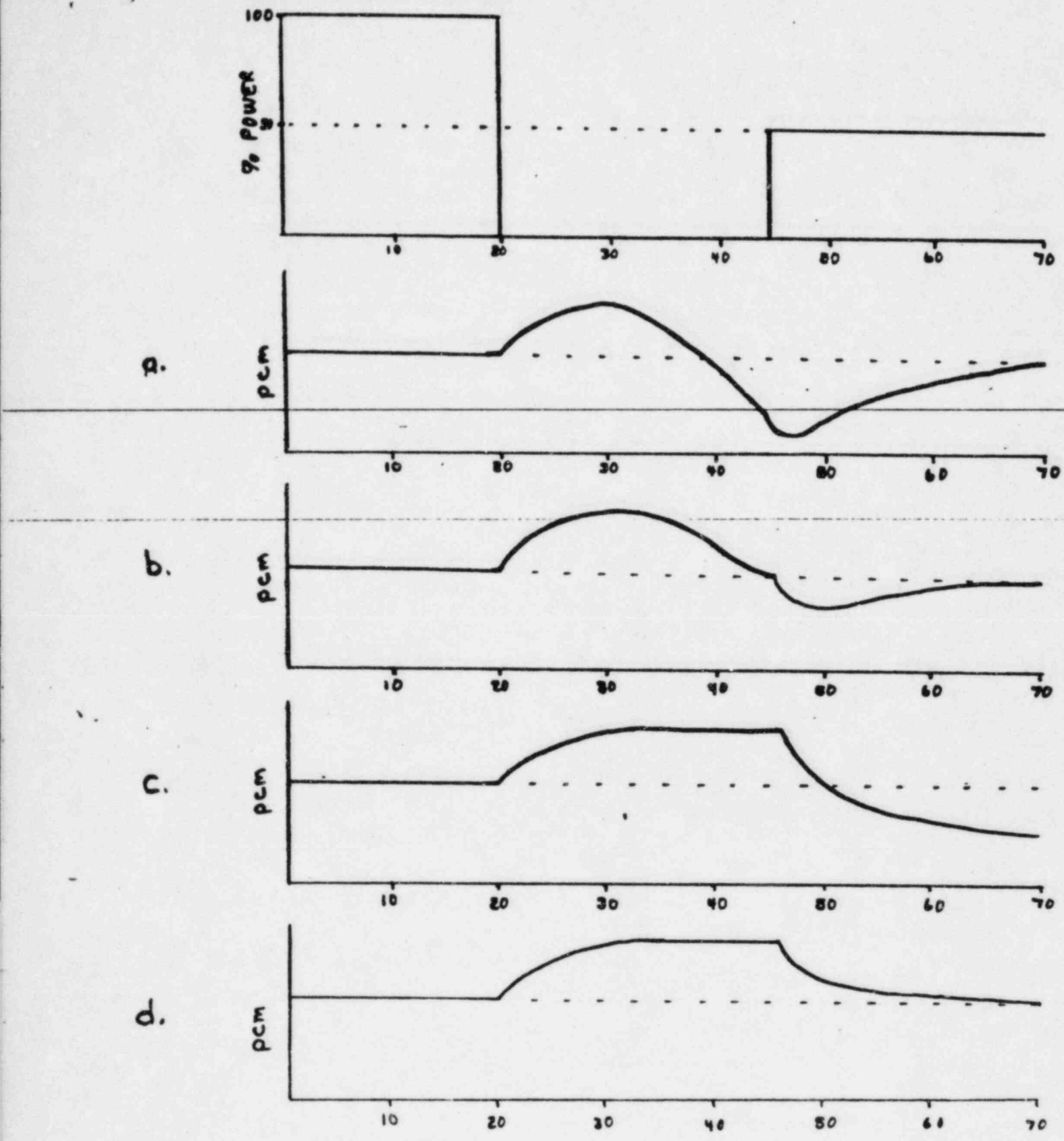


FIGURE # 120

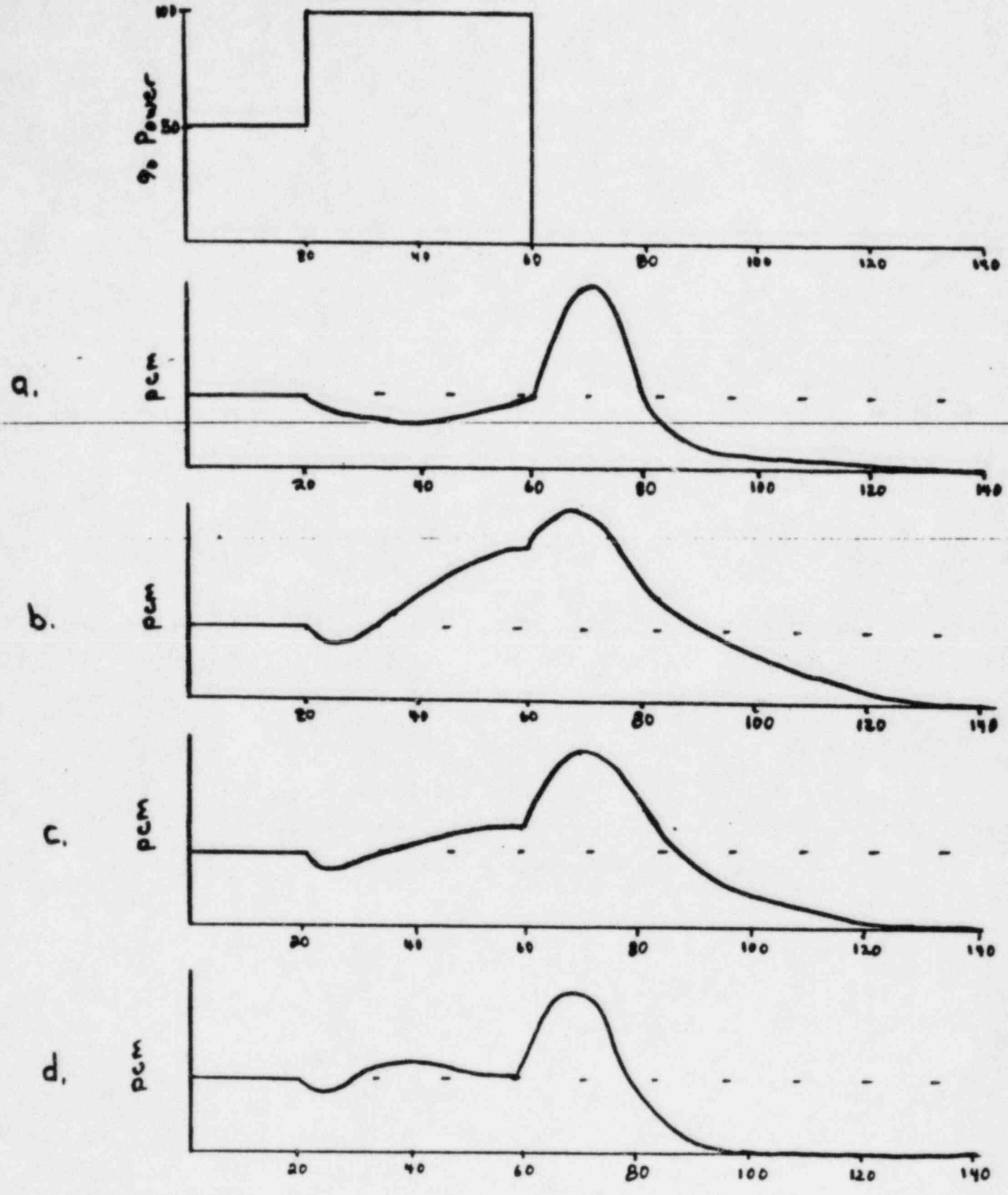


FIGURE #219

QUESTION 5.08 (3.00)

At 30% power a reactor coolant pump trips. With control rods in manual and all other systems in automatic and no operator/protective actions occur, indicate the effects on the following at the end of the transient: (increases, decreases, or remains the same)

	AFFECTED LOOP	UNAFFECTED LOOP
a. steam generator level		
b. steam flow		
c. delta T		

QUESTION 5.09 (1.50)

For the changes listed below (treat each one independently) indicate whether the moderator temperature coefficient will become MORE NEGATIVE, LESS NEGATIVE or have NO EFFECT. (Assume all other parameters are constant)

a) Neutron flux peak shifts radially outward to the edge of the core.

b) Boron concentration increases 100 ppm while core is at MOL.

c) All rods in instead of all rods out.

QUESTION 5.10 (1.00)

Indicate TRUE or FALSE for the following statements concerning the effect that delayed neutrons have on reactivity:

a. Because delayed neutrons are born at lower energies than prompt neutrons, they are less likely to leak out of the core resulting in a positive effect.

b. Delayed neutrons are born at an average energy incapable of causing fast fission of U-238 creating a negative effect.

QUESTION 5.11 (1.00)

What are the two primary factors that provide the driving mechanism for Natural Circulation flow?

(***** CATEGORY 05 CONTINUED ON NEXT PAGE *****)

QUESTION 5.12 (2.00)

Unit 1 has just restarted following a refueling outage while Unit 2 is near EOL. Answer the following regarding the differences in plant response between the two units(explain your answers): Assume Rods in manual

a) At a steady power level of 10EE(-8) amps during a startup, equal reactivity additions are made (approximately 100 pcm). Which Unit will have the higher steady state startup rate?

b) At 50% power, a control rod(100 pcm) drops. Assuming NO RUNBACK or OPERATOR ACTION, which Unit will have the lower steady state Tavg?

QUESTION 5.13 (1.50)

During the performance of an emergency boration while at power, how and why are the following parameters affected? (assume no control rod movement)

a. subcooling

b. over ~~pressure~~ POWER differential temperature setpoint

c. control rod worth

QUESTION 5.14 (1.00)

Explain how decreasing RCS flow (at constant power) will result in decreasing DNBR.

QUESTION 5.15 (.50)

If the equilibrium count rate in a subcritical reactor TRIPLES due to a reactivity addition, what happens to the margin to criticality (direction and magnitude)?

QUESTION 5.16 (3.00)

What are THREE parameters AND their trends which are indications that Natural Circulation in the RCS is established? (numerical values not req'd)

(***** CATEGORY 05 CONTINUED ON NEXT PAGE *****)

QUESTION 5.17 (1.00)

Aux. Feed flow is more critical on a small LOCA than on a large LOCA. Why is this true?

QUESTION 5.18 (1.00)

What are the two reasons for shifting the SI mode from cold leg recirculation to hot leg recirculation approximately 24 hours after a LOCA?

QUESTION 5.19 (2.00)

A rod drops and sticks at the core mid-position from full power conditions with all rods out. A Reactor Trip does not occur. If this condition were to persist for an extended period of time (well beyond T/S limits), what will be the effect on the Excore Axial Offset of the Power Range NI for the quadrant in which the dropped/stuck rod occurs. Include a discussion of xenon effects and a definition of axial offset.

QUESTION 5.20 (1.50)

Use the attached curves, labeled S-24, to explain the following questions. Assume that all systems are in automatic control and that no operator action is taken.

a) Why does S/G level rise at point 4?

b) Why is there no outward rod motion after point 9, even though Tavg is less than Tref?

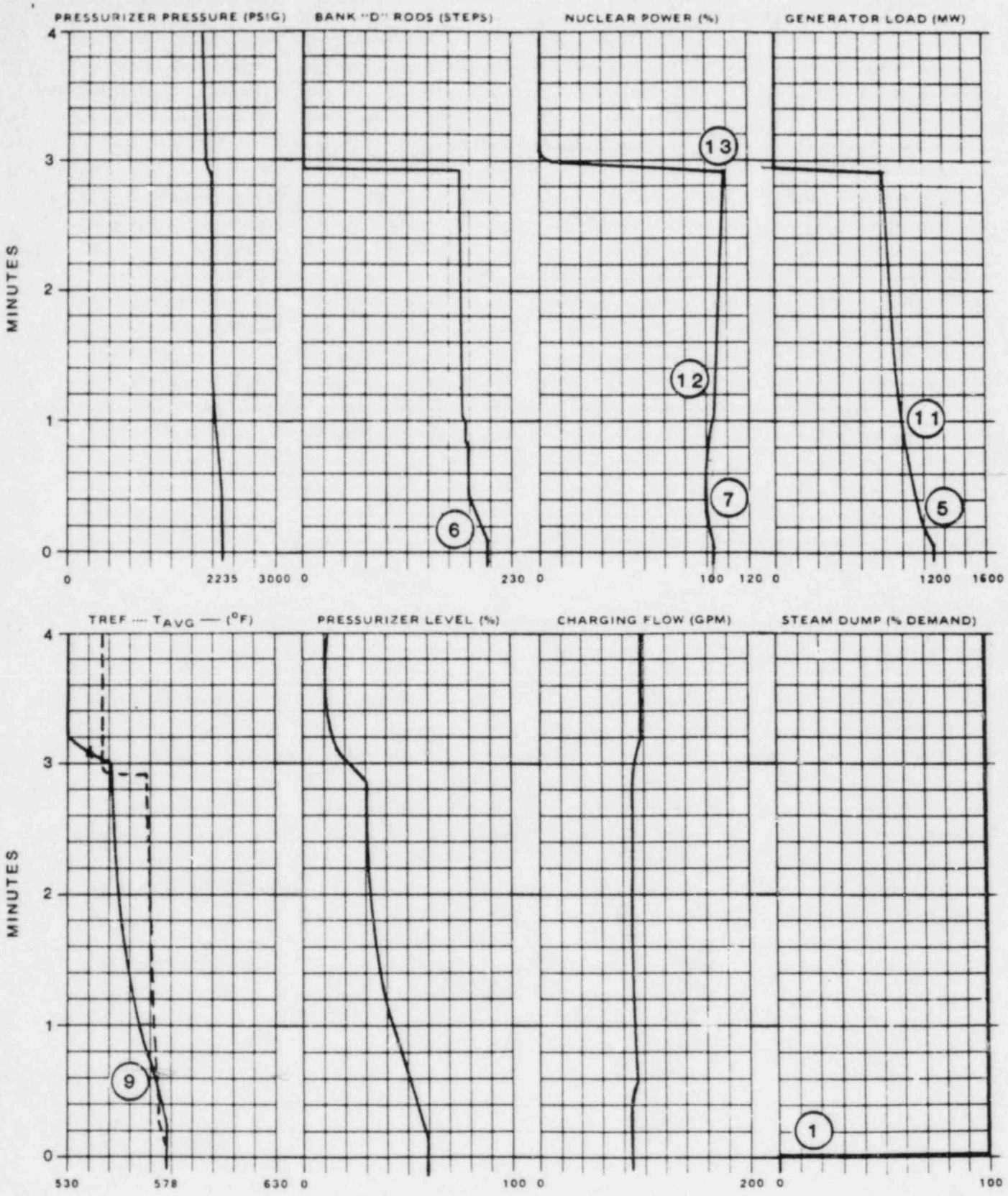
c) Why does steam flow gradually decrease at point 8?

QUESTION 5.21 (1.00)

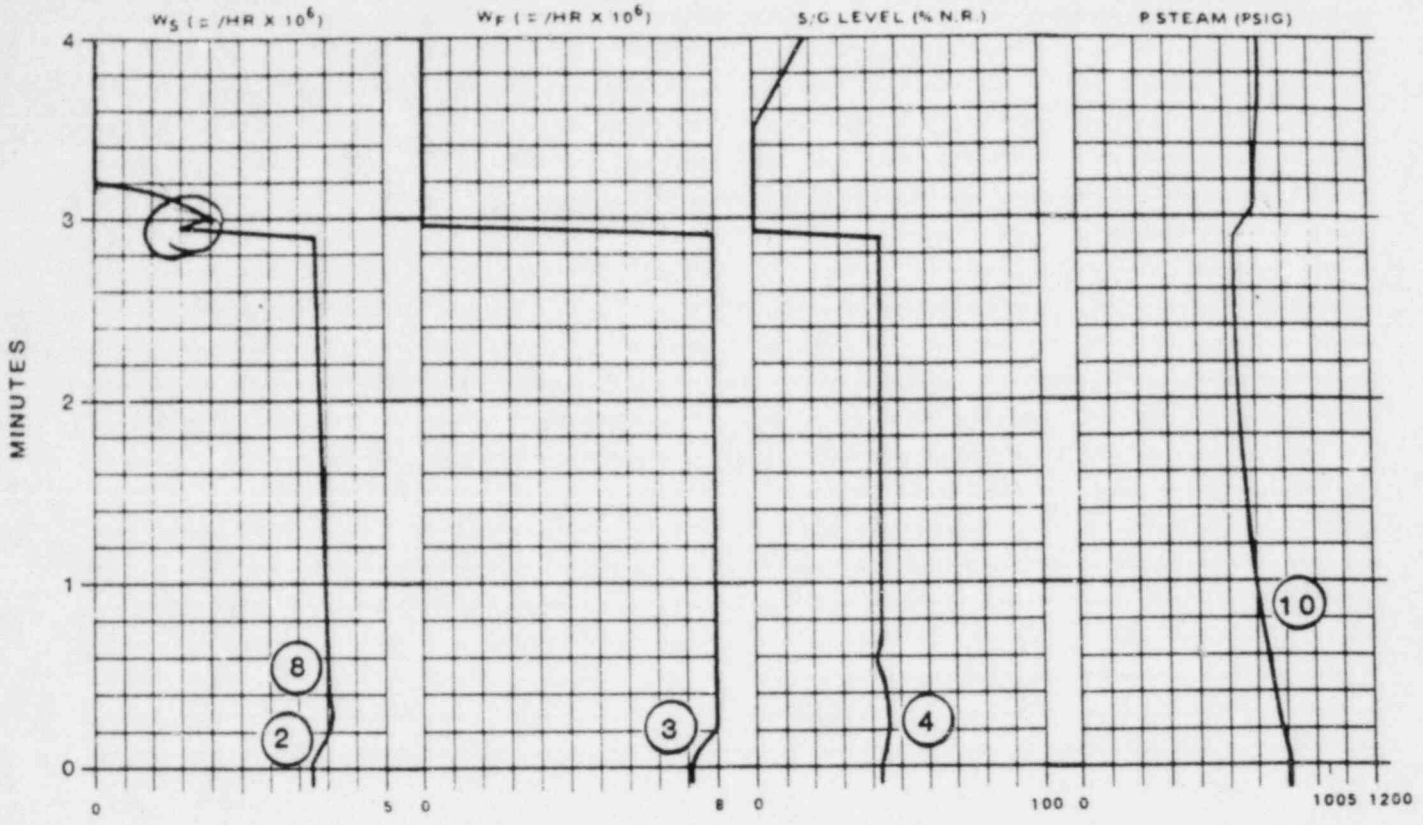
Arrange the following types of radiation in order of penetrating power from LOW to HIGH:

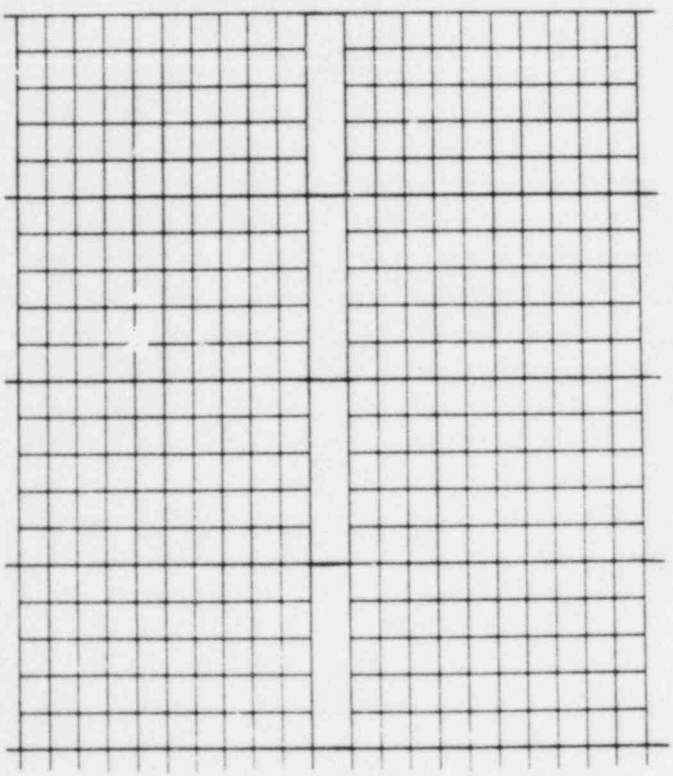
1. Beta
2. Gamma
3. Neutron
4. Alpha

(***** CATEGORY 05 CONTINUED ON NEXT PAGE *****)



ALL STEAM DUMP VALVES FAILED OPEN - 100% POWER





ALL STEAM DUMP VALVES FAILED OPEN - 100% POWER

QUESTION 5.22 (2.00)

Given the following, calculate the required boron change to increase reactor power from 75% to 100% while maintaining constant rod position.

Moderator temp. coeff.	-15 pcm/degree F
Doppler-only power coeff.	-12 pcm/% power
Void reactivity change	-25 pcm
Xenon change	-50 pcm
Boron coeff.	-9 pcm/ppm

(***** END OF CATEGORY 05 *****)

QUESTION 6.01 (1.00)

Which statement below regarding the RCP shaft seals is NOT correct? (1.0)

a. Only #1 and #2 seals are designed to withstand full system pressure

b. Leakoff from #2 seal is used to maintain the level in the standpipe used to supply cooling water to #3 seal

c. An individual #1 seal bypass line cannot be isolated without isolating the other RCP seal bypass lines as well

d. The #1 seal is a "floating" face seal vice a "rubbing" face seal like the #2 and #3 seals.

QUESTION 6.02 (1.00)

According to 10CFR50.46, which of the following is NOT a design criteria of the Emergency Core Cooling System subsystems.

a. The calculated peak centerline temperature shall not exceed 2000 degrees F.

b. The maximum cladding oxidation shall not exceed 17% of the total cladding thickness.

c. The calculated total amount of hydrogen generated from the cladding reaction with water shall not exceed 1% of the amount that would be generated if all the cladding around the fuel reacted.

d. Calculated changes in core geometry shall be such that the core remains in a coolable configuration.

(***** CATEGORY 06 CONTINUED ON NEXT PAGE *****)

QUESTION 6.03 (1.00)

The power range detector current comparator circuit compares which of the following?

a. Each individual power range total power signal to the average of all power range total power signals.

b. Each upper power range detector signal to its respective lower power range signal.

c. Each individual upper(lower) power range detector signal to the average of the upper(lower) power range detector signals.

d. The average upper power range detector signal to the average lower power range detector signal.

QUESTION 6.04 (1.00)

With three reactor coolant pumps operating indicate if the flow in the given loop segment will be in the NORMAL or REVERSED direction in the loop with the non-operating pump.

a. T-h RTD manifold

b. T-c RTD manifold

QUESTION 6.05 (1.00)

Besides the overspeed shutdown, which of the following diesel engine/ generator shutdowns is enabled during an emergency start of the diesel?

a. Voltage restraint overcurrent relay, (51V).

b. Generator differential relay, (87).

c. Phase balance relay, (46).

d. Low lube oil pressure.

(***** CATEGORY 06 CONTINUED ON NEXT PAGE *****)

QUESTION 6.06 (1.00)

Which statement concerning the Rod Control System is CORRECT?

a. The power cabinet provides AC power pulses to drive the control rod drive mechanism.

b. The reactor control unit generates a rod speed and direction signal in response to three ERROR signals.

c. Turbine impulse pressure provides signals to the rate comparator, summing unit and the variable gain unit.

d. Rod power is supplied by two motor generator sets with a 260VDC output through an isolation transformer.

QUESTION 6.07 (1.00)

Which of the below features enhances the operation of the ice condenser and containment spray for heat removal?

a. Containment design, such that the delta P between upper and lower containment drives the air circulation.

b. Ventilation coolers and recirculation fans are used to mix the air and provide additional cooling.

c. Air return fans provide flow to return the air from the upper containment to the lower containment.

d. Pressure operated doors open to allow upper containment air to flow through to the lower containment.

(***** CATEGORY 06 CONTINUED ON NEXT PAGE *****)

QUESTION 6.08 (2.50)

For the following, how will the indication respond (higher, lower, as is) to the given failure?

a) RTD open circuit in detector

b) Intermediate range compensation voltage fails high with reactor power at 100%.

c) Source range pulse height descriminator setting fails low with reactor power in the source range.

d) Thermocouple junction opens

e) Steam flow pressure compensation to steam flow detector fails high

QUESTION 6.09 (.50)

TRUE or FALSE?

After tripping a bistable in a 2/4 logic system, one of three remaining signals reaching the bistable setpoint will cause a trip, even though the logic SYSTEM remains as a 2/4 system.

QUESTION 6.10 (3.00)

Match the type(s) of rod motion that is blocked with the signal that causes the rod block! (More than one response may be required for full credit)

SIGNAL	BLOCKED ROD MOTION
a. OP delta T	1. Automatic Withdrawal
b. OT delta T	2. Automatic Insertion
c. Power Range at 103%	3. Manual Withdrawal
d. Inter. Range at 20% equiv.	4. Manual Insertion
e. Control Bank D > 220 steps	5. No Blocked Motion
f. Urgent Failure in Power Cabinet	
g. P imp < 15%	
h. Tave vs. Tref < 1.5 degrees F	

(***** CATEGORY 06 CONTINUED ON NEXT PAGE *****)

QUESTION 6.11 (1.00)

Fill in the blanks below to correctly complete the statement regarding the Motor Driven Auxiliary Feedwater Pump level control valves:

These valves are _____ operated and will fail _____ on a loss of air. They are normally set to maintain a S/G level of _____% and if pressure downstream drops to < _____ psig, the valves will close automatically.

QUESTION 6.12 ~~(2.00)~~ 1.8

For the following components, indicate whether they will receive an OPEN, CLOSE, or NO signal as a result of a safety injection (with Phase 'A') initiation signal.

a. Control room supply ducts
b. Main feed bypass valves
c. SI accumulator discharge isolation valves
d. Normal charging header isolation valves
e. Main steam isolation valves
~~f. RWST to SI pump suction valves~~ Part. f. deleted
g. Seal water return isolation valve
h. Component cooling isolation valve from RHR system
i. Component cooling isolation from letdown heat exchanger
j. Steam supply valves to turbine-driven feed pump
Clarified Main feed pump.

QUESTION 6.13 (2.00)

The following failures occur causing a subsequent reactor trip. What protection signal would cause the trip? Assume the reactor is initially at 100% power and steady state conditions, all systems in automatic and no operator action. Treat each case independently.

a) CVCS flow rate drops to a minimum of 30 gpm.

b) A narrow range (controlling) cold leg RTD fails high.

(***** CATEGORY 06 CONTINUED ON NEXT PAGE *****)

QUESTION 6.14 (1.00)

Arrange the following in the correct sequence for rod withdrawal (one step).

a. Lift coil OFF

b. Stationary gripper coil ON

c. Moveable gripper coil ON

d. Moveable gripper coil OFF

e. Lift coil ON

f. Stationary gripper coil OFF

QUESTION 6.15 (2.50)

List ALL the protection, alarm and control functions provided by the PZR pressure instruments as pressure decreases from 2350 psig. (Include the applicable setpoints)

QUESTION 6.16 (1.50)

List the 5 Auto-start signals for the Turbine driven AFW pump.

QUESTION 6.17 (2.00)

List four conditions that will generate a "Computer Alarm Rod Dev and Seq NIS PWR Range Tilts" alarm.

QUESTION 6.18 (1.00)

The pressurizer has a resistance temperature detector (RTD) in the STEAM space that is normally used to indicate the PZR saturation temperature. Assuming this RTD is operable, during what plant evolution is the RTD in the PZR WATER space utilized, and why isn't the PZR STEAM RTD used?

(***** CATEGORY 06 CONTINUED ON NEXT PAGE *****)

QUESTION 6.19 (1.00)

While operating at 92% power, the #3 heater drain tank level goes high enough to cause the water in the tank to begin dumping to the condenser. According to SOI's 5.1 & 6.1, what effect will this have on the turbine?

QUESTION 6.20 (1.00)

a. When the RHR system is controlling RCS solid plant conditions, from where does the water leave the RCS?

b. If the control valve which separates RHR and CVCS fails shut, what 3 relief valves would limit RCS pressure? (redundant reliefs count as one response)

QUESTION 6.21 (1.00)

Most RCS pressure control/protection signals are generated by the PZR pressure instruments. What control or protection signal is generated by the pressure instrument on a T-hot leg?

QUESTION 6.22 (1.00)

What is the reason for the interlocks on the CVCS letdown valves and orifice isolation valves?

(***** END OF CATEGORY 06 *****)

QUESTION 7.01 (1.00)

Which of the following is NOT an immediate operator action for a Safety Injection as stated in E-0?

a. Verify Containment Isolation.

b. Check Tavg.

c. Verify AFW status.

d. Verify Steam Dumps actuated.

QUESTION 7.02 (1.00)

It is necessary to reduce the critical boron concentration by 200 ppm prior to pulling the control banks. Prior to the dilution, the source range instruments read 30 and 37 cps. After reducing boron concentration 100 ppm the same instruments read 62 and 75 cps. Which of the following is the proper operator action in accordance with GOE-2?

a. Stop the dilution and borate back to the original count rate.

b. Stop the dilution and evaluate the situation.

c. Continue the dilution and continuously monitor the count rate.

d. Continue the dilution and recalculate the ECC.

e. Continue the dilution as nothing abnormal has occurred.

QUESTION 7.03 (1.00)

During normal CVCS operation, which of the following is an abnormal condition and would require operator action to correct?

a. VCT pressure is 15 psig.

b. The temperature of the fluid leaving the letdown heat exchangers is 127 F.

c. The RCP seal injection water tempeature is 120 F and flow to the seals is 8 gpm/pump.

d. RCP seal differential pressure is 300 psid.

(***** CATEGORY 07 CONTINUED ON NEXT PAGE *****)

QUESTION 7.04 (1.00)

Which of the following statements concerning the procedure for a dropped RCCA is correct?

a. Upon starting recovery of the dropped RCCA, an URGENT FAILURE alarm will occur because the lift coils for the other rods in the group have been disconnected.

b. The delta flux target band is not applicable during a dropped RCCA malfunction and recovery.

c. If two or more RCCA's have dropped, manually trip the reactor and proceed in accordance with EP-1.00.

d. Recovery from a dropped RCCA will be facilitated if Tavg is higher than Tref prior to commencing withdrawal of the dropped RCCA.

QUESTION 7.05 (1.00)

During an inadvertent dilution accident while at 100% power, which of the following will be the most probable cause of a reactor trip?

a. Pressurizer low pressure.

b. Over-temperature delta T.

c. Over-power delta T.

d. Power range monitor positive rate.

QUESTION 7.06 (1.00)

If the reactor trip breakers are closed and the steam generators are under nitrogen pressure, the nitrogen pressure must be vented off the steam generators prior to opening the MSIV's. Why must this be done?

(***** CATEGORY 07 CONTINUED ON NEXT PAGE *****)

QUESTION 7.07 (1.00)

According to a note in GOI-2, what condition must be met prior to exceeding 600 RPM on the main turbine?

a. Main Feedwater Regulating valves are to be in automatic.

b. Tavg is to be at the no-load value.

c. The low pressure turbine inlet metal temperature must be greater t 400 degrees F.

d. Steam dumps must be in Tavg mode.

QUESTION 7.08 (1.50)

Answer the folowing questions regarding EOP usage TRUE or FALSE:

a) If a Function Restoration Procedure (FRP) is entered due to an ORANGE Critical Safety Function (CSF) condition, and a HIGHER priority ORANGE condition is encountered, the original FRP must be completed prior to proceeding to the newly identified FRP.

b) Unless specified, a task need not be fully completed before proceeding to a subsequent step as long as that task is progressing satisfactorily

c) If a procedure transition occurs, any tasks still in progress from the procedure which was in effect need not be completed.

QUESTION 7.09 (1.50)

a. Give the Sequoyah normal quarterly whole body dose limits for the following:

1. TVA personnel

2. Non-TVA personnel (without present quarterly records)

b. Whose consent is required before the emergency exposure guidelines can be used?

(***** CATEGORY 07 CONTINUED ON NEXT PAGE *****)

QUESTION 7.10 (1.00)

a) What levels are required in the containment sump and the RWST to transfer ECCS suction to the containment sump?

b) What actions are required if swapover has not been completed and RWST level reaches 0%?

QUESTION 7.11 (1.00)

What are the SI Re-initiation criteria of ES-0.2, "SI Terminiation"? (Include parameters associated with adverse containment conditions)

QUESTION 7.12 (1.00)

Indicate what increase in count rate is required for the combination of nuclear instruments listed below, such that fuel shuffling operations would have to be immediately stopped: (Exclude Anticipated changes due to detector or source movements)

a) Increase on ANY Nuclear Channel
b) Increase on ALL Nuclear Channels

QUESTION 7.13 (2.00)

LIST the THIRTEEN immediate actions to be taken for a Saftey Injection, in accordance with Emergency Procedure, E-0. (Substeps are not required)

QUESTION 7.14 (1.50)

According to "Immediate Actions and Diagnostics" (EOI-0), if containment pressure is greater than 2.81 psig, what THREE SPECIFIC conditions must be verified?

→ E-0

↳ at time of exceeding 2.81.

(***** CATEGORY 07 CONTINUED ON NEXT PAGE *****)

QUESTION 7.15 (3.00)

a) What are FOUR methods that can be used for identifying the faulted steam generator, during a steam generator tube rupture accident, in accordance with EOI-3? (2.0)

b) What is the purpose of tripping the RCPs during a SGTR when the appropriate trip criteria are reached? (1.0)

QUESTION 7.16 (1.00)

What are ALL the Immediate Operator Actions for a continuous insertion of a control rod bank?

QUESTION 7.17 (2.00)

a. According to GOI-3A, "Hydrazine must not be added to the coolant during any phase of plant cooldown or shutdown, if the primary coolant system is to be opened." Explain WHY this precaution is necessary.

b. Near the completion of plant cooldown (~140 F), Hydrogen Peroxide (H2O2) is added to the RCS and circulated with Reactor Coolant Pumps. WHAT does this action accomplish and WHY is it necessary?

QUESTION 7.18 (1.00)

A NOTE in GOI-2, "Plant Startup from Hot Standby to Minimum Load," states that if control rods were withdrawn 5 steps during heatup, the control rods must be fully inserted prior to withdrawing rods.

a) Why are the rods withdrawn 5 steps during heatup?

b) Why must they be inserted prior to withdrawal?

(***** CATEGORY 07 CONTINUED ON NEXT PAGE *****)

QUESTION 7.19 question deleted (2.00)

a. A safety injection signal is to be considered non-spurious unless specific conditions are exhibited. What are these conditions?

b. The "SI Termination Criteria" for Loss of Primary Coolant and Loss of Secondary Coolant have major differences. What is the major REASON for these differences? 5. deleted

QUESTION 7.20 (2.00)

Sequoyah Procedure, GOI-2 states the following precaution:

"All shutdown banks must be at the fully withdrawn position whenever positive reactivity is being inserted by boron or Xenon concentration changes, reactor coolant temperature changes, or motion of control banks."

State the TWO different plant conditions that are exceptions to this precaution.

QUESTION 7.21 (1.00)

What are the TWO guidelines from (CSF status trees EOI-1 Appendix D) that indicate inadequate core cooling exists?

QUESTION 7.22 (1.50)

An irradiated fuel assembly is being moved from the reactor vessel to the upender when it drops to the bottom of the refueling canal?

A. What are the SRO's immediate actions if radiation monitors indicate increasing levels, in accordance with AOI-29?

B. What is the source (type) of the radiation activity released?

(***** END OF CATEGORY 07 *****)

QUESTION 8.01 (1.00)

Fill in the blank with one of the following TS terms:

"A _____ shall be the qualitative assessment of channel behavior during operation by observation. This determination shall include, where possible, comparison of the channel indication and/or status with other indications and/or status derived from independent instrument channels measuring the same parameter".

a. Channel Calibration

b. Channel Check

c. Channel Functional Test

d. Logic System Functional Test

QUESTION 8.02 (1.00)

In accordance with 10 CFR 55, "if a licensee has not been actively performing the functions of an operator or senior operator for a period of ___(1)___ months, or longer, he shall, prior to resuming activities licensed pursuant to this part, demonstrate to the Commission that his knowledge and understanding of facility operation and administration are satisfactory."

FILL IN THE BLANK WITH ONE OF THE FOLLOWING TIMES:

a. 4

b. 6

c. 12

d. 24

(***** CATEGORY 08 CONTINUED ON NEXT PAGE *****)

QUESTION 8.03 (1.00)

Which of the following MAY proceed given that a Technical Specification Action Statement has been entered requiring that you "suspend all CORE ALTERATIONS"?

a. Removing a neutron source from the core.

b. Using the bridge in the core is allowed, provided that the low load limit is jumpered out.

c. Control rods and burnable poison rods may be shuffled as long as K-effective is less than or equal to .95.

d. Completion of the movement of a component to a safe conservative position within the rx pressure vessel.

QUESTION 8.04 (1.00)

Per GOI-6, Apparatus Operation, which of the following is the proper method for VERIFYING the position of a locked (padlocked) valve?

a. Attempt to move the valve handwheel or operator in the OPEN direction.

b. Attempt to move the valve handwheel or operator in the CLOSED direction.

c. Attempt to move the valve handwheel or operator in the direction SPECIFIED as the correct position.

d. DO NOT attempt to move the valve handwheel or operator - Verify proper valve position by direct observation of the stem and/or local position indicators.

(***** CATEGORY 08 CONTINUED ON NEXT PAGE *****)

QUESTION 8.05 (1.00)

Unit 1 is in COLD SHUTDOWN with T avg being maintained stable at 190 degrees F by RHR . The following equipment is INOP:

- Centrifugal Charging Pump 1B-B * (1 hr)
- Reciprocating Charging Pump 1B * (1 hr)
- DG 1A-A * (1 hr)

* There is no estimate of repair time.

The Shift is directed to recommence the plant cooldown to a RCS T avg of 130 degrees F. SHUTDOWN MARGIN calculations indicate compliance with the TS LCO for "SHUTDOWN MARGIN - T avg < or equal to 200 degrees F" throughout the full range of the anticipated cooldown.

Which of the following actions most correctly detail the allowances and/or limitations imposed by the Technical Specifications in this instance?

NOTE: APPLICABLE TSs ARE ENCLOSED FOR REFERENCE.

a. Plant Cooldown may recommence; OPERATIONAL MODE 6 may be entered with no restrictions on plant operations.

b. Plant cooldown may recommence; OPERATIONAL MODE 6 may be entered BUT CORE ALTERATIONS are precluded.

c. Plant cooldown may recommence; OPERATIONAL MODE 6 may not be entered.

d. Plant cooldown is prohibited AND heatup to 200 degrees F is required.

e. Plant cooldown is prohibited.

(***** CATEGORY 08 CONTINUED ON NEXT PAGE *****)

QUESTION 8.06 (1.00)

Unit 1 is at 90% power with no INOP equipment.

Ten minutes into the shift, two (2) level Instrument Channels associated with the "RWST Level - Low" function of ESFAS Instrumentation fail their CHANNEL FUNCTIONAL TESTS. There is no estimate of repair time.

Which of the following actions most correctly detail the allowances and/or limitations imposed by the Technical Specifications in this instance?

NOTE: APPLICABLE TSs ARE ENCLOSED FOR REFERENCE.

a. Operation may proceed provided the inoperable channels are restored to OPERABLE status within 72 hours or be in at least HOT STANDBY within the next 6 hours and in HOT SHUTDOWN within the following 6 hours.

b. Operation may proceed provided the inoperable channels are placed in the bypassed condition and the other Channels are demonstrated OPERABLE within 1 hour.

c. Within one hour action shall be initiated to place the unit in at least HOT STANDBY within the next 6 hours; and at least HOT SHUTDOWN within the following 6 hours.

d. Take Actions detailed by choice c. AND place the plant in COLD SHUTDOWN within the next 20 hours.

e. Take Actions detailed by choice c. AND place the plant in COLD SHUTDOWN within the subsequent 24 hours.

QUESTION 8.07 (1.50)

Indicate whether alarms on the vertical boards listed below are the responsibility of the Unit 1 Balance of Plant (BOP) operator, Unit 2 BOP or both BOPs.

a) O-M-27A (ERCW)
b) O-M-28A (Cooling Tower Pump Controls)
c) O-M-25 (Meteorological/Environs Monitoring)

(***** CATEGORY 08 CONTINUED ON NEXT PAGE *****)

QUESTION 8.08 (1.00)

Fill in the blanks to complete the following statement regarding temporary alterations:

The Shift Engineer reviews requests to perform temporary alterations for completeness and correctness, verifies it has been reviewed by _____ and approved by _____ and that a/an _____ is attached as required. He also performs _____ for emergency conditions requiring temporary alterations.

QUESTION 8.09 (1.00)

Fill in the blanks in the following statement regarding clearances:

When tagging a breaker open that gives an alarm, if it is to be open for greater than _____, the electricians shall lift the wires to the annunciator and initial the clearance sheet. The ASE will _____ the leads with a _____. When the clearance is released the electricians will connect the annunciator wires and _____ it on the return to normal section of the clearance sheet.

QUESTION 8.10 (1.50)

List the FIVE bases for the minimum temperature for criticality limit of the Technical Specifications, i.e. what does this limitation ensure?

QUESTION 8.11 (1.00)

What ACTION(S) must IMMEDIATELY be initiated (per the TSs) if SHUTDOWN MARGIN decreases to less than 1.0% delta k/k in Mode 5? Be Specific.

(***** CATEGORY 08 CONTINUED ON NEXT PAGE *****)

QUESTION 8.12 (2.00)

STATE which Emergency Classification is appropriate for the following definitions.

a. Events are in progress or have occurred which involve actual or potential substantial degradation of the level of safety of the plant.

b. Events are in progress or have occurred which could develop into, or be indicative of, more serious conditions which are not yet fully realized.

c. Events are in progress or have occurred which involve actual or imminent substantial core failure with the potential for loss of containment integrity.

d. Events are in progress or have occurred which involve an actual or likely major failure of plant functions needed for protection of the public.

QUESTION 8.13 (.50)

Given the following plant conditions:

- K effective = .94
- % RATED THERMAL POWER = 0%
- AVERAGE COOLANT TEMPERATURE = 160 degrees F
- RPV head closure bolts less than fully tensioned
- Fuel in the Rx Vessel

State the OPERATIONAL MODE of the plant as described above.

QUESTION 8.14 (1.00)

Prior to entry into the lower Containment or the Annulus the position of the incore flux detectors shall be verified. What are the two (2) acceptable positions per the Access to Containment procedure, SQNP AI-18?

QUESTION 8.15 Deleted (.50)

One stationary Firewatch position shall be maintained at ALL times per OSLA 73. What is the location of this firewatch? Provide Bldg. elevation and the Major equipment proximity.

(***** CATEGORY 08 CONTINUED ON NEXT PAGE *****)

QUESTION 8.16 (2.00)

What are the four conditions that Tech Specs say must be met to ensure the Nuclear Enthalpy Rise Hot Channel Factor is maintained within limits during periods between in-core surveillances?

QUESTION 8.17 (2.50)

Define IDENTIFIED LEAKAGE (as per Section 1.0 of the TSs).

QUESTION 8.18 (1.50)

Answer the following with regard to the Fuse Control Procedure, SQNP AI-16:

a. Fill in the blank:
A blown control circuit fuse may be replaced _____ time(s) with the correct fuse as identified adjacent to the fuse block. (0.5)

b. Assume the fuse replacement limit of part a. has been met and the replacement fuse(s) have also blown. Who must be notified AND What must be done before further fuse replacement? (1.0)

QUESTION 8.19 (1.00)

Per GOI-6, Apparatus Operation:

a. Why are Manual-Operated Valves (excepting throttle valves) always backseated? (0.5)

b. What specific valve damage could occur if excessive force is used during backseating? (0.5)

(***** CATEGORY 08 CONTINUED ON NEXT PAGE *****)

QUESTION 8.20 (1.00)

Consider the proper procedure for racking in a 6.9 kV breaker per GOI-6, Apparatus Operation:

a. Before beginning racking in, how do ensure that the charging motor circuits energize?

b. During racking in, how do ensure that the charging motor energizes when the closing fuses are installed?

QUESTION 8.21 (1.00)

The TS ACTION Statement for SPECIFIC ACTIVITY requires that the plant be in at least HOT STANDBY with T avg less than 500 degrees F within 6 hours should the specific activity exceed the LCO Limit. Explain the TS Basis for reducing T avg to less than 500 degrees F.

QUESTION 8.22 (2.00)

a) List the 4 rooms which are required by Tech Specs to have operable low pressure CO2 systems. (1.0)

b) What actions are required within 1 hour if one of these systems were to become INOPERABLE? (1.0)

QUESTION 8.23 (.50)

How long may the quarterly surveillance requirement (Q - 92 days) be extended without declaring the component INOP due to the surveillance testing not being performed?

(***** END OF CATEGORY 08 *****)
(********** END OF EXAMINATION **********)

3/4 LIMITING CONDITIONS FOR OPERATION AND SURVEILLANCE REQUIREMENTS

3/4.0 APPLICABILITY

LIMITING CONDITION FOR OPERATION

3.0.1 Compliance with the Limiting Conditions for Operation contained in the succeeding Specifications is required during the OPERATIONAL MODES or other conditions specified therein; except that upon failure to meet the Limiting Conditions for Operation, the associated ACTION requirements shall be met.

3.0.2 Noncompliance with a Specification shall exist when the requirements of the Limiting Condition for Operation and associated ACTION requirements are not met within the specified time intervals. If the Limiting Condition for Operation is restored prior to expiration of the specified time intervals, completion of the ACTION requirements is not required.

3.0.3 When a Limiting Condition for Operation is not met, except as provided in the associated ACTION requirements, within one hour action shall be initiated to place the unit in a MODE in which the Specification does not apply by placing it, as applicable, in:

1. At least HOT STANDBY within the next 6 hours,
2. At least HOT SHUTDOWN within the following 6 hours, and
3. At least COLD SHUTDOWN within the subsequent 24 hours.

Where corrective measures are completed that permit operation under the ACTION requirements, the ACTION may be taken in accordance with the specified time limits as measured from the time of failure to meet the Limiting Condition for Operation. Exceptions to these requirements are stated in the individual Specifications. FP

3.0.4 Entry into an OPERATIONAL MODE or other specified condition shall not be made unless the conditions for the Limiting Condition for Operation are met without reliance on provisions contained in the ACTION requirements. This provision shall not prevent passage through OPERATIONAL MODES as required to comply with ACTION requirements. Exceptions to these requirements are stated in the individual Specifications.

3.0.5 When a system, subsystem, train, component or device is determined to be inoperable solely because its emergency power source is inoperable, or solely because its normal power source is inoperable, it may be considered OPERABLE for the purpose of satisfying the requirements of its applicable Limiting Condition for Operation, provided: (1) its corresponding normal or emergency power source is OPERABLE; and (2) all of its redundant system(s), subsystem(s), train(s), component(s) and device(s) are OPERARLE, or likewise satisfy the requirements of this Specification. Unless both conditions (1) and (2) are satisified, within 2 hours action shall be initiated to place the unit in a MODE in which the applicable Limiting Condition for Operation does not apply by placing it as applicable in:

1. At least HOT STANDBY within the next 6 hpurs,
2. At least HOT SHUTDOWN within the following 6 hours, and
3. At least COLD SHUTDOWN within the subsequent 24 hours.

This Specification is not applicable in MODES 5 or 6.

REACTIVITY CONTROL SYSTEMS

3/4.1.2 BORATION SYSTEMS

FLOW PATHS - SHUTDOWN

LIMITING CONDITION FOR OPERATION

3.1.2.1 As a minimum, one of the following boron injection flow paths shall be OPERABLE:

a. A flow path from the boric acid tank via a boric acid transfer pump and charging pump to the Reactor Coolant System if only the boric acid storage tank in Specification 3.1.2.5a is OPERABLE, or

b. The flow path from the refueling water storage tank via a charging pump to the Reactor Coolant System if only the refueling water storage tank in Specification 3.1.2.5b is OPERABLE.

APPLICABILITY: MODES 5 and 6.

ACTION:

With none of the above flow paths OPERABLE, suspend all operations involving CORE ALTERATIONS or positive reactivity changes.

SURVEILLANCE REQUIREMENTS

4.1.2.1 At least one of the above required flow paths shall be demonstrated OPERABLE:

a. At least once per 7 days by verifying that the temperature of the heat traced portion of the flow path is greater than or equal to 145°F when a flow path from the boric acid tanks is used.

b. At least once per 31 days by verifying that each valve (manual, power operated or automatic) in the flow path that is not locked, sealed, or otherwise secured in position, is in its correct position.

REACTIVITY CONTROL SYSTEMS

FLOW PATHS - OPERATING

LIMITING CONDITION FOR OPERATION

3.1.2.2 At least two of the following three boron injection flow paths shall be OPERABLE:

a. The flow path from the boric acid tanks via a boric acid transfer pump and a charging pump to the Reactor Coolant System.

b. Two flow paths from the refueling water storage tank via charging pumps to the Reactor Coolant System.

APPLICABILITY: MODES 1, 2, 3 and 4.

ACTION:

With only one of the above required boron injection flow paths to the Reactor Coolant System OPERABLE, restore at least two boron injection flow paths to the Reactor Coolant System to OPERABLE status within 72 hours or be in at least HOT STANDBY and borated to a SHUTDOWN MARGIN equivalent to at least 1% delta k/k at 200°F within the next 6 hours; restore at least two flow paths to OPERABLE status within the next 7 days or be in COLD SHUTDOWN within the next 30 hours.

SURVEILLANCE REQUIREMENTS

4.1.2.2 At least two of the above required flow paths shall be demonstrated OPERABLE:

a. At least once per 7 days by verifying that the temperature of the heat traced portion of the flow path from the boric acid tanks is greater than or equal to 145°F when it is a required water source.

b. At least once per 31 days by verifying that each valve (manual, power operated or automatic) in the flow path that is not locked, sealed, or otherwise secured in position, is in its correct position.

c. At least once per 18 months during shutdown by verifying that each automatic valve in the flow path actuates to its correct position on a safety injection test signal.

d. At least once per 18 months by verifying that the flow path required by Specification 3.1.2.2a delivers at least 10 gpm to the Reactor Coolant System.

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CHARGING PUMP - SHUTDOWN

LIMITING CONDITION FOR OPERATION

3.1.2.3 One charging pump in the boron injection flow path required by Specification 3.1.2.1 shall be OPERABLE and capable of being powered from an OPERABLE shutdown board.

APPLICABILITY: MODES 5 and 6.

ACTION:

With no charging pump OPERABLE, suspend all operations involving CORE ALTERATIONS or positive reactivity changes.

SURVEILLANCE REQUIREMENTS

4.1.2.3 The above required charging pump shall be demonstrated OPERABLE by verifying, that on recirculation flow, the pump develops a discharge pressure of greater than or equal to 2400 psig when tested pursuant to Specification 4.0.5.

REACTIVITY CONTROL SYSTEMS

CHARGING PUMPS - OPERATING

LIMITING CONDITION FOR OPERATION

3.1.2.4 At least two charging pumps shall be OPERABLE.

APPLICABILITY: MODES 1, 2, 3 and 4.

ACTION:

With only one charging pump OPERABLE, restore at least two charging pumps to OPERABLE status within 72 hours or be in at least HOT STANDBY and borated to a SHUTDOWN MARGIN equivalent to at least 1% delta k/k at 200°F within the next 6 hours; restore at least two charging pumps to OPERABLE status within the next 7 days or be in COLD SHUTDOWN within the next 30 hours.

SURVEILLANCE REQUIREMENTS

4.1.2.4 At least two charging pumps shall be demonstrated OPERABLE by verifying, that on recirculation flow, each pump develops a discharge pressure of greater than or equal to 2400 psig when tested pursuant to Specification 4.0.5.

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3/4.5.2 ECCS SUBSYSTEMS - T_{avg} Greater Than or Equal to 350°F

LIMITING CONDITION FOR OPERATION

3.5.2 Two independent ECCS subsystems shall be OPERABLE with each subsystem comprised of:

a. One OPERABLE centrifugal charging pump,

b. One OPERABLE safety injection pump,

c. One OPERABLE residual heat removal heat exchanger,

d. One OPERABLE residual heat removal pump, and

e. An OPERABLE flow path capable of taking suction from the refueling water storage tank on a safety injection signal and automatically transferring suction to the containment sump during the recirculation phase of operation.

APPLICABILITY: MODES 1, 2 and 3.

ACTION:

a. With one ECCS subsystem inoperable, restore the inoperable subsystem to OPERABLE status within 72 hours or be in at least HOT STANDBY within the next 6 hours and in HOT SHUTDOWN within the following 6 hours.

b. In the event the ECCS is actuated and injects water into the Reactor Coolant System, a REPORTABLE EVENT shall be prepared and submitted to the Commission pursuant to Specification 6.6.1. This report shall include a description of the circumstances of the actuation and the total accumulated actuation cycles to date. The current value of the usage factor for each affected safety injection nozzle shall be provided in this report whenever its value exceeds 0.70. R40

SURVEILLANCE REQUIREMENTS

4.5.2 Each ECCS subsystem shall be demonstrated OPERABLE:

a. At least once per 12 hours by verifying that the following valves are in the indicated positions with power to the valve operators removed:

3/4.5.3 ECCS SUBSYSTEMS - T_{avg} Less Than 350°F

LIMITING CONDITION FOR OPERATION

3.5.3 As a minimum, one ECCS subsystem comprised of the following shall be OPERABLE:

a. One OPERABLE centrifugal charging pump,

b. One OPERABLE residual heat removal heat exchanger,

c. One OPERABLE residual heat removal pump, and

d. An OPERABLE flow path capable of taking suction from the refueling water storage tank upon being manually realigned and automatically transferring suction to the containment sump during the recirculation phase of operation.

APPLICABILITY: MODE 4.

ACTION:

a. With no ECCS subsystem OPERABLE because of the inoperability of either the centrifugal charging pump or the flow path from the refueling water storage tank, restore at least one ECCS subsystem to OPERABLE status within 1 hour or be in COLD SHUTDOWN within the next 20 hours.

b. With no ECCS subsystem OPERABLE because of the inoperability of either the residual heat removal heat exchanger or residual heat removal pump, restore at least one ECCS subsystem to OPERABLE status or maintain the Reactor Coolant System T_{avg} less than 350°F by use of alternate heat removal methods.

c. In the event the ECCS is actuated and injects water into the Reactor Coolant System, a REPORTABLE EVENT shall be prepared and submitted to the Commission pursuant to Specification 6.6.1. This report shall include a description of the circumstances of the actuation and the total accumulated actuation cycles to date. The current value of the usage factor for each affected safety injection nozzle shall be provided in this report whenever its value exceeds 0.70. R40

3/4.8 ELECTRICAL POWER SYSTEMS

3/4.8.1 A.C. SOURCES

OPERATING

LIMITING CONDITION FOR OPERATION

3.8.1.1 As a minimum, the following A.C. electrical power sources shall be OPERABLE:

a. Two physically independent circuits between the offsite transmission network and the onsite Class 1E distribution system, and

b. Four separate and independent diesel generator sets each with:

1. Two diesels driving a common generator

2. Two engine-mounted fuel tanks containing a minimum volume of 250 gallons of fuel, per tank

3. A separate fuel storage system containing a minimum volume of 62,000 gallons of fuel,

4. A separate fuel transfer pump, and

5. A separate 125-volt D.C. distribution panel, 125-volt D.C. battery bank and associated charger.

APPLICABILITY: MODES 1, 2, 3 and 4.

ACTION:

a. With either an offsite circuit or diesel generator set of the above required A.C. electrical power sources inoperable, demonstrate the OPERABILITY of the remaining A.C. sources by performing Surveillance Requirements 4.8.1.1.1.a and 4.8.1.1.2.a.4 within one hour and at least once per 8 hours thereafter; restore at least two offsite circuits and four diesel generator sets to OPERABLE status within 72 hours or be in at least HOT STANDBY within the next 6 hours and in COLD SHUTDOWN within the following 30 hours.

b. With one offsite circuit and one diesel generator set of the above required A.C. electrical power sources inoperable, demonstrate the OPERABILITY of the remaining A.C. sources by performing Surveillance Requirements 4.8.1.1.1.a and 4.8.1.1.2.a.4 within one hour and at least once per 8 hours thereafter; restore at least one of the inoperable sources to OPERABLE status within 12 hours or be in at least HOT STANDBY within the next 6 hours and in COLD SHUTDOWN within the following 30 hours. Restore at least two offsite circuits and four diesel generator sets to OPERABLE status within 72 hours from the time of initial loss or be in at least HOT STANDBY within the next 6 hours and in COLD SHUTDOWN within the following 30 hours.

ACTION (Continued)

c. With two of the above required offsite A.C. circuits inoperable, demonstrate the OPERABILITY of 4 diesel generator sets by performing Surveillance Requirement 4.8.1.1.2.a.4 within one hour and at least once per 8 hours thereafter, unless the diesel generator sets are already operating; restore at least one of the inoperable offsite sources to OPERABLE status within 24 hours or be in at least HOT STANDBY within the next 6 hours. With only one offsite source restored, restore at least two offsite circuits to OPERABLE status within 72 hours from time of initial loss or be in at least HOT STANDBY within the next 6 hours and in COLD SHUTDOWN within the following 30 hours.

d. With either diesel generator sets 1A-A and/or 2 A-A inoperable simultaneous with 1B-B and/or 2B-B, demonstrate the OPERABILITY of two offsite A.C. circuits by performing Surveillance Requirement 4.8.1.1.1.a within one hour and at least once per 8 hours thereafter; restore at least 1) 1A-A and 2A-A or 2) 1B-B and 2B-B to OPERABLE status within 2 hours or be in at least HOT STANDBY within the next 6 hours and in COLD SHUTDOWN within the following 30 hours. Restore at least four diesel generator sets to OPERABLE status within 72 hours from time of initial loss or be in least HOT STANDBY within the next 6 hours and in COLD SHUTDOWN within the following 30 hours.

SURVEILLANCE REQUIREMENTS

4.8.1.1.1 Each of the above required independent circuits between the offsite transmission network and the onsite Class 1E distribution system shall be:

a. Determined OPERABLE at least once per 7 days by verifying correct breaker alignments, indicated power availability, and

b. Demonstrated OPERABLE at least once per 18 months during shutdown by transferring (manually and automatically) unit power supply from the normal circuit to the alternate circuit.

4.8.1.1.2 Each diesel generator set shall be demonstrated OPERABLE:

a. In accordance with the frequency specified in Table 4.8-1 on a STAGGERED TEST BASIS by:

1. Verifying the fuel level in the engine-mounted day tanks.

2. Verifying the fuel level in the 7 day tank.

3. Verifying the fuel transfer pump can be started and transfers fuel from the storage system to the engine mounted fuel tanks.

ELECTRICAL POWER SYSTEMS

SHUTDOWN

LIMITING CONDITION FOR OPERATION

3.8.1.2 As a minimum, the following A.C. electrical power sources shall be OPERABLE:

a. One circuit between the offsite transmission network and the onsite Class 1E distribution system, and

b. Diesel generator sets 1A-A and 2A-A or 1B-B and 2B-B each with:

1. Two diesels driving a common generator,

2. Two engine-mounted fuel tanks containing a minimum volume of 250 gallons of fuel per tank,

3. A fuel storage system containing a minimum volume of 62,000 gallons of fuel,

4. A fuel transfer pump, and

5. A separate 125-volt D.C. distribution panel, 125-volt D.C. battery bank and associated charger.

APPLICABILITY: MODES 5 and 6.

ACTION:

With less than the above minimum required A.C. electrical power sources OPERABLE, suspend all operations involving CORE ALTERATIONS or positive reactivity changes.

SURVEILLANCE REQUIREMENTS

4.8.1.2 The above required A.C. electrical power sources shall be demonstrated OPERABLE by the performance of each of the Surveillance Requirements of 4.8.1.1.1 and 4.8.1.1.2 (except for requirement 4.8.1.1.2.a.5), 4.8.1.1.3, and 4.8.1.1.4.

INSTRUMENTATION

3/4.3.2 ENGINEERED SAFETY FEATURE ACTUATION SYSTEM INSTRUMENTATION

LIMITING CONDITION FOR OPERATION

3.3.2.1 The Engineered Safety Feature Actuation System (ESFAS) instrumentation channels and interlocks shown in Table 3.3-3 shall be OPERABLE with their trip setpoints set consistent with the values shown in the Trip Setpoint column of Table 3.3-4 and with RESPONSE TIMES as shown in Table 3.3-5.

APPLICABILITY: As shown in Table 3.3-3.

ACTION:

a. With an ESFAS instrumentation channel or interlock trip setpoint less conservative than the value shown in the Allowable Values column of Table 3.3-4, declare the channel inoperable and apply the applicable ACTION requirement of Table 3.3-3 until the channel is restored to OPERABLE status with the trip setpoint adjusted consistent with the Trip Setpoint value.

b. With an ESFAS instrumentation channel or interlock inoperable, take the ACTION shown in Table 3.3-3.

SURVEILLANCE REQUIREMENTS

4.3.2.1.1 Each ESFAS instrumentation channel shall be demonstrated OPERABLE by the performance of the CHANNEL CHECK, CHANNEL CALIBRATION and CHANNEL FUNCTIONAL TEST operations for the MODES and at the frequencies shown in Table 4.3-2.

4.3.2.1.2 The logic for the interlocks shall be demonstrated OPERABLE during the automatic actuation logic test. The total interlock function shall be demonstrated OPERABLE at least once per 18 months during CHANNEL CALIBRATION testing of each channel affected by interlock operation.

4.3.2.1.3 The ENGINEERED SAFETY FEATURES RESPONSE TIME of each ESFAS function shall be demonstrated to be within the limit at least once per 18 months. Each test shall include at least one logic train such that both logic trains are tested at least once per 36 months and one channel per function such that all channels are tested at least once per N times 18 months where N is the total number of redundant channels in a specific ESFAS function as shown in the "Total No. of Channels" Column of Table 3.3-3.

TABLE 3.3-3 (Continued)

ENGINEERED SAFETY FEATURE ACTUATION SYSTEM INSTRUMENTATION

FUNCTIONAL UNIT	TOTAL NO. OF CHANNELS	CHANNELS TO TRIP	MINIMUM CHANNELS OPERABLE	APPLICABLE MODES	ACTION
8. ENGINEERED SAFETY FEATURE ACTUATION SYSTEM INTERLOCKS					
a. Pressurizer Pressure - Not P-11	3	2	2	1, 2, 3	22a
b. T_{avg} - P-12	4	2	3	1, 2, 3	22b
c. Steam Generator Level P-14	3/loop	2/loop any loop	3/loop	1, 2	22c
9. AUTOMATIC SWITCHOVER TO CONTAINMENT SUMP					
A. RWST Level - Low COINCIDENT WITH Containment Sump Level - High AND Safety Injection	4 4	2 2	3 3	1, 2, 3, 4 1, 2, 3, 4	18 18
	(See 1 above for Safety Injection Requirements)				

R11

TABLE 3.3-3 (Continued)

TABLE NOTATION

#Trip function may be bypassed in this MODE below P-11 (Pressurizer Pressure Block of Safety Injection) setpoint.

FP ##Trip function may be bypassed in this MODE below P-12 (T_{avg} Block of Safety Injection) setpoint.

###The channel(s) associated with the protective functions derived from the out of service Reactor Coolant Loop shall be placed in the tripped mode.

*The provisions of Specification 3.0.4 are not applicable.

ACTION STATEMENTS

ACTION 15 - With the number of OPERABLE Channels one less than the Total Number of Channels, be in at least HOT STANDBY within 6 hours and in COLD SHUTDOWN within the following 30 hours; however, one channel may be bypassed for up to 1 hour for surveillance testing per Specification 4.3.2.1.1 provided the other channel is OPERABLE.

FP

ACTION 16 - With the number of OPERABLE Channels one less than the Total Number of Channels, operation may proceed until performance of the next required CHANNEL FUNCTIONAL TEST, provided the inoperable channel is placed in the tripped condition within 1 hour.

ACTION 17 - With a channel associated with an operating loop inoperable, restore the inoperable channel to OPERABLE status within 2 hours or be in at least HOT SHUTDOWN within the following 12 hours; however, one channel associated with an operating loop may be bypassed for up to 2 hours for surveillance testing per Specification 4.3.2.1.1.

FP

ACTION 18 - With the number of OPERABLE Channels one less than the Total Number of Channels, operation may proceed provided the inoperable channel is placed in the bypassed condition and the Minimum Channels OPERABLE requirement is demonstrated within 1 hour; one additional channel may be bypassed for up to 2 hours for surveillance testing per Specification 4.3.2.1.1.

ACTION 19 - With less than the Minimum Channels OPERABLE, operation may continue provided the containment ventilation isolation valves are maintained closed.

ACTION 20 - With the number of OPERABLE Channels one less than the Total Number of Channels, restore the inoperable channel to OPERABLE status within 48 hours or be in at least HOT STANDBY within the next 6 hours and in COLD SHUTDOWN within the following 30 hours.

TABLE 3.3-3 (Continued)

ACTION 21 - With the number of OPERABLE Channels one less than the Total Number of Channels, STARTUP and/or POWER OPERATION may proceed provided the following conditions are satisfied:

a. The inoperable channel is placed in the tripped condition within 1 hour.

b. The Minimum Channels OPERABLE requirements is met; however, one additional channel may be bypassed for up to 2 hours for surveillance testing per Specification 4.3.2.1.1.

ACTION 22 - With less than the Minimum Number of Channels OPERABLE, declare the interlock inoperable and verify that all affected channels of the functions listed below are OPERABLE or apply the appropriate ACTION statement(s) for those functions. Functions to be evaluated are: R16

a. Safety Injection
   Pressurizer Pressure

b. Safety Injection
   High Steam Line Flow
   Steam Line Isolation
   High Steam Line Flow
   Steam Dump

c. Turbine Trip
   Steam Generator Level High-High
   Feedwater Isolation
   Steam Generator Level High-High

ACTION 23 - With the number of OPERABLE channels one less than the Total Number of Channels, be in at least HOT STANDBY within 6 hours and in at least HOT SHUTDOWN within the following 6 hours; however, one channel may be bypassed for up to 1 hour for surveillance testing per Specification 4.3.2.1.

ACTION 24 - With the number of OPERABLE channels one less than the Total Number of Channels, restore the inoperable channel to OPERABLE status within 48 hours or be in at least HOT STANDBY within 6 hours and in at least HOT SHUTDOWN within the following 6 hours.

ACTION 25 - With the number of OPERABLE channels one less than the Total Number of Channels, restore the inoperable channel to OPERABLE status within 48 hours or declare the associated valve inoperable and take the ACTION required by Specification 3.7.1.5. R16

MAR 25 1982

ANSWERS -- SEQUOYAH 1&2 -86/05/26-D.J. NELSON

ANSWER 5.01 (1.00)

a

REFERENCE
SQN/WBN Nuclear theory

ANSWER 5.02 (1.00)

b.

REFERENCE
SQN/WBN HTFF Chap. 2E

ANSWER 5.03 (1.00)

c.

REFERENCE
steam tables

ANSWER 5.04 (1.00)

b

REFERENCE
TS 3/4.2.2

ANSWER 5.05 (1.00)

c

REFERENCE
TPT Requal Lesson Plan, Cycle II, Day 1-1985
TPT SD13, "CVCS", pp 23
SQN "CVCS", pp 24
004/020; A2.13(3.4/3.9)

UNITED STATES
NUCLEAR REGULATORY COMMISSION
REGION II
101 MARIETTA STREET, N.W., SUITE 2900
ATLANTA, GEORGIA 30323

ANSWERS -- SEQUOYAH 1&2 -86/05/26-D.J. NELSON

ANSWER 5.06 (1.00)

d

REFERENCE
EIH: L-RO-606, pp 4, 5; Fig. 4
BSEP: 02-2/3-A, pp 177 - 180; 02-OG-A, pp 60 - 61
BFNP: Xenon and Samarium LP, pp 5, 6; RQ 84/03/05
Westinghouse Nuclear Training Operations, pp. I-5.77 - 79
Turkey Point, Reactor Core Control, pp. 4-30 - 34

001/000-K5.13 (3.7/4.0)

ANSWER 5.07 (1.00)

c

REFERENCE
EIH: CPNT,Vol VII, Chapter 10.1-83-86
BSEP: L/P 02-2/3-A, pp 172 - 176; 02-OG-A, pp 57 - 60
Westinghouse Nuclear Reactor Theory, pp. I-5.77 - 79
Turkey Point, Reactor Core Control, pp. 4-24 - 28

001/000-K5.13 (3.7/4.0)

ANSWER 5.08 (3.00)

	AFFECTED LOOP	+ UNAFFECTED LOOP	
a.	decreases	+ increases	[0.5] each
b.	decreases	+ increases	[0.5] each
c.	decreases	+ increases	[0.5] each

→ or remains the same

REFERENCE
SQN/WBN HTFF/Nuclear theory

ANSWERS -- SEQUOYAH 1&2 -86/05/26-D.J. NELSON

ANSWER 5.09 (1.50)

a) More Negative (+0.5 ea)
b) Less Negative
c) More Negative

REFERENCE
Westinghouse Nuclear Training Operations, pp. I-5.6 - 16
CNTO, "Reactor Core Control", pp 3-16/28

001/000; K5.26(3.3/3.6)

ANSWER 5.10 (1.00)

a. true [0.5]
b. true [0.5]

REFERENCE
Nuclear theory, Inst. Notes VI

ANSWER 5.11 (1.00)

1) Density difference between cold and hot leg (+.5 ea)
(or Heat sink and Heat source with a Delta T)

2) Height difference between hot and cold legs (or S/G and Core)

REFERENCE
CNTO, "Thermal/Hydraulic Principles and Applications II", pp 14-16/17
Westinghouse, "Mitigating Core Damage", CH 1, pp 11/12

002/000; K5.10(3.5/3.9)

ANSWER 5.12 (2,00)

a) Unit 4 ↓ (+.5) due to a lower Beta coefficient at EOL (+.5)
b) Unit 3 ↑ (+.5) due to MTC being less negative, so Tavg must decrease come to add + reactivity) (+.5)

REFERENCE
CNTO "Reactor Core Control", pp 3-21 & "Fundamentals of Nuclear Reactor Physics", pp 7-31

ANSWERS -- SEQUOYAH 1&2 -86/05/26-D.J. NELSON

001/000; K5.49(2.9/3.4) & K5.10(3.9/4.1)

ANSWER 5.13 (1.50)

a. increases due to decreasing Tave [.5]
b. increases due to decreasing Tave [.5]
c. decreases due to decreasing Tave and increasing boron concentration [.5]

REFERENCE
SQN/WBN Nuclear theory

ANSWER 5.14 (1.00)

Lower flow at the same power level results in a larger delta T; CHF decreases toward the top of the core. Lower coolant velocities result in less stripping action which removes nucleate bubbles, a steam film can form at lower heat flux.

REFERENCE
SQN/WBN HTFF

ANSWER 5.15 (.50)

Margin to criticality decreases [0.1] by 2/3 [0.4].

REFERENCE
SQN/WBN Neutron Sources and Subcrit. Mult.

ANSWER 5.16 (3.00)

(three req'd)
1. Delta T across the core [0.5]; constant/decreasing [0.4] and less than 55°F [0.1]
~~full load delta T.[0.1]~~
2. Core outlet temp.[0.5]; constant/decreasing[0.5]
3. Tcold = Tsat for P(S/G)[0.5]]; constant/decreasing[0.5]
4. SG pressure [0.5]; decreasing or stable[0.5]
5. Thot [0.5] stable or decreasing [0.5]

REFERENCE
WTS; Ch. 14, p. 27; AOI 35; SQN ES-0.3

ANSWERS -- SEQUOYAH 1&2 -86/05/26-D.J. NELSON

ANSWER 5.17 (1.00)

In a small LOCA core heat is not being removed sufficiently by the break and little ECCS flow is being delivered due to elevated RCS pressure.

REFERENCE
SQN/WBN SD; Aux Feed Sys; p. 8.f8

ANSWER 5.18 (1.00)

remove boric acid that is precipitated on upper core surfaces (+.5)
terminate any boiling or steam formation in upper head region (+.5)

REFERENCE
Westinghouse PWR Systems Manual, pp 4.2-27
TPT SD-21, "ECCS", pp 26

EPE-011; EK3.13 (3.8/4.2)

ANSWER 5.19 (2.00)

EAO = [(Pt - Pb)/(Pt + Pb)] x 100% (+.5) (or DELTA I/RX POWER = EAO)

Initially, Greater power generated in lower segment of quadrant and EAO will be more negative. This condition will be accentuated as xenon burns out in the lower and builds in the upper segments. (+.75)
As xenon builds into the lower segment while depleting in the upper section due to the neutron flux shift, a higher percentage of power will be generated in the upper segment and EAO will shift towards a positive value.(+.75)

REFERENCE
TPT OP-12304.8; CNTO, "Reactor Core Control", pp 4-28/29 and Section 8

001/010; K5.34(3.2/4.1)

ANSWERS -- SEQUOYAH 1&2 -86/05/Z6-D.J. NELSON

ANSWER 5.20 (1.50)

a) Swell due to increase in steam flow (+.5 ea)

b) OP Delta T Rod stop is actuated

c) Pstm decreases affects the density compensation on Stm flow indication

Also, lower P_{STM} means lower driving head for steam flow.

REFERENCE
SQN Lesson plans on "Steam Dumps", "Rod control", "Main Steam", "RPS"

ANSWER 5.21 (1.00)

4, 1, 3, 2 (-.25 for each switch required to put in correct order)

REFERENCE
TPT GET Radcon Training Lesson Plan, pp 3

068/000; K5.04(3.2/3.5)

ANSWER 5.22 (2.00)

Tave:	30.4 X 0.25 X -15 =	-114 pcm
Power:	25 X -12 =	-300 pcm
Void:		-25 pcm
Xenon:		-50 pcm
total:		-489 pcm
Boron:	-489 / -9 =	54.3 ppm dilution (accept 52 to 56)

REFERENCE
SQN/WBN Nuclear theory

ANSWERS -- SEQUOYAH 1&2 -86/05/26-D.J. NELSON

ANSWER 6.01 (1.00)

b.

REFERENCE
SQN/WBN SD; RCS; CVCS
West. PWR Sys. Manual

ANSWER 6.02 (1.00)

a

REFERENCE
10CFR50.46

ANSWER 6.03 (1.00)

c.

ANSWER 6.04 (1.00)

a. reversed
b. normal

REFERENCE
West. PWR Sys. Manual / SQN/WBN HTFF

ANSWER 6.05 (1.00)

b.

REFERENCE
SQNP Diesels handout, p. 6.

ANSWERS -- SEQUOYAH 1&2 -86/05/26-D.J. NELSON

ANSWER 6.06 (1.00)

c

REFERENCE
SQNP Rod Control Lesson, pp 5 & 6 of 11.
Systems Manual, Chapter 11.1, p. 11.1-63.

ANSWER 6.07 (1.00)

c.

REFERENCE
System Manual, Chapter 4, p. 4.0-2

ANSWER 6.08 (2.50)

a. higher
b. as is
c. higher
d. lower
e. higher

ANSWER 6.09 (.50)

True.

REFERENCE
Reactor Protection Lesson, p. 8 of 13, item d.

ANSWER 6.10 (3.00)

a. 1,3
b. 1,3
c. 1,3
d. 1,3
e. 1
f. 1,2,3,4
g. 1
h. 5

[0.2] each of 15 responses

REFERENCE
West. PWR Sys. Manual, 11.1

ANSWERS -- SEQUOYAH 1&2 -86/05/26-D.J. NELSON

ANSWER 6.11 (1.00)

Solenoid Air; open; 33%; 500 [+.25 ea]
or air

REFERENCE
Aux Feed Lesson Plan, p. 5 of 8.

ANSWER 6.12 ~~(2.00)~~ (1.8)

a. CLOSE
b. CLOSE
c. OPEN
d. CLOSE
e. NO
f. ~~OPEN~~ ~~NO~~ deleted
g. CLOSE
h. NO
i. NO
j. ~~NO~~ CLOSE [0.2 ea.]

REFERENCE
SQNP System Description, ECCS, CVCS, MNSTM, CCW

ANSWER 6.13 (2.00)

a. high pressurizer level (letdown isolates)
b. low pressurizer pressure (rods drive Tave and PZR level down)
[1.0] each

REFERENCE
Channel Failure Handout; TAB A&C; 3,4-11

ANSWER 6.14 (1.00)

c,f,e,b,d,a or b,c,f,e,b,d,a,f

REFERENCE
West. PWR Sys. Manual

ANSWERS -- SEQUOYAH 1&2 -86/05/26-D.J. NELSON

ANSWER 6.15 (2.50)

decreasing: 2335 PORV closes (+.05 for setpoint, +.2 function)
2310 sprays start closing
2260 sprays closed
2250 variable heaters start to come on
2220 variable heaters full on
2210 low pressure alarm, backup heaters on
2210 Backup heaters on
1970 Low pressure SI block enabled
1970 Low pressure reactor trip
1870 Low pressure SI

REFERENCE
SQN SD; RCS,RPS

ANSWER 6.16 (1.50)

Lo-Lo level in 2/4 S/Gs (+.3 ea)
SIS
Loss of both MFP
Loss of one MFP > 80% power
LOSP

REFERENCE
Aux. Feed Lesson Plan, pp 4-6.

ANSWER 6.17 (2.00)

1. two percent radial flux tilt (+.5 ea for any 4)
2. improper rod sequence
3. shutdown bank rods less than 220 steps
4. rods within a bank greater than 12 steps from the bank demand
5. rods greater than 12 steps from each other within a bank

REFERENCE
SQN, SOI-55-1M4, XA-55-4B, p 25

ANSWER 6.18 (1.00)

Used during cooldown because the steam space detector response is poor due to poor heat transfer.

ANSWERS -- SEQUOYAH 1&2 -86/05/26-D.J. NELSON

REFERENCE
SQN/WBN Inst. Notes; RCS

ANSWER 6.19 (1.00)

Turbine runback[0.5] to ~~85%~~[0.5].
≈75% accept 70 to 80%

REFERENCE
SOI-5.1 & 6.1; p7.

ANSWER 6.20 (1.00)

a. loop 4 hot leg (.25)
b. either the relief valve downstream of the letdown orifices if it is unisolated, PORV on the PZR, or RHR suction reliefs. (.25 each)

REFERENCE
SQN Inst. Notes; RHR

ANSWER 6.21 (1.00)

Interlock to prevent openning of RHR when RCS pressure > 380 psig.

REFERENCE
SQN/WBN Inst. Notes; RCS

or/and auto close when > 700 psig
or input into cold overpressure protection

ANSWER 6.22 (1.00)

To ensure the regenerative heat exchanger always has RCS system pressure in it to prevent flashing of high temperature water.

REFERENCE
SQN/WBN SD; CVCS

ANSWERS -- SEQUOYAH 1&2 -86/05/26-D.J. NELSON

ANSWER 7.01 (1.00)

d.

REFERENCE
SQNP E-0 pp. 2 - 5

ANSWER 7.02 (1.00)

b.

REFERENCE
SQNP GOI-2, pg. 1

ANSWER 7.03 (1.00)

a.

REFERENCE
SQNP SOI-62.1B, pp. 8, 9

ANSWER 7.04 (1.00)

a.

REFERENCE
SQNP AOI-2D, pp. 10 - 12

ANSWER 7.05 (1.00)

c.

REFERENCE
SQNP AOI-3D, p. 1 of 2

ANSWERS -- SEQUOYAH 1&2 -86/05/26-D.J. NELSON

ANSWER 7.06 (1.00)

To prevent EST actuation (+.7) on lo-lo S/G level (+.3)

REFERENCE
SQNP GOI-1, p. 4; precaution T.

ANSWER 7.07 (1.00)

b

REFERENCE
SQNP GOI-2, p. 16

ANSWER 7.08 (1.50)

a) False (+.5 ea)
b) True
c) False

REFERENCE
Westinghouse User's Guide for TPT EOPs, pp 5-12

ANSWER 7.09 (1.50)

a. 1. 3 rem [+.5 ea]
   2. 300 mrem
b. Plant ~~Superintendent~~ Manager (or authorized representative) [0.5]

REFERENCE
SQN, RCI-1, p. 7-8 or SED.

ANSWER 7.10 (1.00)

a) RWST: 29% SUMP:10% (+.25 ea)

b) Stop all pumps taking a suction on RWST until swapover is complete(+.5)

ANSWERS -- SEQUOYAH 1&2 -86/05/26-D.J. NELSON

REFERENCE
SQNP ES-1.3 p. 1 of 4; ES-1.2 p. 1 of 3, App. A

ANSWER 7.11 (1.00)

PZR level(+.35) < 20 % (+.1)
< 50 % adverse containment (+.1)
RCS Subcooling (+.35) < 40 degrees F (+.1)

REFERENCE
SQNP ES-0.2, pp 3, 4

ANSWER 7.12 (1.00)

a) 5 (+.5 ea)
b) 2

REFERENCE
SQNP, FHI-7, p 4.

ANSWER 7.13 (2.00)

1. Verify Reactor Trip.
2. Verify Turbine Trip.
3. Verify Shutdown Boards Energized.
4. Check if SI Actuated.
5. Verify ECCS status.
6. Verify Cntmt. Isolation. + ECCS alignment
7. Verify MFW Isolation.
8. Verify AFW status.
9. Verify CCS Pumps Running.
10. Verify ERCW Pumps Running.
11. Verify EGTS and ABGTS Running.
12. Check Cntmt. press less than 2.81 psig.
13. Check Tavg.

REFERENCE
SQNP E-0, pp 2-5

ANSWERS -- SEQUOYAH 1&2 -86/05/26-D.J. NELSON

ANSWER 7.14 (1.50)

1. Containment spray pumps running.
2. MSIVs closed.
3. Phase "B" Isolation (status monitor panel 6E and 6F lights). (1.5)

REFERENCE
SQNP EOI-0, p 5

ANSWER 7.15 (3.00) also hi rad. cond. vacuum exhaust

a) 1. Unexpected rise in on S/G level with feedwater flow reduced or stopped, (+.5 ea)
   2. High radiation from any S/G B/D line by rad monitor
   3. High radiation from any one S/G B/D line by analysis or rad monitor
   4. High radiation from monitoring of steam lines

b) SBLOCA considerations: If the pumps are not tripped, an inadvertant loss of RCPs later (+.3) could result in uncovering the core due to excessive loss of mass (+.7)

c. 1. (At least one of the four CCP/SI pumps running) If RCS pressure decreases below 1250 psig (1/2 credit given for Uncontrolled Depressurization)

   2. Phase B cntmt. isolation

[1.0]

REFERENCE
EOI-3; pp 2-3.
Westinghouse ERG Manual on E-3

ANSWERS -- SEQUOYAH 1&2 -86/05/26-D.J. NELSON

ANSWER 7.16 (1.00)

1. Rod control in manual (or individual bank select) and restore Tave.
2. If unable to stop rod insertion, trip reactor.

[0.5] each

REFERENCE
SQN,AOI-2B, p 1

ANSWER 7.17 (2.00)

a. Addition of hydrazine will result in the additional production of gases that must be removed prior to opening the RCS. Also accepted, the gas presents personnel hazards if opened to atmosphere when it exists in the RCS. (1.0)

b. (H2O2) will cause activated corrosion products (Co 58, Co 60, and others) to be put into solution in the RCS. [0.5] This will result in decreased radiation levels (and corresponding radiation exposures). [0.5]

(1.0)

REFERENCE
GOI-3A, p 3
GOI-3C, P 30
SOI-62.3B,p 6.

ANSWER 7.18 (1.00)

a. to prevent thermal lock up.
b. to prevent bank overlap malfunction.

REFERENCE
SQN, GOI-1, p 3,4

ANSWERS -- SEQUOYAH 1&2 -86/05/26-D.J. NELSON

ANSWER 7.19 deleted (2.00)

a. Normal readings on containment temperature, pressure, radiation, and sump level. [0.5]
Normal readings on Aux building radiation and ventilation monitoring. [0.5]
Normal readings on Steam Generator blowdown and vacuum pump exhaust radiation. [0.5]

b. Due to the low RCS temperatures and pressures following a loss of secondary coolant (with the RCS intact), SI repressurization could lead to RCS overpressurization and damage. (PTS) [1.0]

deleted

REFERENCE
SQN EOP-2, p.5; EOP-1 p.4; EOP-0, p.7

ANSWER 7.20 (2.00)

a. The RCS temperature and boron concentration are being maintained at the hot shutdown, Xenon free condition. (1.0)

b. The RCS has been borated to the cold shutdown concentraton AND the plant is being cooled down. (1.0)

REFERENCE
SQNP GOI-2, p 2

ANSWER 7.21 (1.00)

a. ~~More than four incore T/C's greater then or equal to 1200 F, or,~~

b. ~~Hot leg RTD's pegged high,(700 F).~~ (1.0)

a. Core exit max T/C > 1200 F

b. Subcooling < 40° with > 700° core exit

REFERENCE
~~EOI 1; Appx D, p 1.~~
CSF Status trees

ANSWERS -- SEQUOYAH 1&2 -86/05/26-D.J. NELSON

ANSWER 7.22 (1.50)

A. Announce radiation abnormal in the reactor building and over the PA for all personnel to evacuate the containment building. (1.0)

B. Airborne gases (I, Kr, etc.) (0.5)

REFERENCE
AOI-29.

ANSWERS -- SEQUOYAH 1&2 -86/05/26-D.J. NELSON

ANSWER 8.01 (1.00)

b

REFERENCE
GGNS TSs Definitions
SQN TSs Definitions Section 1.0

ANSWER 8.02 (1.00)

a

REFERENC
10 CFR 55.31.e

ANSWER 8.03 (1.00)

d.

REFERENCE
SQN TS Section 1.0

ANSWER 8.04 (1.00)

b.

REFERENCE
SQNP GOI-6, p. 4

ANSWER 8.05 (1.00)

e.

REFERENCE
SQN TSs 3.0.5, 3.1.2.1, 3.1.2.2, 3.1.2.3, 3.1.2.4, 3.8.1.1, 3.8.1.2

ANSWERS -- SEQUOYAH 1&2 -86/05/26-D.J. NELSON

ANSWER 8.06 (1.00)

e.

REFERENCE
SQN TSs 3.0.3, 3.3.2.1, 3.5.2, 3.5.3

ANSWER 8.07 (1.50)

a) Unit 2
b) Unit 2
c) Unit 2

REFERENCE
SQNP AI-2, pp 10

PWG-23: Station Directives related to staffing/activities (2.8/3.5)

ANSWER 8.08 (1.00)

PORC; Plant Manager; USQD; safety review (+.25 ea)

REFERENCE
SQNP AI-9, pp 2

PWG-23: Use of procedures/station directives (2.8/3.5)

ANSWER 8.09 (1.00)

one 8 hour shift; tag the disconnected leads; H.N.; double verify (+.25ea)

REFERENCE
SQNP AI-3, pp 4

PWG-14: Tagging/Clearance Procedures (3.6/4.0)

ANSWERS -- SEQUOYAH 1&2 -86/05/26-D.J. NELSON

ANSWER 8.10 (1.50)

1 MTC within analyzed range (0.3)
2. Trip instrumentation within operating range (0.3)
3. Above P-12 setpoint (0.3)
4. Pzr capable of being operable (0.15) with a steam bubble (0.15) (0.3)
5. Rx vessel above its RT (NDT) (0.3)

REFERENCE
Cat, TS, p. 3/4 1-17
FNP/SQNP TS B3/4.1.1.4

001/050; PWG-5 (2.9/4.3)

ANSWER 8.11 (1.00)

Immediately initiate and continue boration (0.3) at greater than or equal to 10 gpm (0.3) of a solution containing greater than or equal to 20,000 ppm or equivalent (0.3) until the required SHUTDOWN MARGIN is restored (+.1)

REFERENCE
SQN TS 3.1.1.2

ANSWER 8.12 (2.00)

a. Alert

b. (Notification of) Unusual Event

c. General Emergency

d. Site Area Emergency (0.5 each)

REFERENCE
EIH: GET Handbook, pp 57, 58, 60, 61
HNP-x-4420, HNP-x-4520, HNP-x-4620, HNP-x-4720
BFNP: BFN-IPD, IP-1, p 1; RQ 85/04/01
SQN : SQN IPD ,IP-1; NUREG-0654

ANSWERS -- SEQUOYAH 1&2 -86/05/26-D.J. NELSON

ANSWER 8.13 (.50)

MODE 6 - REFUELING

REFERENCE
COLR TS TABLE 1.1

ANSWER 8.14 (1.00)

- Storage position, (the lead shielded storage area in the seal table room)
- Inserted to within 10 feet of the core

REFERENCE
SQNP AI-18, p. 2

ANSWER 8.15 deleted (.50)

Auxiliary Bldg.(.17) Elevation 669 (.17) near U-1 Auxiliary Turbine Feed Pump Room (.16)

REFERENCE
SQN OSLA 73, p. 1

ANSWER 8.16 (2.00)

1. Control rods in a single group move together with no individual rod insertion differing by more than + or - 13 steps from the group demand position.
2. Control rod groups are sequenced with overlapping groups (as described in TS 3.1.3.6) per procedure.
3. The control rod insertion limits of TSs (3.1.3.5 and 3.1.3.6) are maintained.
4. The axial power distribution, expressed in terms of AXIAL FLUX DIFFERENCE, is maintained within the limits.

REFERENCE
SQN TS B 3/4 2.2 and 3/4.2.3
TPT TS B3.2.5

ANSWERS -- SEQUOYAH 1&2 -86/05/26-D.J. NELSON

001/000; K5.46(2.3/3.6)

ANSWER 8.17 (2.50)

1. Leakage (except CONTROLLED LEAKAGE) into closed systems,(0.5) (such as pump seal or valve packing leaks) that are captured and conducted to a sump or collecting tank,(0.5) or

2. Leakage into the containment atmosphere from sources that are both specifically located and known (.34) either not to interfere with the operation of leakage detection systems (.33) or not to be PRESSURE BOUNDARY LEAKAGE, (.33) OR

3. Reactor coolant leakage through a steam generator to the secondary system.(0.5)

REFERENCE
SQN TSs Section 1.0

ANSWER 8.18 (1.50)

a. one (0.5)

b. Maintenance section must be notified (0.5) to check circuit before further fuse replacement (0.5).

REFERENCE
SQN AI-16, p. 1

ANSWER 8.19 (1.00)

a. Always backseat valves to isolate packing from line pressure.

b. Excessive force could cause the separaton of stem and disc.

REFERENCE
SQNP GOI-6, p. 3

ANSWERS -- SEQUOYAH 1&2 -86/05/26-D.J. NELSON

ANSWER 8.20 (1.00)

a. Check the toggle switch on for the charging motor circuit.

b. Listen for the closing spring charging up when the closing fuses are installed.

REFERENCE
SQNP GOI-6- p. 6

ANSWER 8.21 (1.00)

Reducing T avg to < 500 degrees F prevents the release of activity should a SG tube rupture (0.5) since P sat of the primary coolant is below the lift pressure of the atmospheric steam relief valves.(0.5)

REFERENCE
SQN TS B 3/4.4.8

ANSWER 8.22 (2.00)

a) Computer Room; Aux Instrument Room; EDG Rooms; Fuel Oil Pump Room (+.25 ea)
b) Establish a continuous fire watch (+.25) with backup fire suppression (+.25) for those areas in which redundant systems/components could be damaged (+.25)
Establish hourly fire watch patrol for other areas (+.25)

REFERENCE
SQNP TS 3.7.11.3

096/000; K4.06 (3.0/3.3) & PWG-36 (2.8/3.7)

ANSWER 8.23 (.50)

23 days (25% x 92 days)

REFERENCE
SQN TS 4.0.2

U. S. NUCLEAR REGULATORY COMMISSION
REACTOR OPERATOR LICENSE EXAMINATION

FACILITY: SEQUOYAH 1&2

REACTOR TYPE: PWR-WEC4

DATE ADMINISTERED: 86/05/26

EXAMINER: D.J. NELSON

APPLICANT: Master and Key

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
30.00	25.00			1. PRINCIPLES OF NUCLEAR POWER PLANT OPERATION, THERMODYNAMICS, HEAT TRANSFER AND FLUID FLOW
~~30.00~~ 29.8	25.00			2. PLANT DESIGN INCLUDING SAFETY AND EMERGENCY SYSTEMS
30.00	25.00			3. INSTRUMENTS AND CONTROLS
~~30.00~~ 28.00	25.00			4. PROCEDURES - NORMAL, ABNORMAL, EMERGENCY AND RADIOLOGICAL CONTROL
~~120.00~~ 117.8	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 1.01 (1.00)

Which of the following will cause the fuel temperature coefficient (pcm/degree) to become less negative?

a. fuel temperature increase
b. boron concentration decrease
c. control rod insertion (at constant power)
d. increase in the Pu-240 to U-238 ratio

QUESTION 1.02 (1.00)

Select the statement about single speed, motor driven, centrifugal pumps that is correct.

a. Upon throttling open the discharge valve to increase flow, discharge pressure decreases and therefore motor amps decreases.

b. Upon throttling open the discharge valve to increase flow, net positive suction head required increases and differential pressure across the pump decreases.

c. Upon throttling shut the discharge valve, flow decreases, total developed head decreases and net positive suction head available increases.

d. Pump cavitation can be reduced by throttling open the discharge valve thereby reducing total developed head.

QUESTION 1.03 (1.00)

The most serious problem with reaching the critical heat flux is caused by:

a. the poor thermal conductivity of steam.

b. the heat stress on the fuel cladding when nucleate boiling ceases and cladding temperature increases.

c. the displacement of boron from the core as steam bubble formation becomes significant.

d. the pressure fluctuations in the RCS caused by steam bubble formation and subsequent collapse.

(***** CATEGORY 01 CONTINUED ON NEXT PAGE *****)

QUESTION 1.04 (1.0C)

Which of the following describes the changes to steam that occurs between the inlet and outlet of a REAL (not ideal) turbine?

a. enthalpy decreases, entropy decreases, quality decreases.

b. enthalpy decreases, entropy increases, quality decreases.

c. enthalpy decreases, entropy constant, quality constant.

d. enthalpy constant, entropy increases, quality decreases.

QUESTION 1.05 (1.00)

Of the following, which must the main condenser remove the most heat from to condense? (Assume steam is of equal quality)

a. one pound of steam at 0 psia.

b. one pound of steam at 300 psia.

c. two pounds of steam at 600 psia.

d. two pounds of steam at 1200 psia.

QUESTION 1.06 (1.00)

Attached Figure # 219 shows a power history and four possible xenon traces (reactivity vs time). Select (a, b, c, or d) the curve that correctly displays the expected xenon transient for the given power history.

(***** CATEGORY 01 CONTINUED ON NEXT PAGE *****)

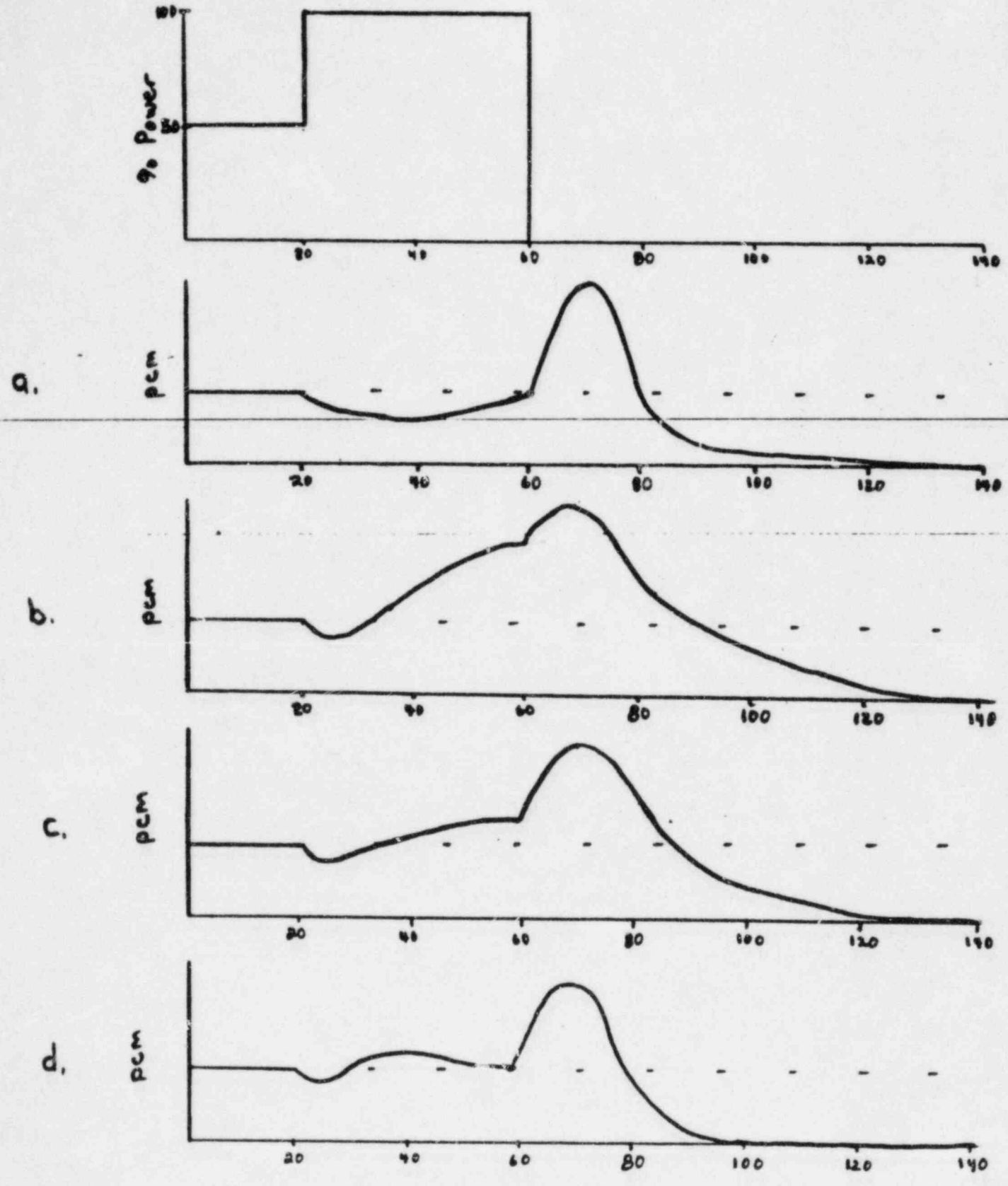
% Power
100
50
20
40
60
80
100
120
140
a.
pcm
b.
pcm
c.
pcm
d.
pcm
TIME (HOURS)

FIGURE #19

QUESTION 1.07 (3.00)

At 30% power a reactor coolant pump trips. With control rods in manual and all other systems in automatic and no operator/protective actions occur, indicate the effects on the following at the end of the transient: (increases, decreases, or remains the same)

	AFFECTED LOOP	UNAFFECTED LOOP
a. steam generator level		
b. steam flow		
c. delta T		

QUESTION 1.08 (1.50)

A reactor is taken critical with xenon concentration at zero. Power is raised to 50% at 5%/min. A trip occurs as power reaches 50%. What is the xenon concentration trend (increasing, decreasing, or near equilibrium):

a. one hour after the trip?

b. 12 hours after the trip?

c. 4 hours after the trip and the reactor has been restarted and power is at 25%?

QUESTION 1.09 (1.50)

Indicate whether the following changes cause the differential boron worth to become MORE NEGATIVE, LESS NEGATIVE, or REMAIN THE SAME. Consider each separately.

a. Boron concentration increases (0.5)

b. Moderator temperature increases (0.5)

c. Core age increases (at a constant boron concentration) (0.5)

(***** CATEGORY 01 CONTINUED ON NEXT PAGE *****)

QUESTION 1.10 (1.00)

Indicate TRUE or FALSE for the following statements concerning the effect that delayed neutrons have on reactivity:

a. Because delayed neutrons are born at lower energies than prompt neutrons, they are less likely to leak out of the core resulting in a positive effect.

b. Delayed neutrons are born at an average energy incapable of causing fast fission of U-238 creating a negative effect.

QUESTION 1.11 (1.00)

a. TRUE or FALSE: During cold plant conditions, you would expect the COLD calibrated PZR level instrument to indicate HIGHER than the HOT calibrated level instrument.

b. Give two different conditions involving the reference leg which could result in a false high level on the PZR level instrument.

QUESTION 1.12 (2.00) (Absolute value)

Both Pu-239 and Pu-240 concentrations increase over core life. Indicate whether this will cause the MAGNITUDE of the following paramcters to INCREASE, DECREASE or HAVE NO EFFECT:

a) Average Delayed Neutron fraction
b) Core Reproduction Factor
c) MTC (assume it is negative)
d) FTC

QUESTION 1.13 (.50)

Answer TRUE or FALSE for the following statement concerning Xenon-135 production and removal:

a. At full power equilibrium conditions about half of the xenon is produced by iodine decay and the other half is produced as a direct fission product.

(***** CATEGORY 01 CONTINUED ON NEXT PAGE *****)

QUESTION 1.14 (1.00)

List three significant heat transfer advantages of a counter flow heat exchanger over a parallel flow heat exchanger.

QUESTION 1.15 (1.50)

During the performance of an emergency boration while at power, how and why are the following parameters affected? (assume no control rod movement)

a. subcooling

b. over ~~pressure~~ POWER differential temperature setpoint

c. control rod worth

QUESTION 1.16 (1.00)

If bank D control rods were positioned at core midplane long enough to establish equilibrium conditions, and then withdrawn, describe the effect on Delta I.

QUESTION 1.17 (1.00)

Explain how decreasing RCS flow (at constant power) will result in decreasing DNBR.

QUESTION 1.18 (.50)

If the equilibrium count rate in a subcritical reactor TRIPLES due to a reactivity addition, what happens to the margin to criticality (direction and magnitude)?

QUESTION 1.19 (1.00)

Explain why the equilibrium (at power) value of samarium reactivity is independent of power level.

(***** CATEGORY 01 CONTINUED ON NEXT PAGE *****)

QUESTION 1.20 (3.00)

What are THREE parameters AND their trends which are indications that Natural Circulation in the RCS is established? (numerical values not req'd)

QUESTION 1.21 (1.00)

Aux. Feed flow is more critical on a small LOCA than on a large LOCA. Why is this true?

QUESTION 1.22 (1.50)

From 80% power, 100% flow (assume delta T = 48 degrees F) a station blackout occurs. Natural circulation is established and core delta T stabilizes at 40 degrees F. If decay heat is 2.0% of full power, what is the mass flow rate (% of full flow)? Show all calculations.

QUESTION 1.23 (2.00)

Given the following, calculate the required boron change to increase reactor power from 75% to 100% while maintaining constant rod position.

Moderator temp. coeff.	-15 pcm/degree F
Doppler-only power coeff.	-12 pcm/% power
Void reactivity change	-25 pcm
Xenon change	-50 pcm
Boron coeff.	-9 pcm/ppm

(***** END OF CATEGORY 01 *****)

QUESTION 2.01 (1.00)

Which statement below regarding the RCP shaft seals is NOT correct? (1.0)

a. Only #1 and #2 seals are designed to withstand full system pressure

b. Leakoff from #2 seal is used to maintain the level in the standpipe used to supply cooling water to #3 seal

c. When an individual #1 seal bypass line is isolated, the other RCP seal bypass lines are isolated as well

d. The #1 seal is a "floating" face seal vice a "rubbing" face seal like the #2 and #3 seals.

QUESTION 2.02 (1.00)

According to 10CFR50.46, which of the following is NOT a design criteria of the Emergency Core Cooling System subsystems.

a. The calculated peak centerline temperature shall not exceed 2000 degrees F.

b. The maximum cladding oxidation shall not exceed 17% of the total cladding thickness.

c. The calculated total amount of hydrogen generated from the cladding reaction with water shall not exceed 1% of the amount that would be generated if all cladding around the fuel reacted.

d. Calculated changes in core geometry shall be such that the core remains in a coolable configuration.

QUESTION 2.03 (1.00)

Which of the following is NOT a purpose of the Reactor Protection System?

a. Prevent maximum DNBR from increasing above 1.3.

b. Prevent the maximum power density (kw/ft.) from exceeding limits.

c. Prevent RCS pressure from exceeding 110% of design pressure.

d. Prevent secondary system pressure from exceeding 110% of design pressure.

(***** CATEGORY 02 CONTINUED ON NEXT PAGE *****)

QUESTION 2.04 (1.00)

With three reactor coolant pumps operating indicate if the flow in the given loop segment will be in the NORMAL or REVERSED direction in the loop with the non-operating pump.

a) T-h RTD manifold

b) T-c RTD manifold

QUESTION 2.05 (1.00)

The purpose of the CVCS demineralizers is to:

a. Remove all chemicals from the RCS fluids.

b. Remove soluable and insoluable material from the RCS.

c. Replace insoluable material with soluable ions.

d. Provide a method for boron control during reactor operations.

QUESTION 2.06 (1.00)

Besides the overspeed shutdown, which of the following diesel engine/ generator shutdowns is enabled during an emergency start of the diesel?

a. Voltage restraint overcurrent relay, (51V).

b. Generator differential relay, (87).

c. Phase balance relay, (46).

d. Low lube oil pressure.

QUESTION 2.07 (.50)

With normal power unavailable and ONE vital battery out of service, how long will the remaining THREE batteries be capable of supplying all loads required for safe shutdown of BOTH units?

(***** CATEGORY 02 CONTINUED ON NEXT PAGE *****)

QUESTION 2.08 (1.00)

Which of the below features enhances the operation of the ice condenser and containment spray for heat removal?

a. Containment design, such that the delta P between upper and lower containment drives the air circulation.

b. Ventilation coolers and recirculation fans are used to mix the air and provide additional cooling.

c. Air return fans provide flow to return the air from the upper containment to the lower containment.

d. Pressure operated doors open to allow upper containment air to flow through to the lower containment.

QUESTION 2.09 (.50)

TRUE or FALSE?

After tripping a bistable in a 2/4 logic system, one of three remaining signals reaching the bistable setpoint will cause a trip, even though the logic SYSTEM remains as a 2/4 system.

QUESTION 2.10 (1.00)

Name the plant temperature (HOT or COLD) and the RCP status (starting FIRST or LAST reactor coolant pump) for which you would expect the highest pump starting current.

(***** CATEGORY 02 CONTINUED ON NEXT PAGE *****)

QUESTION 2.11 ~~(2.00)~~ 1.80

For the following components, indicate whether they will receive an OPEN, CLOSE, or NO signal as a result of a safety injection (with Phase 'A') initiation signal.

a. Control room supply ducts
b. Main feed bypass valves
c. SI accumulator discharge isolation valves
d. Normal charging header isolation valves
e. Main steam isolation valves
f. ~~RWST to SI pump suction valves~~ part f deleted
g. Seal water return isolation valve
h. Component cooling isolation valve from RHR system
i. Component cooling isolation from letdown heat exchanger
j. Steam supply valves to turbine-driven feed pump

clarified MAIN feed pump

QUESTION 2.12 (1.00)

Fill in the blanks below to correctly complete the statement regarding the Motor Driven Auxiliary Feedwater Pump level control valves:

These valves are _____ operated and will fail _____ on a loss of air. They are normally set to maintain a S/G level of _____% and if pressure downstream drops to < _____ psig, the valves will close automatically.

QUESTION 2.13 (1.00)

List four relief valve discharges accepted by the PRT from inside containment. (other than PZR PORV and safties)

QUESTION 2.14 (2.00)

Aside from alarms/annunciators, list eight indications that are monitored which would indicate a coolant leak from the primary system.

QUESTION 2.15 (2.00)

List four different ways to emergency borate. (Valve Numbers not required)

(***** CATEGORY 02 CONTINUED ON NEXT PAGE *****)

QUESTION 2.16 (1.00)

Arrange the following in the correct sequence for rod withdrawal (one step).

a. Lift coil OFF

b. Stationary gripper coil ON

c. Moveable gripper coil ON

d. Moveable gripper coil OFF

e. Lift coil ON

f. Stationary gripper coil OFF

QUESTION 2.17 (1.50)

What segments of the Rod Control System are provided with signals from the Turbine Impulse Pressure Detectors?

QUESTION 2.18 (1.50)

List the 5 Auto-start signals for the Turbine driven AFW pump.

QUESTION 2.19 (1.00)

Why is a seal bypass necessary for the reactor coolant pump #1 seal?

QUESTION 2.20 (1.00)

What is compared in the power range detector current comparator?

QUESTION 2.21 (1.00)

Following a RCS boron dilution at power, how is the water in the pressurizer brought to the same concentration?

(***** CATEGORY 02 CONTINUED ON NEXT PAGE *****)

QUESTION 2.22 (1.00)

a. When the RHR system is controlling RCS pressure during solid plant conditions, where does the water leave the RCS?

b. If the control valve which separates RHR and CVCS fails shut, what 3 relief valves could limit RCS pressure? (redundant system reliefs count as one response)

QUESTION 2.23 (1.00)

The pressurizer has a resistance temperature detector (RTD) in the STEAM space that is normally used to indicate the PZR saturation temperature. Assuming this RTD is operable, during what plant evolution is the RTD in the PZR WATER space utilized, and why isn't the PZR STEAM RTD used?

QUESTION 2.24 (1.50)

Which chemical is used to accomplish the following methods of RCS corrosion control?

a. Control pH during startup

b. Scavenge oxygen during a startup from cold conditions

c. Control oxygen during normal at power operations

QUESTION 2.25 (2.50)

a) What force(s) is/ are used for Main Steam Isolation Valve (MSIV):

a. closing ?
b. opening ?

b) What component prevents MSIV damage on fast closure?

c) What are ALL the MSIV automatic closure signals?

(***** END OF CATEGORY 02 *****)

QUESTION 3.01 (1.00)

What set of signals below are sent to the Reactor Protection System to indicate a Turbine Trip?

a. Throttle valves closed & Auto Stop Oil pressure low

b. Throttle valves closed & EHC pressure low

c. Governor valves closed & Auto Stop Oil pressure low

d. Governor valves closed & EHC pressure low

QUESTION 3.02 (2.50)

For the following, how will the indication respond (higher, lower, as is) to the given failure?

a. RTD open circuit in detector

b. Intermediate range compensation voltage fails high with reactor power at 100%.

c. Source range pulse height descriminator setting fails low with reactor power in the source range.

d. Thermocouple junction opens

e. Steam flow pressure compensation to the steam flow detector fails high

QUESTION 3.03 (1.50)

Indicate whether the OT Delta-T AND OP Delta-T SETPOINT will INCREASE, DECREASE or NOT CHANGE if the following operating parameter changes occur. CONSIDER EACH CHANGE INDEPENDENTLY.

1. Pressurizer pressure decreases 100 psig.

2. The N-41 lower detector fails low.

3. Overdilution of the RCS, which causes rods to insert slowly to maintain constant load and Tave. → at point rods start to insert.

(***** CATEGORY 03 CONTINUED ON NEXT PAGE *****)

QUESTION 3.04 (3.00)

Match the type(s) of rod motion that is blocked with the signal that causes the rod block:

SIGNAL	BLOCKED ROD MOTION
a. OP delta T	1. Automatic Withdrawal
b. OT delta T	2. Automatic Insertion
c. Power Range at 103%	3. Manual Withdrawal
d. Inter. Range at 20% equiv.	4. Manual Insertion
e. Control Bank D > 220 steps	5. No Blocked Motion
f. Urgent Failure in the Power Cabinet	
g. P imp < 15%	
h. Tave vs. Tref < 1.5 degrees F	

QUESTION 3.05 (1.00)

a) If the turbine trips from an initial power of LESS than 50%, which steam dump controller will control the steam dumps?

b) In addition to being an input to the steam dump controllers, what function does Tave provide in the Steam Dump Control circuitry?

QUESTION 3.06 (2.00)

The following failures occur causing a subsequent automatic reactor trip. What protection signal would cause the trip? Assume the reactor is initially at 100% power and steady state conditions, all systems in automatic and no operator action. Treat each independently.

a) CVCS flow rate drops to a minimum of 30 gpm.

b) A narrow range (controlling) cold leg RTD fails high.

(***** CATEGORY 03 CONTINUED ON NEXT PAGE *****)

QUESTION 3.07 (3.00)

a. List THREE Main Feedwater isolation signals.

b. List ALL automatic actions that occur on a feedwater isolation signal.

c. What automatically happens as main feed pump suction pressure approaches saturation (low NPSH)?

d. What is the setpoint for the "Low NPSH at MFP's" alarm AND what are the sensing point locations for this signal?

QUESTION 3.08 (1.75)

List the SEVEN RPS Permissives by nomenclature (eg P-2), that block safeguards actions. Indicate the permissives that must be done manually.

QUESTION 3.09 (2.00)

List four conditions that will generate a "Computer Alarm Rod Dev and Seq NIS PWR Range Tilts" alarm.

QUESTION 3.10 (3.00)

What are three functions of the Overspeed Protection Controller (OPC)? In your answer include which valves are actuated for each function.

QUESTION 3.11 (1.75)

List the protective/control outputs for the following: (Increasing severity of the same function like lo and lo-lo level count as one response)

a) LOOP Tave Instrument, (FOUR REQUIRED)

b) Auctioneered HIGH Tave Instrument, (THREE REQUIRED)

(***** CATEGORY 03 CONTINUED ON NEXT PAGE *****)

QUESTION 3.12 (2.50)

List ALL the protection, alarm and control functions provided by the PZR pressure instruments as pressure decreases from 2350 psig. (Include the applicable setpoints)

QUESTION 3.13 (1.00)

What is the reason for the interlocks on the CVCS letdown valves and orifice isolation valves?

QUESTION 3.14 (1.00)

While operating at 92% power, the #3 heater drain tank level goes high enough to cause the water in the tank to begin dumping to the condenser. According to SOI's 5.1 & 6.1, what effect will this have on the turbine?

QUESTION 3.15 (1.00)

Most RCS pressure control/protection signals are generated by the PZR pressure instruments. What control or protection signal is generated by the pressure instrument on a T-hot leg?

QUESTION 3.16 (2.00)

List ALL the automatic actions that occur upon detection of high radiation in the following radiation monitors:

a) Component Cooling water liquid effluent monitor.

b) Steam Generator blowdown liquid effluent monitor.

c) Containment purge air exhaust monitor.

d) Fuel Pool radiation monitor.

(***** END OF CATEGORY 03 *****)

QUESTION 4.01 (1.00)

Which of the following is NOT an immediate operator action for a Safety Injection as stated in E-0?

a. Verify Containment Isolation.

b. Check Tavg.

c. Verify AFW status.

d. Verify Steam Dumps actuated.

QUESTION 4.02 (1.00)

It is necessary to reduce the critical boron concentration by 200 ppm prior to pulling the control banks. Prior to the dilution, the source range instruments read 30 and 37 cps. After reducing the boron concentration by 100 ppm the same instruments read 62 and 75 cps. Which of the following is the proper operator action in accordance with GOI-2?

a. Stop the dilution and borate back to the original count rate.

b. Stop the dilution and evaluate the situation.

c. Continue the dilution and continuously monitor the count rate.

d. Continue the dilution and recalculate the ECC.

QUESTION 4.03 (1.00)

During normal CVCS operation, which of the following is an abnormal condition and would require operator action to correct?

a. VCT pressure is 15 psig.

b. The temperature of the fluid leaving the letdown heat exchangers is 127 F.

c. The RCP seal injection water tempeature is 120 F and flow to the seals is 8 gpm/pump.

d. RCP seal differential pressure is 300 psid.

(***** CATEGORY 04 CONTINUED ON NEXT PAGE *****)

QUESTION 4.04 (1.00)

Which of the following statements concerning the procedure for a dropped RCCA is correct?

a. Upon starting recovery of the dropped RCCA, an URGENT FAILURE alarm will occur because the lift coils for the other rods in the group have been disconnected.

b. The delta flux target band is not applicable during a dropped RCCA malfunction and recovery.

c. If two or more RCCA's have dropped, manually trip the reactor and proceed in accordance with EP-1.00.

d. Recovery from a dropped RCCA will be facilitated if Tavg is higher than Tref prior to commencing withdrawal of the dropped RCCA.

QUESTION 4.05 (1.00)

During an inadvertent dilution accident while at 100% power, with controls in automatic and no operator action, which of the following will be the most probable cause of a reactor trip?

a. Pressurizer low pressure.

b. Over-temperature delta T.

c. Over-power delta T.

d. Power range monitor positive rate.

QUESTION 4.06 (1.00)

According to a note in GOI-2, what condition must be met prior to exceeding 600 RPM on the main turbine?

a. Main Feedwater Regulating valves are to be in automatic.

b. Tavg is to be at the no-load value.

c. The low pressure turbine inlet metal temperature must be greater t 400 degrees F.

d. Steam dumps must be in Tavg mode.

(***** CATEGORY 04 CONTINUED ON NEXT PAGE *****)

QUESTION 4.07 (1.50)

List SIX alarms that may actuate which would be symptoms of rods failing to insert following a decrease in turbine load.

QUESTION 4.08 (1.00)

If the reactor trip breakers are closed and the steam generators are under nitrogen pressure, the nitrogen pressure must be vented off the steam generators prior to opening the MSIV's. Why must this be done?

QUESTION 4.09 (1.00)

TRUE or FALSE?

a. The transfer of ECCS suction to the Containment Sump is accomplished RWST level is < 29% and Containment Sump Level is > 10%.

b. When RWST level reaches 0%, the Containment Spray Pumps are shifted to the Containment Sump.

QUESTION 4.10 (2.00)

TRUE or FALSE?

a. When the axial flux difference monitor is inoperable, the AFD must be logged once a shift by performing SI-44.

b. Any off-frequency turbine operation is to be reported to the results section for record keeping.

c. If the "Rod Control Banks Limit Low" alarm comes in when critical, commence boration to clear the alarm.

d. When the quadrant power tilt ratio alarm is inoperable, the QPTR must be calculated every 12 hours by performing SI-133.

(***** CATEGORY 04 CONTINUED ON NEXT PAGE *****)

QUESTION 4.11 (2.50)

Match the evolutions performed during a power increase in column A with the power at which it is normally performed in column B. Column B answers may be used more than once.

COLUMN A	COLUMN B
a. verify chemistry within limits	1. 35%
b. place MSR in service	2. 90%
c. load second MFPT	3. 50%
d. perform calorimetric calibration	4. 30%
e. verify P-8 light goes out	5. 40%

QUESTION 4.12 (1.00)

What are the SI Re-initiation criteria of ES-0.2, "SI Termination"? (Include parameters associated with adverse containment conditions)

QUESTION 4.13 (1.00)

List the quarterly exposure limits for the following:

a) TVA employee, Whole Body
b) TVA employee, extremities
c) Non-TVA employee without exposure record, Whole Body

QUESTION 4.14 (2.00)

LIST the THIRTEEN immediate actions to be taken for a Saftey Injection, in accordance with Emergency Procedure, E-0. (Substeps are NOT required)

QUESTION 4.15 (1.00)

What are ALL the Immediate Operator Actions for a continuous insertion of a control rod bank?

(***** CATEGORY 04 CONTINUED ON NEXT PAGE *****)

QUESTION 4.16 (1.00)

A NOTE in GOI-2, "Plant Startup from Hot Standby to Minimum Load," states that if control rods were withdrawn 5 steps during heatup, the control rods must be fully inserted prior to withdrawing rods.

a) Why are the rods withdrawn 5 steps during heatup?

b) Why must they be inserted prior to withdrawal?

QUESTION 4.17 (2.00)

a) If the plant was operating in Mode 1 when the RCS pressure exceeds 2735 psig, what action must you take, in accordance with the Technical Specifications? INCLUDE applicable time limit.

b) If the plant was in Mode 3 when the RCS pressure exceeds 2735 psig, what action must you take, in accordance with the T. S.? INCLUDE applicable time limit.

QUESTION 4.18 question deleted (2.00)

a. A safety injection signal is to be considered non-spurious unless specific conditions exist. What are these conditions?

b. The "SI Termination Criteria" for Loss of Primary Coolant and Loss of Secondary Coolant have major differences. What is the major REASON for these differences? deleted

QUESTION 4.19 (3.50)

According to AOI-4D, "Nuclear Instrumentation Malfunction, Power Range Failure," the immediate operator action requires that the rod control be switched to MANUAL if in AUTOMATIC when a PR Instrument fails HIGH.

a) Identify the particular component of the rod control system that makes this immediate action necessary and explain its basic operation. (1.5)

b) Identify four bypasses or bistables which must be tripped if this situation were to occur. (2.0)

(***** CATEGORY 04 CONTINUED ON NEXT PAGE *****)

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QUESTION 4.20 (1.00)

According to CSF status trees

What are the TWO guidelines from EOI-1 Appendix D that indicate inadequate core cooling exists?

QUESTION 4.21 (1.50)

Make a rough sketch of the Curves for Reactor Core Safety Limits for four loop operation (Exact Numbers are NOT required). Ensure that you indicate the parameters that are being measured and the region of acceptable operation.

(***** END OF CATEGORY 04 *****)

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

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$f = \frac{1}{T}$

$w = mg$

$E = mc^2$

$KE = 1/2\ mv^2$

$PE = mgh$

$V_f = V_o + at$

$W = v\ \Delta P$

$\Delta E = 931\ \Delta m$

$\dot{Q} = \dot{m}\Delta h$

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

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

$Pwr = W_f \Delta h$

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

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

$SUR = 26.06/T$

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

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

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

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

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

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

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

$\Sigma = \sigma N$

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

$a = (V_f - V_o)/t$

$w = \theta/t$

$A = \frac{\pi D^2}{4}$

$\dot{m} = V_{av} A_o$

Cycle efficiency = (Net work out)/(Energy in)

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

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

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

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

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

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

$TVL = 1.3/\mu$

$HVL = -0.693/\mu$

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

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

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

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

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

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

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

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

$I_1 d_1 = I_2 d_2$

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

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

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

Water Parameters

1 gal. = 8.345 lbm.
1 gal. = 3.78 liters
1 ft^3 = 7.48 gal.
Density = 62.4 lbm/ft^3
Density = 1 gm/cm^3
Heat of vaporization = 970 Btu/lbm
Heat of fusion = 144 Btu/lbm
1 Atm = 14.7 psi = 29.9 in. Hg.
1 ft. H_2O = 0.4335 lbf/in.

Miscellaneous Conversions

1 curie = 3.7×10^{10} dps
1 kg = 2.21 lbm
1 hp = 2.54×10^3 Btu/hr
1 mw = 3.41×10^6 Btu/hr
1 in = 2.54 cm
°F = 9/5°C + 32
°C = 5/9 (°F-32)
1 BTU = 778 ft-lbf
e = 2.718

Temp °F	Press. psia	Volume, ft³/lb			Enthalpy, Btu/lb			Entropy, Btu/lb x °F			Temp °F
		Water v_f	Evap v_{fg}	Steam v_g	Water h_f	Evap h_{fg}	Steam h_g	Water s_f	Evap s_{fg}	Steam s_g	
32	0.08859	0.01602	3305	3305	-0.02	1075.5	1075.5	0.0000	2.1873	2.1873	32
35	0.09991	0.01602	2948	2948	3.00	1073.8	1076.8	0.0061	2.1706	2.1767	35
40	0.12163	0.01602	2446	2446	8.03	1071.0	1079.0	0.0162	2.1432	2.1594	40
45	0.14744	0.01602	2037.7	2037.8	13.04	1068.1	1081.2	0.0262	2.1164	2.1426	45
50	0.17795	0.01602	1704.8	1704.8	18.05	1065.3	1083.4	0.0361	2.0901	2.1262	50
60	0.2561	0.01603	1207.6	1207.6	28.06	1059.7	1087.7	0.0555	2.0391	2.0946	60
70	0.3629	0.01605	868.3	868.4	38.05	1054.0	1092.1	0.0745	1.9900	2.0645	70
80	0.5068	0.01607	633.3	633.3	48.04	1048.4	1096.4	0.0932	1.9426	2.0359	80
90	0.6981	0.01610	468.1	468.1	58.02	1042.7	1100.8	0.1115	1.8970	2.0086	90
100	0.9492	0.01613	350.4	350.4	68.00	1037.1	1105.1	0.1295	1.8530	1.9825	100
110	1.2750	0.01617	265.4	265.4	77.98	1031.4	1109.3	0.1472	1.8105	1.9577	110
120	1.6927	0.01620	203.25	203.26	87.97	1025.6	1113.6	0.1646	1.7693	1.9339	120
130	2.2230	0.01625	157.32	157.33	97.96	1019.8	1117.8	0.1817	1.7295	1.9112	130
140	2.8892	0.01629	122.98	123.00	107.95	1014.0	1122.0	0.1985	1.6910	1.8895	140
150	3.718	0.01634	97.05	97.07	117.95	1008.2	1126.1	0.2150	1.6536	1.8686	150
160	4.741	0.01640	77.27	77.29	127.96	1002.2	1130.2	0.2313	1.6174	1.8487	160
170	5.993	0.01645	62.04	62.06	137.97	996.2	1134.2	0.2473	1.5822	1.8295	170
180	7.511	0.01651	50.21	50.22	148.00	990.2	1138.2	0.2631	1.5480	1.8111	180
190	9.340	0.01657	40.94	40.96	158.04	984.1	1142.1	0.2787	1.5148	1.7934	190
200	11.526	0.01664	33.62	33.64	168.09	977.9	1146.0	0.2940	1.4824	1.7764	200
210	14.123	0.01671	27.80	27.82	178.15	971.6	1149.7	0.3091	1.4509	1.7600	210
212	14.696	0.01672	26.78	26.80	180.17	970.3	1150.5	0.3121	1.4447	1.7568	212
220	17.186	0.01678	23.13	23.15	188.23	965.2	1153.4	0.3241	1.4201	1.7442	220
230	20.779	0.01685	19.364	19.381	198.33	958.7	1157.1	0.3388	1.3902	1.7290	230
240	24.968	0.01693	16.304	16.321	208.45	952.1	1160.6	0.3533	1.3609	1.7142	240
250	29.825	0.01701	13.802	13.819	218.59	945.4	1164.0	0.3677	1.3323	1.7000	250
260	35.427	0.01709	11.745	11.762	228.76	938.6	1167.4	0.3819	1.3043	1.6862	260
270	41.856	0.01718	10.042	10.060	238.95	931.7	1170.6	0.3960	1.2769	1.6729	270
280	49.200	0.01726	8.627	8.644	249.17	924.6	1173.8	0.4098	1.2501	1.6599	280
290	57.550	0.01736	7.443	7.460	259.4	917.4	1176.8	0.4236	1.2238	1.6473	290
300	67.005	0.01745	6.448	6.466	269.7	910.0	1179.7	0.4372	1.1979	1.6351	300
310	77.67	0.01755	5.609	5.626	280.0	902.5	1182.5	0.4506	1.1726	1.6232	310
320	89.64	0.01766	4.896	4.914	290.4	894.8	1185.2	0.4640	1.1477	1.6116	320
340	117.99	0.01787	3.770	3.788	311.3	878.8	1190.1	0.4902	1.0990	1.5892	340
360	153.01	0.01811	2.939	2.957	332.3	862.1	1194.4	0.5161	1.0517	1.5678	360
380	195.73	0.01836	2.317	2.335	353.6	844.5	1198.0	0.5416	1.0057	1.5473	380
400	247.26	0.01864	1.8444	1.8630	375.1	825.9	1201.0	0.5667	0.9607	1.5274	400
420	308.78	0.01894	1.4808	1.4997	396.9	806.2	1203.1	0.5915	0.9165	1.5080	420
440	381.54	0.01926	1.1976	1.2169	419.0	785.4	1204.4	0.6161	0.8729	1.4890	440
460	466.9	0.0196	0.9746	0.9942	441.5	763.2	1204.8	0.6405	0.8299	1.4704	460
480	566.2	0.0200	0.7972	0.8172	464.5	739.6	1204.1	0.6648	0.7871	1.4518	480
500	680.9	0.0204	0.6545	0.6749	487.9	714.3	1202.2	0.6890	0.7443	1.4333	500
520	812.5	0.0209	0.5386	0.5596	512.0	687.0	1199.0	0.7133	0.7013	1.4146	520
540	962.8	0.0215	0.4437	0.4651	536.8	657.5	1194.3	0.7378	0.6577	1.3954	540
560	1133.4	0.0221	0.3651	0.3871	562.4	625.3	1187.7	0.7625	0.6132	1.3757	560
580	1326.2	0.0228	0.2994	0.3222	589.1	589.9	1179.0	0.7876	0.5673	1.3550	580
600	1543.2	0.0236	0.2438	0.2675	617.1	550.6	1167.7	0.8134	0.5195	1.3330	600
620	1786.9	0.0247	0.1962	0.2208	646.9	506.3	1153.2	0.8403	0.4659	1.3092	620
640	2059.9	0.0260	0.1543	0.1802	679.1	454.6	1133.7	0.8686	0.4134	1.2821	640
660	2365.7	0.0277	0.1166	0.1443	714.9	392.1	1107.0	0.8995	0.3502	1.2498	660
680	2708.6	0.0304	0.0808	0.1112	758.5	310.1	1068.5	0.9365	0.2720	1.2086	680
700	3094.3	0.0366	0.0386	0.0752	822.4	172.7	995.2	0.9901	0.1490	1.1390	700
705.5	3208.2	0.0508	0	0.0508	906.0	0	906.0	1.0612	0	1.0612	705.5

TABLE A.2 PROPERTIES OF SATURATED STEAM AND SATURATED WATER (TEMPERATURE)

Press psia	Temp F	Volume, ft³/lb			Enthalpy, Btu/lb			Entropy, Btu/lb x F			Energy, Btu/lb		Press psia
		Water	Evap	Steam	Water	Evap	Steam	Water	Evap	Steam	Water	Steam	
		v_f	v_{fg}	v_g	h_f	h_{fg}	h_g	s_f	s_{fg}	s_g	u_f	u_g	
0.0886	32.018	0.01602	3302.4	3302.4	0.00	1075.5	1075.5	0	2.1872	2.1872	0	1021.3	0.0886
0.10	35.023	0.01602	2945.5	2945.5	3.03	1073.8	1076.8	0.0061	2.1705	2.1766	3.03	1022.3	0.10
0.15	45.453	0.01602	2004.7	2004.7	13.50	1067.9	1081.4	0.0271	2.1140	2.1411	13.50	1025.7	0.15
0.20	53.160	0.01603	1526.3	1526.3	21.22	1063.5	1084.7	0.0422	2.0738	2.1160	21.22	1028.3	0.20
0.30	64.484	0.01604	1039.7	1039.7	32.54	1057.1	1089.7	0.0641	2.0168	2.0809	32.54	1032.0	0.30
0.40	72.869	0.01606	792.0	792.1	40.92	1052.4	1093.3	0.0799	1.9762	2.0562	40.92	1034.7	0.40
0.5	79.586	0.01607	641.5	641.5	47.62	1048.6	1096.3	0.0925	1.9446	2.0370	47.62	1036.9	0.5
0.6	85.218	0.01609	540.0	540.1	53.25	1045.5	1098.7	0.1028	1.9186	2.0215	53.24	1038.7	0.6
0.7	90.09	0.01610	466.93	466.94	58.10	1042.7	1100.8	0.1	1.8966	2.0083	58.10	1040.3	0.7
0.8	94.38	0.01611	411.67	411.69	62.39	1040.3	1102.6	0.1117	1.8775	1.9970	62.39	1041.7	0.8
0.9	98.24	0.01612	368.41	368.43	66.24	1038.1	1104.3	0.1264	1.8606	1.9870	66.24	1042.9	0.9
1.0	101.74	0.01614	333.59	333.60	69.73	1036.1	1105.8	0.1326	1.8455	1.9781	69.73	1044.1	1.0
2.0	126.07	0.01623	173.74	173.76	94.03	1022.1	1116.2	0.1750	1.7450	1.9200	94.03	1051.8	2.0
3.0	141.47	0.01630	118.71	118.73	109.42	1013.2	1122.6	0.2009	1.6854	1.8864	109.41	1056.7	3.0
4.0	152.96	0.01636	90.63	90.64	120.92	1006.4	1127.3	0.2199	1.6428	1.8626	120.90	1060.2	4.0
5.0	162.24	0.01641	73.515	73.53	130.20	1000.9	1131.1	0.2349	1.6094	1.8443	130.18	1063.1	5.0
6.0	170.05	0.01645	61.967	61.98	138.03	996.2	1134.2	0.2474	1.5820	1.8294	138.01	1065.4	6.0
7.0	176.84	0.01649	53.634	53.65	144.83	992.1	1136.9	0.2581	1.5587	1.8168	144.81	1067.4	7.0
8.0	182.86	0.01653	47.328	47.35	150.87	988.5	1139.3	0.2676	1.5384	1.8060	150.84	1069.2	8.0
9.0	188.27	0.01656	42.385	42.40	156.30	985.1	1141.4	0.2760	1.5204	1.7964	156.28	1070.8	9.0
10	193.21	0.01659	38.404	38.42	161.26	982.1	1143.3	0.2836	1.5043	1.7879	161.23	1072.3	10
14.696	212.00	0.01672	26.782	26.80	180.17	970.3	1150.5	0.3121	1.4447	1.7568	180.12	1077.6	14.696
15	213.03	0.01673	26.274	26.29	181.21	969.7	1150.9	0.3137	1.4415	1.7552	181.16	1077.9	15
20	227.96	0.01683	20.070	20.087	196.27	960.1	1156.3	0.3358	1.3962	1.7320	196.21	1082.0	20
30	250.34	0.01701	13.7266	13.744	218.9	945.2	1164.1	0.3682	1.3313	1.6995	218.8	1087.9	30
40	267.25	0.01715	10.4794	10.497	236.1	933.6	1169.8	0.3921	1.2844	1.6765	236.0	1092.1	40
50	281.02	0.01727	8.4967	8.514	250.2	923.9	1174.1	0.4112	1.2474	1.6586	250.1	1095.3	50
60	292.71	0.01738	7.1562	7.174	262.2	915.4	1177.6	0.4273	1.2167	1.6440	262.0	1098.0	60
70	302.93	0.01748	6.1875	6.205	272.7	907.8	1180.6	0.4411	1.1905	1.6316	272.5	1100.2	70
80	312.04	0.01757	5.4536	5.471	282.1	900.9	1183.1	0.4534	1.1675	1.6208	281.9	1102.1	80
90	320.28	0.01766	4.8777	4.895	290.7	894.6	1185.3	0.4643	1.1470	1.6113	290.4	1103.7	90
100	327.82	0.01774	4.4133	4.431	298.5	888.6	1187.2	0.4743	1.1284	1.6027	298.2	1105.2	100
120	341.27	0.01789	3.7097	3.728	312.6	877.8	1190.4	0.4919	1.0960	1.5879	312.2	1107.6	120
140	353.04	0.01803	3.2010	3.219	325.0	868.0	1193.0	0.5071	1.0681	1.5752	324.5	1109.6	140
160	363.55	0.01815	2.8155	2.834	336.1	859.0	1195.1	0.5206	1.0435	1.5641	335.5	1111.2	160
180	373.08	0.01827	2.5129	2.531	346.2	850.7	1196.9	0.5328	1.0215	1.5543	345.6	1112.5	180
200	381.80	0.01839	2.2689	2.287	355.5	842.8	1198.3	0.5438	1.0016	1.5454	354.8	1113.7	200
250	400.97	0.01865	1.8245	1.8432	376.1	825.0	1201.1	0.5679	0.9585	1.5264	375.3	1115.8	250
300	417.35	0.01889	1.5238	1.5427	394.0	808.9	1202.9	0.5882	0.9223	1.5105	392.9	1117.2	300
350	431.73	0.01913	1.3064	1.3255	409.8	794.2	1204.0	0.6058	0.8909	1.4968	408.6	1118.1	350
400	444.60	0.0193	1.14162	1.1610	424.2	780.4	1204.6	0.6217	0.8630	1.4847	422.7	1118.7	400
450	456.28	0.0195	1.01224	1.0318	437.3	767.5	1204.8	0.6360	0.8378	1.4738	435.7	1118.9	450
500	467.01	0.0198	0.90787	0.9276	449.5	755.1	1204.7	0.6490	0.8148	1.4639	447.7	1118.8	500
550	476.94	0.0199	0.82183	0.8418	460.9	743.3	1204.3	0.6611	0.7936	1.4547	458.9	1118.6	550
600	486.20	0.0201	0.74962	0.7698	471.7	732.0	1203.7	0.6723	0.7738	1.4461	469.5	1118.2	600
700	503.08	0.0205	0.63505	0.6556	491.6	710.2	1201.8	0.6928	0.7377	1.4304	488.9	1116.9	700
800	518.21	0.0209	0.54809	0.5690	509.8	689.6	1199.4	0.7111	0.7051	1.4163	506.7	1115.2	800
900	531.95	0.0212	0.47968	0.5009	526.7	669.7	1196.4	0.7279	0.6753	1.4032	523.2	1113.0	900
1000	544.58	0.0216	0.42436	0.4460	542.6	650.4	1192.9	0.7434	0.6476	1.3910	538.6	1110.4	1000
1100	556.28	0.0220	0.37863	0.4006	557.5	631.5	1189.1	0.7578	0.6216	1.3794	553.1	1107.5	1100
1200	567.19	0.0223	0.34013	0.3625	571.9	613.0	1184.8	0.7714	0.5969	1.3683	566.9	1104.3	1200
1300	577.42	0.0227	0.30722	0.3299	585.6	594.6	1180.2	0.7843	0.5733	1.3577	580.1	1100.9	1300
1400	587.07	0.0231	0.27871	0.3018	598.8	576.5	1175.3	0.7966	0.5507	1.3474	592.9	1097.1	1400
1500	596.20	0.0235	0.25372	0.2772	611.7	558.4	1170.1	0.8085	0.5288	1.3373	605.2	1093.1	1500
2000	635.80	0.0257	0.16266	0.1883	672.1	466.2	1138.3	0.8629	0.4256	1.2881	662.6	1068.6	2000
2500	668.11	0.0286	0.10209	0.1307	731.7	361.6	1093.3	0.9139	0.3206	1.2345	718.5	1032.9	2500
3000	695.33	0.0343	0.05073	0.0850	801.8	218.4	1020.3	0.9728	0.1891	1.1619	782.8	973.1	3000
3208.2	705.47	0.0508	0	0.0508	906.0	0	906.0	1.0612	0	1.0612	875.9	875.9	3208.2

TABLE A.3 PROPERTIES OF SATURATED STEAM AND SATURATED WATER (PRESSURE)

Abs press. lb/sq in. (sat. temp)		Temperature, F													
		100	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500
	v	0.0161	392.5	452.3	511.9	571.5	631.1	690.7								
1	h	68.00	1150.2	1195.7	1241.8	1288.6	1336.1	1384.5								
(101.74)	s	0.1295	2.0509	2.1152	2.1722	2.2237	2.2708	2.3144								
	v	0.0161	78.14	90.24	102.24	114.21	126.15	138.08	150.01	161.94	173.86	185.78	197.70	209.62	221.53	233.45
5	h	68.01	1148.6	1194.8	1241.3	1288.2	1335.9	1384.3	1433.6	1483.7	1534.7	1586.7	1639.6	1693.3	1748.0	1803.5
(162.24)	s	0.1295	1.8716	1.9369	1.9943	2.0460	2.0932	2.1369	2.1776	2.2159	2.2521	2.2866	2.3194	2.3509	2.3811	2.4101
	v	0.0161	38.84	44.93	51.03	57.04	63.03	69.00	74.98	80.94	86.91	92.87	98.84	104.80	110.76	116.72
10	h	68.02	1146.6	1193.7	1240.6	1287.8	1335.5	1384.0	1433.4	1483.5	1534.6	1586.6	1639.5	1693.3	1747.9	1803.4
(193.21)	s	0.1295	1.7928	1.8593	1.9173	1.9692	2.0166	2.0603	2.1011	2.1394	2.1757	2.2101	2.2430	2.2744	2.3046	2.3337
	v	0.0161	0.0166	29.899	33.963	37.985	41.986	45.978	49.964	53.946	57.926	61.905	65.882	69.858	73.833	77.807
15	h	68.04	168.09	1192.5	1239.9	1287.3	1335.2	1383.8	1433.2	1483.4	1534.5	1586.5	1639.4	1693.2	1747.8	1803.4
(213.03)	s	0.1295	0.2940	1.8134	1.8720	1.9242	1.9717	2.0155	2.0563	2.0946	2.1309	2.1653	2.1982	2.2297	2.2599	2.2890
	v	0.0161	0.0166	22.356	25.428	28.457	31.466	34.465	37.458	40.447	43.435	46.420	49.405	52.388	55.370	58.352
20	h	68.05	168.11	1191.4	1239.2	1286.9	1334.9	1383.5	1432.9	1483.2	1534.3	1586.3	1639.3	1693.1	1747.8	1803.3
(227.96)	s	0.1295	0.2940	1.7805	1.8397	1.8921	1.9397	1.9836	2.0244	2.0628	2.0991	2.1336	2.1665	2.1979	2.2282	2.2572
	v	0.0161	0.0166	11.036	12.624	14.165	15.685	17.195	18.699	20.199	21.697	23.194	24.689	26.183	27.676	29.168
40	h	68.10	168.15	1186.6	1236.4	1285.0	1333.6	1382.5	1432.1	1482.5	1533.7	1585.8	1638.8	1992.7	1747.5	1803.0
(267.25)	s	0.1295	0.2940	1.6992	1.7608	1.8143	1.8624	1.9065	1.9476	1.9860	2.0224	2.0569	2.0899	2.1224	2.1516	2.1807
	v	0.0161	0.0156	7.257	8.354	9.400	10.425	11.438	12.446	13.450	14.452	15.452	16.450	17.448	18.445	19.441
60	h	68.15	168.20	1181.6	1233.5	1283.2	1332.3	1381.5	1431.3	1481.8	1533.2	1585.3	1638.4	1692.4	1747.1	1802.8
(292.71)	s	0.1295	0.2939	1.6492	1.7134	1.7681	1.8168	1.8612	1.9024	1.9410	1.9774	2.0120	2.0450	2.0765	2.1068	2.1359
	v	0.0161	0.0166	0.0175	6.218	7.018	7.794	8.560	9.319	10.075	10.829	11.581	12.331	13.081	13.829	14.577
80	h	68.21	168.24	269.74	1230.5	1281.3	1330.9	1380.5	1430.5	1481.1	1532.6	1584.9	1638.0	1692.0	1746.8	1802.5
(312.04)	s	0.1295	0.2939	0.4371	1.6790	1.7349	1.7842	1.8289	1.8702	1.9089	1.9454	1.9800	2.0131	2.0446	2.0750	2.1041
	v	0.0161	0.0166	0.0175	4.935	5.588	6.216	6.833	7.443	8.050	8.655	9.258	9.860	10.460	11.060	11.659
100	h	68.26	168.29	269.77	1227.4	1279.3	1329.6	1379.5	1429.7	1480.4	1532.0	1584.4	1637.6	1691.6	1746.5	1802.2
(327.82)	s	0.1295	0.2939	0.4371	1.6516	1.7088	1.7586	1.8036	1.8451	1.8839	1.9205	1.9552	1.9883	2.0199	2.0502	2.0794
	v	0.0161	0.0166	0.0175	4.0786	4.6341	5.1637	5.6831	6.1929	6.7006	7.2060	7.7096	8.2119	8.7130	9.2134	9.7130
120	h	68.31	168.33	269.81	1224.1	1277.4	1328.1	1378.4	1428.8	1479.8	1531.4	1583.9	1637.1	1691.3	1746.2	1802.0
(341.27)	s	0.1295	0.2939	0.4371	1.6286	1.6872	1.7376	1.7829	1.8246	1.8635	1.9001	1.9349	1.9680	1.9996	2.0300	2.0592
	v	0.0161	0.0166	0.0175	3.4651	3.9526	4.4119	4.8585	5.2995	5.7364	6.1709	6.6036	7.0349	7.4652	7.8946	8.3233
140	h	68.37	168.38	269.85	1220.8	1275.3	1326.8	1377.4	1428.0	1479.1	1530.8	1583.4	1636.7	1690.9	1745.9	1801.7
(353.04)	s	0.1295	0.2939	0.4370	1.6085	1.6686	1.7196	1.7652	1.8071	1.8461	1.8829	1.9176	1.9508	1.9825	2.0129	2.0421
	v	0.0161	0.0166	0.0175	3.0060	3.4413	3.8480	4.2420	4.6295	5.0132	5.3945	5.7741	6.1522	6.5293	6.9055	7.2811
160	h	68.42	168.42	269.89	1217.4	1273.3	1325.4	1376.4	1427.2	1478.4	1530.3	1582.9	1636.3	1690.5	1745.6	1801.4
(363.55)	s	0.1294	0.2938	0.4370	1.5906	1.6522	1.7039	1.7499	1.7919	1.8310	1.8678	1.9027	1.9359	1.9676	1.9980	2.0273
	v	0.0161	0.0166	0.0174	2.6474	3.0433	3.4093	3.7621	4.1084	4.4505	4.7907	5.1289	5.4657	5.8014	6.1363	6.4704
180	h	68.47	168.47	269.92	1213.8	1271.2	1324.0	1375.3	1426.3	1477.7	1529.7	1582.4	1635.9	1690.2	1745.3	1801.2
(373.08)	s	0.1294	0.2938	0.4370	1.5743	1.6376	1.6900	1.7362	1.7784	1.8176	1.8545	1.8894	1.9227	1.9545	1.9849	2.0142
	v	0.0161	0.0166	0.0174	2.3598	2.7247	3.0583	3.3783	3.6915	4.0008	4.3077	4.6128	4.9165	5.2191	5.5209	5.8219
200	h	68.52	168.51	269.96	1210.1	1269.0	1322.6	1374.3	1425.5	1477.0	1529.1	1581.9	1635.4	1689.8	1745.0	1800.9
(381.80)	s	0.1294	0.2938	0.4369	1.5593	1.6242	1.6776	1.7239	1.7663	1.8057	1.8426	1.8776	1.9109	1.9427	1.9732	2.0025
	v	0.0161	0.0166	0.0174	0.0186	2.1504	2.4662	2.6872	2.9410	3.1909	3.4382	3.6837	3.9278	4.1709	4.4131	4.6546
250	h	68.65	168.63	270.05	375.10	1263.5	1319.0	1371.6	1423.4	1475.3	1527.6	1580.6	1634.4	1688.9	1744.2	1800.2
(400.97)	s	0.1294	0.2937	0.4368	0.5567	1.5951	1.6502	1.6976	1.7405	1.7801	1.8173	1.8524	1.8858	1.9177	1.9482	1.9776
	v	0.0161	0.0166	0.0174	0.0186	1.7665	2.0044	2.2263	2.4407	2.6509	2.8585	3.0643	3.2688	3.4721	3.6746	3.8764
300	h	68.79	168.74	270.14	375.15	1257.7	1315.2	1368.9	1421.3	1473.6	1526.2	1579.4	1633.3	1688.0	1743.4	1799.6
(417.35)	s	0.1294	0.2937	0.4367	0.5565	1.5703	1.6274	1.6758	1.7192	1.7591	1.7964	1.8317	1.8652	1.8972	1.9278	1.9572
	v	0.0161	0.0166	0.0174	0.0186	1.4913	1.7028	1.8970	2.0832	2.2652	2.4445	2.6219	2.7980	2.9730	3.1471	3.3205
350	h	68.92	168.85	270.24	375.21	1251.5	1311.4	1366.2	1419.2	1471.8	1524.7	1578.2	1632.3	1687.1	1742.6	1798.9
(431.73)	s	0.1293	0.2935	0.4367	0.5564	1.5483	1.6077	1.6571	1.7009	1.7411	1.7787	1.8141	1.8477	1.8798	1.9105	1.9400
	v	0.0161	0.0166	0.0174	0.0186	1.2841	1.4763	1.6490	1.8151	1.9759	2.1339	2.2901	2.4450	2.5987	2.7515	2.9037
400	h	69.05	168.97	270.33	375.27	1245.1	1307.4	1363.4	1417.0	1470.1	1523.3	1576.9	1631.2	1686.2	1741.9	1798.2
(444.60)	s	0.1293	0.2935	0.4366	0.5563	1.5282	1.5901	1.6406	1.6850	1.7255	1.7632	1.7988	1.8325	1.8647	1.8955	1.9250
	v	0.0161	0.0166	0.0174	0.0186	0.9919	1.1584	1.3037	1.4397	1.5708	1.6992	1.8256	1.9507	2.0746	2.1977	2.3200
500	h	69.32	169.19	270.51	375.38	1231.2	1299.1	1357.7	1412.7	1466.6	1520.3	1574.4	1629.1	1684.4	1740.3	1796.9
(467.01)	s	0.1292	0.2934	0.4364	0.5560	1.4921	1.5595	1.6123	1.6578	1.6990	1.7371	1.7730	1.8069	1.8393	1.8702	1.8998

TABLE A.4 PROPERTIES OF SUPERHEATED STEAM AND COMPRESSED WATER (TEMPERATURE AND PRESSURE)

Abs press. lb/sq in (sat. temp)		Temperature, F													
		100	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500
	v	0.0161	0.0166	0.0174	0.0186	0.7944	0.9456	1.0726	1.1892	1.3008	1.4093	1.5160	1.6211	1.7252	1.8284	1.9309
600	h	69.58	169.42	270.70	375.49	1215.9	1290.3	1351.8	1408.3	1463.0	1517.4	1571.9	1627.0	1682.6	1738.8	1795.6
(486.20)	s	0.1292	0.2933	0.4362	0.5657	1.4590	1.5379	1.5844	1.6351	1.6769	1.7155	1.7517	1.7859	1.8184	1.8494	1.8792
	v	0.0161	0.0166	0.0174	0.0186	0.0704	0.7928	0.9072	1.0102	1.1078	1.2023	1.2948	1.3858	1.4757	1.5647	1.6530
700	h	69.04	169.65	270.89	375.61	487.93	1281.0	1345.6	1403.7	1459.4	1514.4	1569.4	1624.8	1680.7	1737.2	1794.3
(503.08)	s	0.1291	0.2932	0.4360	0.5655	0.6809	1.5090	1.5673	1.6154	1.6580	1.6970	1.7335	1.7679	1.8006	1.8318	1.8617
	v	0.0161	0.0166	0.0174	0.0186	0.0704	0.6774	0.7829	0.8759	0.9631	1.0470	1.1289	1.2093	1.2885	1.3669	1.4446
800	h	70.11	169.88	271.07	375.73	487.88	1271.1	1339.2	1399.1	1455.8	1511.4	1566.9	1622.7	1678.9	1735.0	1792.9
(518.2.)	s	0.1290	0.2930	0.4358	0.5652	0.6885	1.4869	1.5484	1.5980	1.6413	1.6807	1.7175	1.7522	1.7851	1.8164	1.8464
	v	0.0161	0.0166	0.0174	0.0186	0.0704	0.5869	0.6858	0.7713	0.8504	0.9262	0.9998	1.0720	1.1430	1.2131	1.2825
900	h	70.37	170.10	271.26	375.84	487.83	1260.6	1332.7	1394.4	1452.2	1508.5	1564.4	1620.6	1677.1	1734.1	1791.6
(531.95)	s	0.1290	0.2929	0.4357	0.5649	0.6881	1.4659	1.5311	1.5822	1.6263	1.6662	1.7033	1.7382	1.7713	1.8028	1.8329
	v	0.0161	0.0166	0.0174	0.0186	0.0704	0.5137	0.6080	0.6875	0.7603	0.8295	0.8966	0.9622	1.0266	1.0901	1.1529
1000	h	70.63	170.33	271.44	375.96	487.79	1249.3	1325.9	1389.6	1448.5	1504.4	1561.9	1618.4	1675.3	1732.5	1790.3
(544.58)	s	0.1289	0.2928	0.4355	0.5647	0.6876	1.4457	1.5149	1.5677	1.6126	1.6530	1.6905	1.7256	1.7589	1.7905	1.8207
	v	0.0161	0.0166	0.0174	0.0185	0.0703	0.4531	0.5440	0.6188	0.6865	0.7505	0.8121	0.8723	0.9313	0.9894	1.0468
1100	h	70.90	170.56	271.63	376.08	487.75	1237.3	1318.8	1384.7	1444.7	1502.4	1559.4	1616.3	1673.5	1731.0	1789.0
(556.28)	s	0.1289	0.2927	0.4353	0.5644	0.6872	1.4259	1.4996	1.5542	1.6000	1.6410	1.6787	1.7141	1.7475	1.7793	1.8097
	v	0.0161	0.0166	0.0174	0.0185	0.0703	0.4016	0.4905	0.5615	0.6250	0.6835	0.7418	0.7974	0.8519	0.9055	0.9584
1200	h	71.16	170.78	271.82	376.20	487.72	1224.2	1311.5	1379.7	1440.9	1499.4	1556.9	1614.2	1671.6	1729.4	1787.6
(567.19)	s	0.1288	0.2926	0.4351	0.5642	0.6868	1.4061	1.4851	1.5415	1.5883	1.6298	1.6679	1.7035	1.7371	1.7691	1.7996
	v	0.0161	0.0166	0.0174	0.0185	0.0703	0.3176	0.4059	0.4712	0.5282	0.5809	0.6311	0.6798	0.7272	0.7737	0.8195
1400	h	71.68	171.24	272.19	376.44	487.65	1194.1	1296.1	1369.3	1433.2	1493.2	1551.8	1609.9	1668.0	1726.3	1785.0
(587.07)	s	0.1287	0.2923	0.4348	0.5636	0.6859	1.3652	1.4575	1.5182	1.5670	1.6096	1.6484	1.6845	1.7185	1.7508	1.7815
	v	0.0161	0.0166	0.0173	0.0185	0.0702	0.0236	0.3415	0.4032	0.4555	0.5031	0.5482	0.5915	0.6336	0.6748	0.7153
1600	h	72.21	171.69	272.57	376.69	487.60	616.77	1279.4	1358.5	1425.2	1486.9	1546.6	1605.6	1664.3	1723.2	1782.3
(604.87)	s	0.1286	0.2921	0.4344	0.5631	0.6851	0.8129	1.4312	1.4968	1.5478	1.5916	1.6312	1.6678	1.7022	1.7344	1.7657
	v	0.0160	0.0165	0.0173	0.0185	0.0702	0.0235	0.2906	0.3500	0.3988	0.4426	0.4836	0.5229	0.5609	0.5980	0.6343
1800	h	72.73	172.15	272.95	376.93	487.56	615.58	1261.1	1347.2	1417.1	1480.6	1541.1	1601.2	1660.7	1720.1	1779.7
(621.02)	s	0.1284	0.2918	0.4341	0.5626	0.6843	0.8109	1.4054	1.4768	1.5302	1.5753	1.6156	1.6528	1.6876	1.7204	1.7516
	v	0.0160	0.0165	0.0173	0.0184	0.0701	0.0233	0.2488	0.3072	0.3534	0.3942	0.4320	0.4680	0.5027	0.5365	0.5695
2000	h	73.26	172.60	273.32	377.19	487.53	614.48	1240.9	1353.4	1408.7	1447.1	1536.2	1596.9	1657.0	1717.0	1777.1
(635.80)	s	0.1283	0.2916	0.4337	0.5621	0.6834	0.8091	1.3794	1.4578	1.5138	1.5603	1.6014	1.6391	1.6743	1.7075	1.7389
	v	0.0160	0.0165	0.0173	0.0184	0.0700	0.0230	0.1681	0.2293	0.2712	0.3068	0.3390	0.3692	0.3980	0.4259	0.4529
2500	h	74.57	173.74	274.27	377.82	487.50	612.08	1176.7	1303.4	1386.7	1457.5	1522.9	1585.9	1647.8	1709.2	1770.4
(668.11)	s	0.1280	0.2910	0.4329	0.5609	0.6815	0.8048	1.3076	1.4129	1.4766	1.5269	1.5703	1.6094	1.6456	1.6796	1.7116
	v	0.0160	0.0165	0.0172	0.0183	0.0700	0.0228	0.0982	0.1759	0.2161	0.2484	0.2770	0.3033	0.3282	0.3522	0.3753
3000	h	75.83	174.88	275.22	378.47	487.52	610.08	1060.5	1267.0	1363.2	1440.2	1500.4	1574.8	1635.5	1701.4	1761.8
(695.33)	s	0.1277	0.2904	0.4320	0.5597	0.6796	0.8009	1.1966	1.3692	1.4429	1.4976	1.5434	1.5841	1.6214	1.6561	1.6888
	v	0.0160	0.0165	0.0172	0.0183	0.0699	0.0227	0.0335	0.1588	0.1987	0.2301	0.2576	0.2827	0.3065	0.3291	0.3510
3200	h	76.4	175.3	275.6	378.7	487.5	609.4	800.8	1250.9	1353.4	1433.1	1503.8	1570.3	1634.8	1698.3	1761.2
(705.08)	s	0.1276	0.2902	0.4317	0.5592	0.6788	0.7994	0.9708	1.3515	1.4300	1.4866	1.5335	1.5749	1.6126	1.6477	1.6806
	v	0.0160	0.0164	0.0172	0.0183	0.0699	0.0225	0.0307	0.1364	0.1764	0.2066	0.2326	0.2563	0.2784	0.2995	0.3199
3500	h	77.2	176.0	276.2	379.1	487.6	608.4	779.4	1224.6	1338.2	1422.2	1495.5	1563.3	1629.2	1693.6	1757.2
	s	0.1274	0.2899	0.4312	0.5585	0.6777	0.7973	0.9508	1.3242	1.4112	1.4709	1.5194	1.5618	1.6002	1.6358	1.6691
	v	0.0159	0.0164	0.0172	0.0182	0.0698	0.0223	0.0287	0.1052	0.1463	0.1752	0.1994	0.2210	0.2411	0.2601	0.2783
4000	h	78.5	177.2	277.1	379.8	487.7	606.5	763.0	1174.3	1311.6	1403.0	1481.3	1552.2	1619.8	1685.7	1750.6
	s	0.1271	0.2893	0.4304	0.5573	0.6760	0.7940	0.9343	1.2754	1.3807	1.4461	1.4976	1.5417	1.5812	1.6177	1.6516
	v	0.0159	0.0164	0.0171	0.0181	0.0696	0.0219	0.0268	0.0591	0.1038	0.1312	0.1529	0.1718	0.1890	0.2050	0.2203
5000	h	81.1	179.5	279.1	381.2	488.1	604.6	746.0	1042.9	1252.9	1364.0	1452.1	1529.1	1600.9	1670.0	1737.4
	s	0.1265	0.2881	0.4287	0.5550	0.6726	0.7880	0.9153	1.1593	1.3207	1.4001	1.4582	1.5061	1.5481	1.5863	1.6216
	v	0.0159	0.0163	0.0170	0.0180	0.0695	0.0216	0.0256	0.0397	0.0757	0.1020	0.1221	0.1391	0.1544	0.1684	0.1817
6000	h	83.7	181.7	281.0	382.7	488.6	602.9	736.1	945.1	1188.8	1323.6	1422.3	1505.9	1582.0	1654.2	1724.0
	s	0.1258	0.2870	0.4271	0.5528	0.6693	0.7826	0.9026	1.0176	1.2615	1.3574	1.4229	1.4745	1.5194	1.5593	1.5962
	v	0.0158	0.0163	0.0170	0.0180	0.0693	0.0213	0.0248	0.0334	0.0573	0.0816	0.1004	0.1160	0.1298	0.1424	0.1542
7000	h	86.2	184.4	283.0	384.2	489.3	601.7	729.3	901.8	1124.9	1281.7	1392.2	1482.6	1563.1	1639.6	1711.1
	s	0.1252	0.2859	0.4256	0.5507	0.6663	0.7777	0.8926	1.0350	1.2055	1.3171	1.3904	1.4486	1.4938	1.5345	1.5725

TABLE A.4 PROPERTIES OF SUPERHEATED STEAM AND COMPRESSED WATER (TEMPERATURE AND PRESSURE) (CONTINUED)

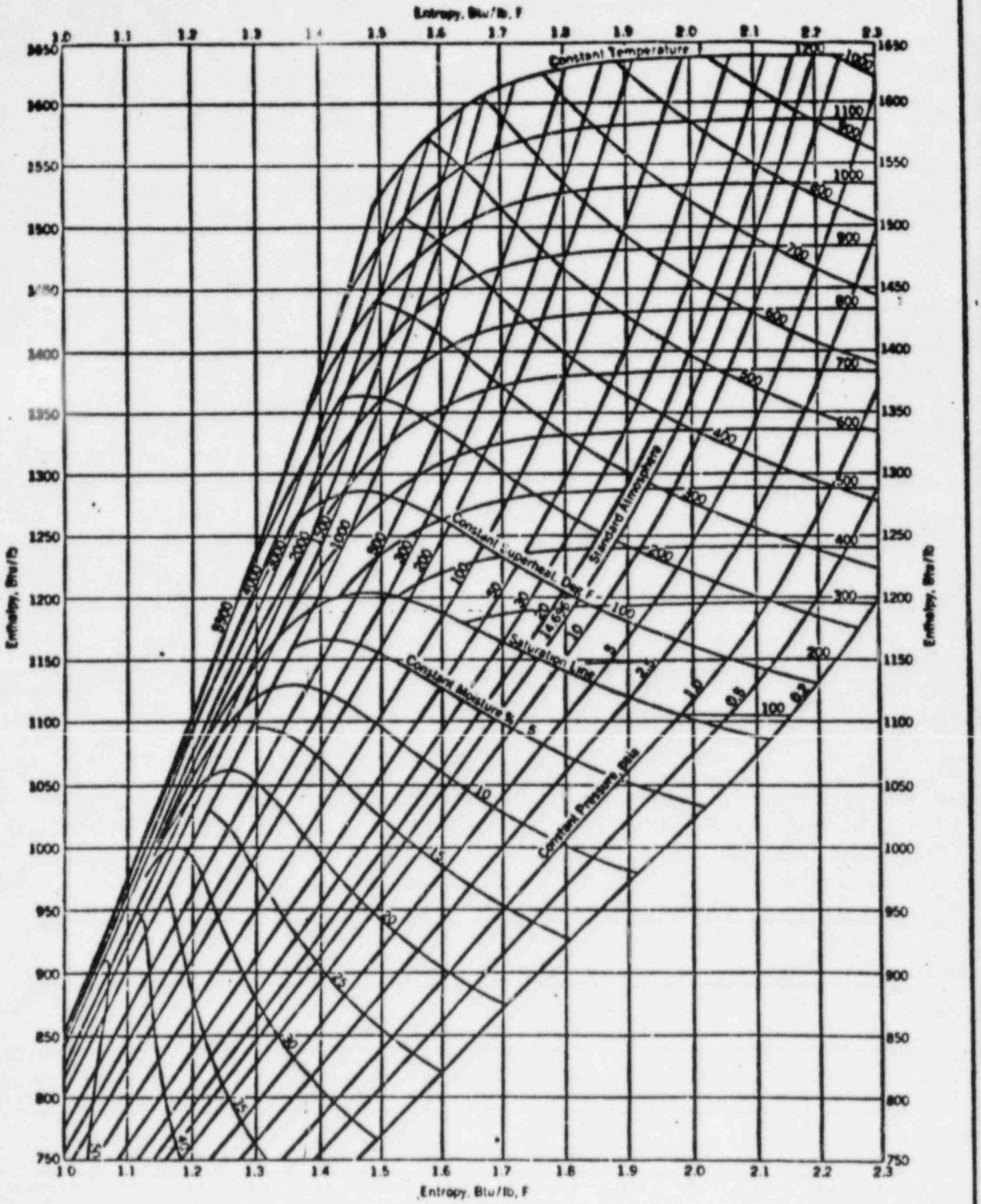

FIGURE A.5 MOLLIER ENTHALPY-ENTROPY DIAGRAM

PROPERTIES OF WATER

Density ρ
(lbs/ft³)

Temp (°F)	Saturated Liquid	PSIA							
		1000	2000	2100	2200	2300	2400	2500	3000
32	62.414	62.637	62.846	62.867	62.888	62.909	62.93	62.951	63.056
50	62.38	62.55	62.75	62.774	62.798	62.822	62.846	62.87	62.99
100	61.989	62.185	62.371	62.390	62.409	62.427	62.446	62.465	62.559
200	60.118	60.314	60.511	60.53	60.549	60.568	60.587	60.606	60.702
300	57.310	57.537	57.767	57.79	57.813	57.836	57.859	57.882	57.998
400	53.651	53.903	54.218	54.249	54.28	54.311	54.342	54.373	54.529
410	53.248	53.475	53.79	53.825	53.86	53.89	53.925	53.95	54.11
420	52.798	53.025	53.36	53.40	53.425	53.46	53.50	53.53	53.69
430	52.356	52.575	52.925	52.95	52.99	53.02	53.065	53.09	53.265
440	51.921	52.125	52.42	52.45	52.475	52.51	52.54	52.56	52.275
450	51.546	51.66	52.025	52.065	52.10	52.14	52.175	52.21	52.41
460	51.020	51.175	51.56	51.61	51.64	51.68	51.725	51.76	51.96
470	50.505	50.70	51.1	51.14	51.175	51.22	51.25	51.30	51.50
480	50.00	50.20	50.62	50.66	50.7	50.74	50.78	50.825	51.035
490	49.505	49.685	50.13	50.175	50.22	50.265	50.31	50.35	50.575
500	48.943	49.097	49.618	49.666	49.714	49.762	49.81	49.858	50.098
510	48.31	48.51	49.05	49.101	49.152	49.203	49.254	49.305	49.56
520	47.85	47.91	48.46	48.515	48.57	48.625	48.68	48.735	49.01
530	47.17	47.29	47.86	47.919	47.978	48.037	48.096	48.155	48.45
540	46.51		47.23	47.296	47.362	47.428	47.494	47.56	47.89
550	45.87		46.59	46.658	46.726	46.794	46.862	46.93	47.27
560	45.25		45.92	45.994	46.068	46.142	46.216	46.29	46.66
570	44.64		45.22	45.30	45.38	45.46	45.54	45.62	46.02
580	43.86		44.50	44.586	44.672	44.758	44.844	44.93	45.36
590	43.10		43.73	43.825	43.92	44.015	44.11	44.205	44.68
600	42.321		42.913	43.017	43.122	43.226	43.33	43.434	43.956
610	41.49		41.96	42.08	42.196	42.314	42.432	42.55	43.14
620	40.552		40.950	41.083	41.217	41.35	41.483	41.616	42.283
630	39.53								41.44
640	38.491								40.388
650	37.31								39.26
660	36.01								38.008
670	34.48								36.52
680	32.744								34.698
690	30.516								32.144

TABLE A.6 PROPERTIES OF WATER, DENSITY

ANSWERS -- SEQUOYAH 1&2 -86/05/26-D.J. NELSON

ANSWER 1.01 (1.00)

a

REFERENCE
SQN/WBN Nuclear theory

ANSWER 1.02 (1.00)

b.

REFERENCE
SQN/WBN HTFF Chap. 2E

ANSWER 1.03 (1.00)

a.

REFERENCE
SQN/WBN HTFF

ANSWER 1.04 (1.00)

b.

REFERENCE
SQN/WBN thermo

ANSWER 1.05 (1.00)

c.

REFERENCE
steam tables

ANSWERS -- SEQUOYAH 1&2 -86/05/26-D.J. NELSON

ANSWER 1.06 (1.00)

c

REFERENCE
EIH: GPNT,Vol VII, Chapter 10.1-83-86
BSEP: L/P 02-2/3-A, pp 172 - 176; 02-OG-A, pp 57 - 60
Westinghouse Nuclear Reactor Theory, pp. I-5.77 - 79
Turkey Point, Reactor Core Control, pp. 4-24 - 28

001/000-K5.13 (3.7/4.0)

ANSWER 1.07 (3.00)

	AFFECTED LOOP	+	UNAFFECTED LOOP	
a.	decreases	+	increases	[0.5] each
b.	decreases	+	increases	[0.5] each
c.	decreases	+	increases	[0.5] each

→ OT remains the same

REFERENCE
SQN/WBN HTFF/Nuclear theory

ANSWER 1.08 (1.50)

a. increasing [0.5]
b. decreasing [0.5]
c. decreasing [0.5]

REFERENCE
SQN/WBN Nuclear theory

ANSWER 1.09 (1.50)

a. Less negative (0.5)
b. Less negative (0.5)
c. Less negative (0.5)

REFERENCE
Turkey Point, Reactor Core Control, Chapter 5, Fig. SNP-RF-9

004/000; K5.06(3.0/3.3)

ANSWERS -- SEQUOYAH 1&2 -86/05/26-D.J. NELSON

ANSWER 1.10 (1.00)

a. true [0.5]
b. true [0.5]

REFERENCE
Nuclear theory, Inst. Notes VI

ANSWER 1.11 (1.00)

a. FALSE [0.5]

b. reference leg draining
voids in reference leg
elevated reference leg temperature

(two required) [0.25] each

REFERENCE
SQN/WBN SD

ANSWER 1.12 (2.00)

a. Decrease (+.5 ea)
b. Increase
c. Increase
d. Increase

REFERENCE
NUS, Nuclear Energy Trng.- Reactor Op., pp. 9.2-5, 11.3-2, 11.4-3

ANSWER 1.13 (.50)

a. FALSE

REFERENCE
SQN/WBN Nuclear Theory Inst. Notes

ANSWERS -- SEQUOYAH 1&2 -86/05/26-D.J. NELSON

ANSWER 1.14 (1.00)

-Minimizes thermal stress due to more uniform temp difference of fluids
-The outlet temp of the colder fluid approaches the inlet temp of the hotter fluid
-A more uniform heat transfer rate is achieved throughout the heat exchanger (+.33 ea)
(more efficient is an acceptable response also)

REFERENCE
CNTO, "Thermal/Hydraulic Principles and Applications", pp 5-10

004/020; K5.02(2.5/2.9)

ANSWER 1.15 (1.50)

a. increases due to decreasing Tave [.5]
b. increases due to decreasing Tave [.5]
c. decreases due to decreasing Tave and increasing boron concentration [.5]

REFERENCE
SQN/WBN Nuclear theory

ANSWER 1.16 (1.00)

Delta I becomes more positive due to the increase of neutron flux in the top of the core relative to the bottom.

REFERENCE
SQN/WBN Nuclear theory

ANSWER 1.17 (1.00)

Lower flow at the same power level results in a larger delta T; CHF decreases toward the top of the core. Lower coolant velocities result in less stripping action which removes nucleate bubbles, a steam film can form at lower heat flux.

REFERENCE
SQN/WBN HTFF

ANSWERS -- SEQUOYAH 1&2 -86/05/26-D.J. NELSON

ANSWER 1.18 (.50)

Margin to criticality decreases [0.1] by 2/3 [0.4].

REFERENCE
SQN/WBN Neutron Sources and Subcrit. Mult.

ANSWER 1.19 (1.00)

Since samarium is a stable isotope both the production rate and removal rate are proportional to power level.

REFERENCE
West. Nuc. Trng. Ops., p.I-5.77

ANSWER 1.20 (3.00)

(three req'd)
1. Delta T across the core [0.5]: constant/decreasing [0.4] and less than 55°F [0.1]
~~full load delta T:[0.1]~~
2. Core outlet temp.[0.5]: constant/decreasing[0.5]
3. Tcold = Tsat for S/G Pressure[0.5]; constant or decreasing [0.5]
4. SG pressure [0.5]: decreasing [0.5]
5. Thot [0.5]; constant or decreasing [0.5]

REFERENCE
WTS; Ch. 14, p. 27; AOI 35

ANSWER 1.21 (1.00)

In a small LOCA core heat is not being removed sufficiently by the break and little ECCS flow is being delivered due to elevated RCS pressure.

REFERENCE
SQN/WBN SD; Aux Feed Sys; p. 8.f8

ANSWERS -- SEQUOYAH 1&2 -86/05/26-D.J. NELSON

ANSWER 1.22 (1.50)

Q=mcDelta T(+.5) .02/.8=(m/100)(40/48) (+.5) >>> m= 6/200 x 100%= 3%(+.5)

REFERENCE
SQN/WBN HTFF

ANSWER 1.23 (2.00)

Tave: 30.4 X 0.25 X -15 = -114 pcm
Power: 25 X -12 = -300 pcm
Void: -25 pcm
Xenon: -50 pcm
total: -489 pcm
Boron: -489 / -9 = 54.3 ppm dilution (accept 52 to 56)

REFERENCE
SQN/WBN Nuclear theory

ANSWERS -- SEQUOYAH 1&2 -86/05/26-D.J. NELSON

ANSWER 2.01 (1.00)

b.

REFERENCE
SQN/WBN SD; RCS; CVCS
West. PWR Sys. Manual

ANSWER 2.02 (1.00)

a

REFERENCE
10CFR50.46

ANSWER 2.03 (1.00)

a.

REFERENCE
SQN SD; RPS

ANSWER 2.04 (1.00)

a. reversed
b. normal

REFERENCE
West. PWR Sys. Manual / SQN/WBN HTFF

ANSWER 2.05 (1.00)

b.

REFERENCE
System Manual, Chapter 3, pp 4, 10
SQNP System Descriptions, CVCS

ANSWERS -- SEQUOYAH 1&2 -86/05/26-D.J. NELSON

ANSWER 2.06 (1.00)

b.

REFERENCE
SQNP Diesels handout, p. 6.

ANSWER 2.07 (.50)

30 minutes

REFERENCE
Review of Elec. Distribution Lesson, p 10.

ANSWER 2.08 (1.00)

c.

REFERENCE
System Manual, Chapter 4, p. 4.0-2

ANSWER 2.09 (.50)

True.

REFERENCE
Reactor Protection Lesson, p. 8 of 13, item d.

ANSWER 2.10 (1.00)

cold; last pump

REFERENCE
SQN/WBN HTFF

ANSWERS -- SEQUOYAH 1&2 -86/05/26-D.J. NELSON

ANSWER 2.11 ~~2.00~~ 1.80

a. CLOSE
b. CLOSE
c. OPEN
d. CLOSE
e. NO
f. ~~OPEN~~ part f deleted
g CLOSE
h. NO
i. NO
j. ~~NO~~ CLOSE [0.2 ea.]

REFERENCE
SQNP System Description, ECCS, CVCS, MNSTM, CCW

ANSWER 2.12 (1.00)

Solenoid Air; open; 33%; 500 [+.25 ea]
& air

REFERENCE
Aux Feed Lesson Plan, p. 5 of 8.

ANSWER 2.13 (1.00)

1. RHR suction (+.25 ea up to 1.0)
2. RHR discharge
3. SI pump suction
4. SI pump discharge
5. letdown orifice relief valve
also RCP seal water return reliefs

REFERENCE
SQN/WBN Inst. Notes; RCS

ANSWERS -- SEQUOYAH 1&2 -86/05/26-D.J. NELSON

ANSWER 2.14 (2.00)

Containment sump level and flow monitoring.
Containment upper and lower radiation monitoring.
Containment temperature.
Containment humidity.
Containment pressure.
Pressurizer level and pressure.
Volume control tank makeup.

also condenser vacuum exhausts, charging flow, others as appropriate

(eight required-[0.25 each])

REFERENCE
SQN/WBN SD; RCS,CVCS,Cont.

ANSWER 2.15 (2.00)

1. Manual emergency borate valve to blender.
2. Emergency borate valve in main control room.
3. Normal boration path to charging pump suction.
4. Divert charging pump suction from VCT to RWST.
5. Align the charging pumps to inject the SIT by openning the motor operated inlet and outlet valves.

four required

REFERENCE
SQN/WBN SD; CVCS

ANSWER 2.16 (1.00)

c,f,e,b,d,a

b can be used first, also; however if used first, f must be used last i.e. b,c,f,e,b,d,a,f

REFERENCE
West. PWR Sys. Manual

ANSWER 2.17 (1.50)

Summing Unit, Rate Comparator and Variable Gain Unit (+.5 ea)

REFERENCE
SQNP Rod Control Lesson, pp 5 & 6 of 11.
Systems Manual, Chapter 11.1, p. 11.1-63.

ANSWERS -- SEQUOYAH 1&2 -86/05/26-D.J. NELSON

ANSWER 2.18 (1.50)

Lo-Lo level in 2/4 S/Gs (+.3 ea)
SIS
Loss of both MFP
Loss of one MFP > 80% power
LOSP

REFERENCE
Aux. Feed Lesson Plan, pp 4-6.

ANSWER 2.19 (1.00)

When there is low flow due to low RCS pressure (+.3), this will increase the flow to improve the cooling for the pump lower bearing (+.7)

REFERENCE
West. PWR Sys. Manual
SQN Lesson Plan "RCS", pp 22

ANSWER 2.20 (1.00)

Each individual detector(both upper and lower) (+.5) is compared to the average of the sum of the upper (or lower) detectors (+.5)

ANSWER 2.21 (1.00)

PZR continuous spray flow will equilize the boron concentration.

REFERENCE
SQN/WBN SD; RCS

ANSWER 2.22 (1.00)

a. loop 4 hot leg
b. either the relief valve downstream of the letdown orifices if it is unisolated, PORV on the PZR, or RHR suction reliefs.

REFERENCE
SQN Inst. Notes; RHR

ANSWERS -- SEQUOYAH 1&2 -86/05/26-D.J. NELSON

ANSWER 2.23 (1.00)

Used during cooldown because the steam space detector response is poor due to poor heat transfer.

REFERENCE
SQN/WBN Inst. Notes; RCS

ANSWER 2.24 (1.50)

a. lithium
b. hydrazine
c. hydrogen

REFERENCE
SQN/WBN Inst. Notes; RCS, CVCS

ANSWER 2.25 (2.50)

1. a. air [0.5]
   b. spring and steam pressure [0.5]
2. Air accumulator [0.5]
3. High steam flow with low steam pressure or low low Tave. [0.5]
   Phase B isolation ; hi cont. press. [0.5]

REFERENCE
SQN/WBN SD; MS

ANSWERS -- SEQUOYAH 1&2 -86/05/26-D.J. NELSON

ANSWER 3.01 (1.00)

a

REFERENCE
SQNP System Descrip. "RPS", pp 10 & RPS Mechanical Logic Drawing 012/000; K6.03 (3.1/3.5)

ANSWER 3.02 (2.50)

a. higner
b. as is
c. higher
d. lower
e. higher

ANSWER 3.03 (1.50)

a.

	OP Delta-T	OT Delta-T	
1.	no change	decreases	
2.	no change	decreases	
3.	no change	decreases	[0.25 each] (1.5)

REFERENCE
Sequoyah Tcchnical Specifications p 2-7 - 2-10, B2-4,5.

ANSWER 3.04 (3.00)

a. 1,3
b. 1,3
c. 1,3
d. 1,3
e. 1
f. 1,2,3,4
g. 1
h. 5

[0.2] each of 15 responses

REFERENCE
West. PWR Sys. Manual, 11.1

ANSWERS -- SEQUOYAH 1&2 -86/05/26-D.J. NELSON

ANSWER 3.05 (1.00)

a) Load rejection controller (C-7; rate). [0.5]

b) Provides a blocking signal for 9 valves during cooldown below the low-low Tave setpoint (i.e. uncontrolled cooldown). [0.5]

REFERENCE
Instructor Notes; Steam Dump Control System.

ANSWER 3.06 (2.00)

a. high pressurizer level (letdown isolates)
b. low pressurizer pressure (rods drive Tave and PZR level down)
[1.0] each

REFERENCE
Channel Failure Handout; TAB A&C: 3,4-11

ANSWER 3.07 (3.00)

a. 1. High-high level (75%) in any S/G (P-14).
2. SIS.
3. Rx trip with low Tavg (554-F). [0.33 each] (1.0)

b. (Both MFP's trip) MFRV's and bypass valves close; MFW isolation valves close. (condensate system recirc's to condenser) (1.0)

c. Condensate booster pump (selected for P-auto) starts. (0.5)
(Because the suction valve opens)

d. 100 psid decreasing; between No. 2 heater shell and MFP suction. (0.5)

REFERENCE
Sequoyah System Description, Section 8, p 6,10; Annunciator Response Vol I, tab 5, p 29.

ANSWERS -- SEQUOYAH 1&2 -86/05/26-D.J. NELSON

ANSWER 3.08 (1.75)

Permissives- 6, 10, 11, 12 are manually initiated (+.25 EA)
Permissives 7, 8, 9 are automatic

REFERENCE

PLS; pp 7-8.

ANSWER 3.09 (2.00)

1. two percent radial flux tilt
2. improper rod sequence
3. shutdown bank rods less than 220 steps
4. rods within a bank greater than 12 steps from the bank demand
5. rods greater than 12 steps from each other within a bank

dropped rod accepted if in place of # 4 or 5.

REFERENCE
SQN, SOI-55-1M4, XA-55-4B, p 25

ANSWER 3.10 (3.00)

1. anticipated overspeed [0.5]; governor and intercept valves [0.5]
2. overspeed [0.5]; governor and intercept valves [0.5]
3. partial unloading protection [0.5]; intercept valves [0.5]

REFERENCE
SQN Inst. Notes; Turbine Control, p.5

ANSWER 3.11 (1.75)

A. 1. Over Temp delta T
   2. Over Pwr delta T
   3. Low Tave intlk.
   4. Low-low Tave intlk.

B. 1. Rod Control
   2. Steam Dump Control
   3. Pzr Level Control [0.25] each

REFERENCE
SNP Exam Bank; 3-6.

ANSWERS -- SEQUOYAH 1&2 -86/05/26-D.J. NELSON

ANSWER 3.12 (2.50)

decreasing: 2335 PORV closes (+.05 for setpoint, +.2 function)
2310 sprays start closing
2260 sprays closed
2250 variable heaters start to come on
2220 variable heaters full on
2210 low pressure alarm, backup heaters on
2210 Backup heaters on
1970 Low pressure SI block enabled
1970 Low pressure reactor trip
1870 Low pressure SI

REFERENCE
SQN SD; RCS,RPS

ANSWER 3.13 (1.00)

To ensure the regenerative heat exchanger always has RCS system pressure in it to prevent flashing of high temperature water.

REFERENCE
SQN/WBN SD; CVCS

ANSWER 3.14 (1.00)

Turbine runback[0.5] to ~~85%~~[0.5]. ≥75% accept 70→80%

REFERENCE

SOI-5.1 & 6.1; p7.

ANSWER 3.15 (1.00)

Interlock to prevent openning of RHR when RCS pressure > 380 psig.

REFERENCE
SQN/WBN Inst. Notes; RCS

and/or auto shut when > 700 psig.

accepted also: Cold overpressure protection input.

ANSWERS -- SEQUOYAH 1&2 -86/05/26-D.J. NELSON

ANSWER 3.16 (2.00)

a) Surge tank vent valve shu's (+.5 ea)
b) B/D diverted to Con DI
c) Containment Ventilation Isolation
d) Aux Bldg isolation and Aux Bldg emerg gas treatment starts

REFERENCE
Systems Manual; Radiation Monitoring, pp 2-25.

ANSWERS -- SEQUOYAH 1&2 -86/05/26-D.J. NELSON

ANSWER 4.01 (1.00)

d.

REFERENCE
SQNP E-0 pp. 2 - 5

ANSWER 4.02 (1.00)

b.

REFERENCE
SQNP GOI-2, pg. 1

ANSWER 4.03 (1.00)

a.

REFERENCE
SQNP SOI-62.1B, pp. 8, 9

ANSWER 4.04 (1.00)

a.

REFERENCE
SQNP AOI-2D, pp. 10 - 12

ANSWER 4.05 (1.00)

~~b.~~ c.

REFERENCE
SQNP AOI-3D, p. 1 of 2

ANSWERS -- SEQUOYAH 1&2 -86/05/26-D.J. NELSON

ANSWER 4.06 (1.00)

b

REFERENCE
SQNP GOI-2, p. 16

ANSWER 4.07 (1.50)

Reactor Coolant Loop Tref-Tauct Hi-Lo (+.25 ea up to six)
PZR Level High, Backup Heaters On
Reactor Coolant Loop Tavg/Tauct deviation High-Low
Rod Withdrawal Stop due to OPDeltaT
" " " " " OPDeltaP
" " " " " High Flux at 103%
" " " " " C-5(15% impulse power)
" " " " " IR Instrument (20%)
other alarms as appropriate

REFERENCE
AOI-2A, p2

ANSWER 4.08 (1.00)

To prevent ESF actuation (+.7) on lo-lo S/G level (+.3)
a Rx trip

REFERENCE
SQNP GOI-1, p. 4; precaution T.

ANSWER 4.09 (1.00)

a. TRUE

b. FALSE.

REFERENCE
SQNP ES-1.3 p. 1 of 4; ES-1.2 p. 1 of 3, App. A

ANSWERS -- SEQUOYAH 1&2 -86/05/26-D.J. NELSON

ANSWER 4.10 (2.00)

a. False. (+.5 ea)
b. True.
c. True.
d. True.

REFERENCE
SQNP GOI-5A, pp 2 & 3

ANSWER 4.11 (2.50)

a. 4
b. 1
c. 5
d. 2
e. 1 [0.5] each

REFERENCE
SQN, GOI-5A, p 5-9

ANSWER 4.12 (1.00)

PZR level(+.35) < 20 % (+.1)
< 50 % adverse containment (+.1)
RCS Subcooling (+.35) < 40 degrees F (+.1)

REFERENCE
SQNP ES-0.2, pp 3, 4

ANSWER 4.13 (1.00)

a) 3 Rem (+.33 ea)
b) 18.75 Rem
c) 300 Mrem

REFERENCE
SQN RCI-1, pp 7

ANSWERS -- SEQUOYAH 1&2 -86/05/26-D.J. NELSON

ANSWER 4.14 (2.00)

1. Verify Reactor Trip.
2. Verify Turbine Trip.
3. Verify Shutdown Boards Energized.
4. Check if SI Actuated.
5. Verify ECCS status.
6. Verify Cntmt. Isolation.
7. Verify MFW Isolation.
8. Verify AFW status.
9. Verify CCS Pumps Running.
10. Verify ERCW Pumps Running.
11. Verify EGTS and ABGTS Running.
12. Check Cntmt. press less than 2.81 psig.
13. Check Tavg.

REFERENCE
SQNP E-0, pp 2-5

ANSWER 4.15 (1.00)

1. Rod control in manual (or individual bank select) and restore Tave.
2. If unable to stop rod insertion, trip reactor.

[0.5] each

REFERENCE
SQN.AOI-28, p 1

ANSWER 4.16 (1.00)

a. to prevent thermal lock up.
b. to prevent bank overlap malfunction.

REFERENCE
SQN, GOI-1, p 3,4

ANSWERS -- SEQUOYAH 1&2 -86/05/26-D.J. NELSON

ANSWER 4.17 (2.00)

A. Be in Hot Standby within one hour. (1.0)

B. Reduce RCS pressure to less than 2735 psig within 5 minutes. (1.0)

REFERENCE
TS, p 2-1.

ANSWER 4.18 question deleted (2.00)

a. Normal readings on containment temperature, pressure, radiation, and sump level. [0.5]
Normal readings on Aux building radiation and ventilation monitoring. [0.25]
Normal readings on Steam Generator blowdown and vacuum pump exhaust radiation. [0.25]

b. Due to the low RCS temreratures and pressures following a loss of secondary coolant (with the RCS intact), SI repressurization could lead to RCS overpressurization and damage. (PTS) [1.0]

deleted

REFERENCE
SQN EOP-2, p.5; EOP-1 p.4; EOP-0, p.7

ANSWER 4.19 (3.50)

a. power mismatch circuit [0.5]; auct. nuclear power goes high causing a large P-ref/nuclear power mismatch ~~and rods drive in at the maximum rate~~ [1.0]

b. 1. overpower rod stop
2. power mismatch (for rod control)
3. upper detector current comparator
4. lower detector current comparator
5. comparator channel defeat
6. nuclear flux bistables (remove control power fuses)
4 req'd [0.5] each

REFERENCE
SQN AOI-4D

ANSWERS -- SEQUOYAH 1&2 -86/05/26-D.J. NELSON

ANSWER 4.20 (1.00)

a. ~~More than four incore T/C's greater than or equal to 1200 F, or~~

b. ~~Hot leg RTD's pegged high (700 F)~~

a. Core exit most T/C >1200 (1.0)

b. Subcooling < 40° with > 700° core exit

REFERENCE

~~EOI 1; App. D, p 1~~

CSF Status Tree

ANSWER 4.21 (1.50)

See attached curves for grading criteria

REFERENCE

SQN Tech. Specs.

Revision 23

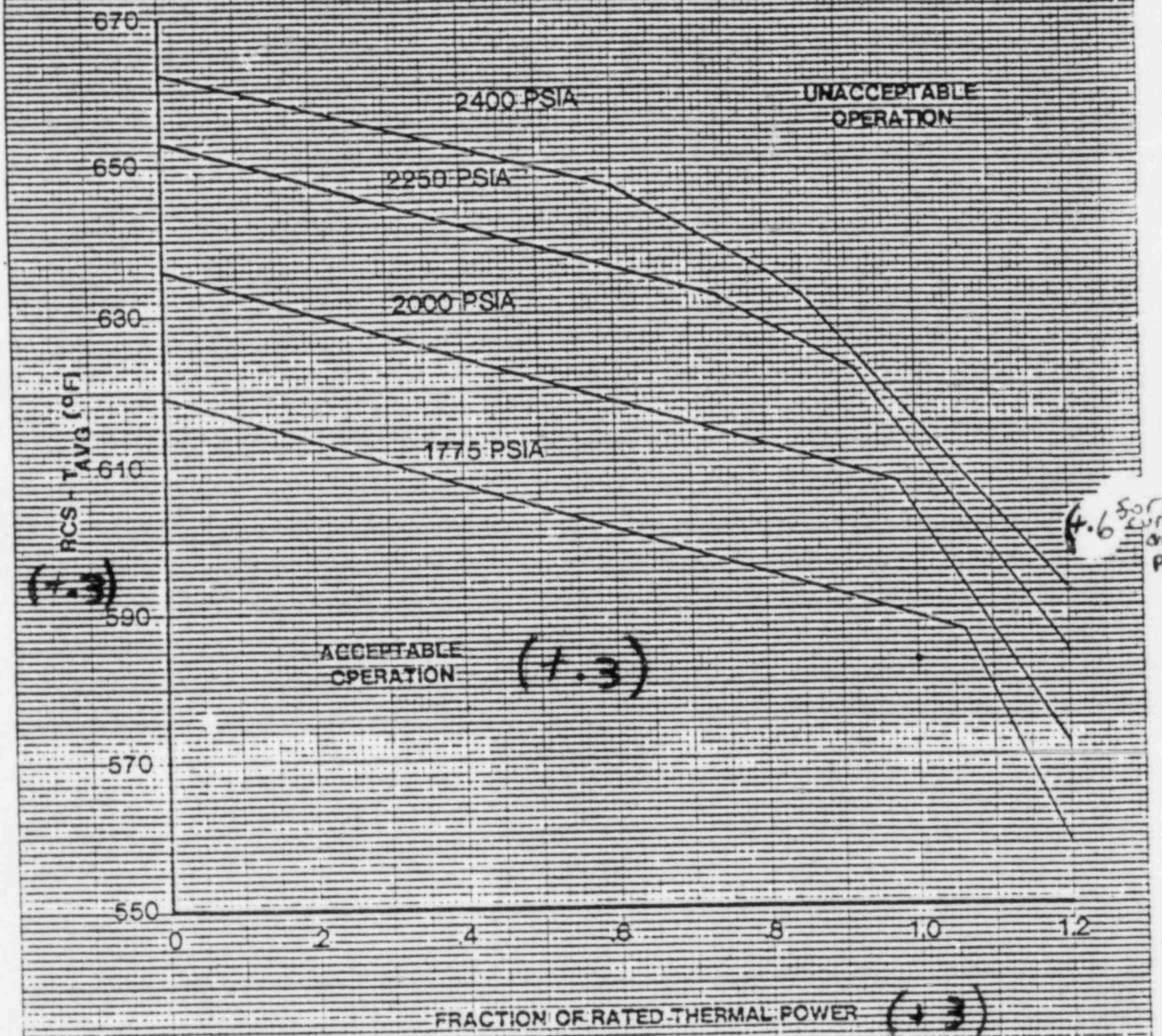

Figure 2.1-1. Reactor Core Safety Limit - Four Loops in Operation