ENCLOSURE 1

EXAMINATION REPORT - 50-327/OL-85-02

Facility Licensee: Tennessee Valley Authority
6N11 B Missionary Ridge Place
1101 Market Street
Chattanooga, TN 37402-2801

Facility Name: Sequoyah Nuclear Plant

Facility Docket No. 50-327

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

Chief Examiner: William A. Dean — William A. Dean — 1/16/86 — Date Signed

Approved by: Bruce A. Wilson — Bruce A. Wilson, Section Chief — 1/16/86 — Date Signed


Summary:

Examinations on November 12-15, 1985

A written examination was administered to one reactor operator candidate who did not pass. Complete examinations were administered to four reactor operator candidates and three senior reactor operator candidates. Two reactor operator candidates and two senior reactor operator candidates passed all portions of the exam. One reactor operator candidate did not pass the oral and written examinations and the remaining two candidates did not pass the written examination.

## REPORT DETAILS

1. Facility Employees Contacted:

   *R. J. Johnson, Nuclear Training Branch
   *C. M. Noble, Superintendent (Operations and Engineering)
   *C. T. Benton, Unit Supervisor
   *L. C. Bush, Assistant Operations Supervisor
   *J. M. Anthony, Operations Supervisor
   *C. H. Noe, Nuclear Training Branch
   *B. C. Lake, Training
   *C. O. Brewer, Simulator Section Supervisor
   *E. Keyser, TVA Senior Engineer

   *Attended Exit Meeting

2. Examiners:

   *William M. Dean (did not attend exit meeting)
   Lawrence L. Lawyer (Acting Chief Examiner Onsite)
   William A. Douglas

   *Chief Examiner

3. Examination Review Meeting

   At the end of the examination week, the facility provided comments regarding the written examinations and answer keys. These are included as an attachment to this report. The NRC resolutions below refer to each question commented on by the facility.

   NRC Written Examination, Comment Resolutions

   a. RO Exam

      (1) Question 1.09: Accept 'radiation' or 'convection' for part (b)

      (2) Question 2.03: Misprint resulted in incorrect answer on the key. (b) is the correct answer.

      (3) Question 2.12: Accept "Train A" and "Train B" as alternate answers for the first two responses.

      (4) Question 3.16: Delta T will be deleted as a required answer.

      (5) Question 4.02: Material provided to the examiners did not list inventory as a monitored CSF. Question will be deleted.

(6) Question 4.15: Knowledge of evacuation sites and operations personnel assembly points is considered to be basic elements of emergency plans of which reactor operators should be cognizant. Question stands.

b. SRO Exam (Applicable RO Exam Questions are in Parenthesis)

(7) Question 5.09(1.12): Question does not refer to Pressurized Thermal Shock, but conditions required to cause brittle fracture in a metal. Flexibility in grading the answers will be utilized, as long as the three criteria in the key are present in acceptable form.

(8) Question 5.10(1.13): The additional training material provided the NRC after the examination does not change the ordering of isotopes in terms of relative importance. A wider range of % of contribution (47-57% -U235, 36-46% -Pu239) will be accepted.

(9) Question 5.15: The term "precursors" was not intended to be part of the question. This makes the question ambiguous with no easily defined response. It will be deleted.

(10) Question 5.16(1.18): The referenced information in the facility training material does not coincide with information on actual plant performance. Answer key will be modified to identify the decrease in boron concentration due to fuel burnout as the overriding factor.

(11) Question 5.21: Facility made no recommendation regarding the disposition of this question or references supporting their comment. Question stands.

(12) Question 5.22(1.21): For the conditions given in the question, it would take an extraordinary situation to achieve a situation where Tc, Th and Tavg are equal. This question was also examining candidates' knowledge of programmed temperature. Answer key stands.

(13) Question 6.02(3.03): Due to erroneous material provided by the facility to the NRC, both (a) and (b) will be accepted as correct answers.

| | |
|---|---|
| (14) Question 6.06(3.09): | As the question asked for "engine shutdown troubles" and the overcurrent relay only trips the feeder breaker, it will not be required as part of the answer. Note that material provided by the facility to the NRC listed "overcurrent relay" as an engine shutdown trouble bypassed on an emergency start. Material provided subsequent to the exam contradicted this. |
| (15) Question 6.07: | The diffuser pond is in the facility controlled area, and does not adequately fit within a reasonable description of the "environment". Answer key will remain as is. |
| (16) Question 6.08(2.09): | The answer for (a) will be changed to reflect recent Tech Spec change and the answer for (b) will be expanded to allow steam leakage causing valve damage as an alternate answer. |
| (17) Question 6.09: | The body of the question clearly states "crane" giving the candidate a significant clue as to which interlocked device is in question. The answer key will stand as is. |
| (18) Question 6.12(2.13): | In the situation described in the body of the question, the containment spray system operates in a recirculation path through the containment. Answer key stands as is. |
| (19) Question 6.13: | SIS is not an appropriate answer. Partial credit will be given to Aux. Bldg. Isol. signals. Will include the high temperature in the ventilation supply as an additional required answer, using the same total point value. |
| (20) Question 6.14(2.15): | Reference material supplied by the facility listed condensate recirc as an automatic action. Based on post-exam material brought to the NRC's attention, this answer will not be required, and the question point value will be decreased by .25. |

(21) Question 6.17: The answer key will be modified to reflect "prevention" of automatic transfer.

(22) Question 6.22(3.20): Only a Failure High Channel I will cause all the events listed and in the sequence given. Answer key stands as is.

(23) Question 7.06(4.07): Based on minimal interaction of facility operators with this aspect of health physics; question will be deleted.

(24) Question 7.09(4.11)(c): Answer key will be changed to reflect change that was not included in material sent to the NRC.

(25) Question 7.14(a): The answer key covers all components "sequentially loaded" and will remain unchanged.

(26) Question 7.15: Answer key will be modified to not require memorization of surveillance required. Answers will be evaluated for adequate coverage of required personnel and other facility notifications.

(27) Question 7.20(4.23): The question asks for those parameters monitored for "cooldown" not natural circulation. The parameters listed in the answer key are required for full credit per SQN-ES.0.3. Additional natural circulation parameters will not result in any penalties to the candidate.

(28) Question 7.23(4.25): SQNP-AOI-2 is very specific about steam dumps being put in Tavg Mode after rods are in Auto. There is some flexibility in the time of occurrence of the subsequent steps regarding 6.9 Kv Unit Board. Transfer and putting feed reg valve in Auto so sequence 4, 3, 2, 1 will also be accepted.

(29) Question 8.03: Misprint in the answer key. (b) is the correct answer.

(30) Question 8.07(a): Agree, "Yes" is the correct answer.

(31) Question 8.08(a)&(b): Question may not be clear in its intent to elicit only those trips which provide protection according to accident analysis. Will also accept answer "5" for (a) and "1" for (b).

(32) Question 8.18: A broader answer will be accepted as long as "personal hazards" and "incapacitating equipment electrically" are discussed.

(33) Question 8.19: The facility supplied PLS manual should either be updated to match other facility instructions and precautions, or eliminated as a source of information due to the multitude of contradictions contained within the PLS. Answer key will be modified to change (a) to ±15 psig and (c) to ±3°F.

(34) Question 8.23: Both NUREG-1021 and 10 CFR 55.22 require senior reactor operators to be examined on their knowledge of design limitations in technical specifications, operating characteristics, and reactor thermal limits. Question stands.

5. 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. Those individuals who had clearly passed the simulator and oral examinations were identified.

There were no generic weaknesses noted during the oral and simulator exams.

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

ATTACHMENT

(1.5) 1.09 Indicate the most significant type of heat transfer that is taking place in each of the following conditions. (i.e. Condiction, Convection or Radiation)

a. Nucleate boiling on the cladding surface of the fuel assembly.

b. Accident condition in which steam is passing through the coolant channels.

c. Heat from fission accross a fuel pellet.

ANSWER
a.) Convection (+.5 ea)
b.) Radiation
c.) Conduction

REFERENCE
Nuclear Power Plant Oper. Trng. Program, HTFF & Thermo, pp 193-206
002/000; K5.01 (3.1/3.4)

TVA COMMENT

Statement places no restriction on what the accident condition is (Small-break LOCA, Large-break LOCA) and on the state of the steam passing through the core. A low-quality steam mixture is highly likely in some small-break LOCA's which have relatively high convective heat-transfer coefficients and small radiation heat transfer coefficients. Convection is still the most significant type of heat transfer in these cases.

Radiation heat transfer would be more significant for only high-quality steam or superheated steam conditions. However, the question only states "steam" states.

The non-specification of "accident condition" and "steam" ma' this part of the question (b) ambiguous and not acceptable as a test question.

(1.0) 2.03 Which of the following is the preferred order of valve operation for initiation of Emergency Boration as stated in AOI-34?

a. 62-135 & 136 (RWST Suction Valves), BIT Injection Valves, HCV-62-929 (Emergency Borate Manual Valve), FCV-62-138 (Emergency Borate MOV)

b. FCV-62-138, HCV-62-929, 62-135 & 136, BIT Injection Valves

c. FCV-62-929, FCV-62-138, 61-135 & 136, BIT Injection Valves

d. FCV-62-138, 62-135 & 136, BIT Injection Valves, FCV-62 929

e. HCV-62-929, BIT Injection Valves, 62-135 & 136, FCV-62-138

ANSWER
c

REFERENCE
SQNP Lesson Plan "CVCS" pp 14 & AOI--34A
EPE-024; PWG-11 (4.0/4.0) & EA2.02 (3.9/4.4)

TVA COMMENTS

AOI-34 does not list flow paths in preferencial order as indicated in c. Refer to your copy of AOI-34 and re-read instruction you will find that the answer is b.

(1.0) 2.12 Fill in the blanks below to complete the statement concerning Auxiliary Control Air:
The Containment Building is supplied with redundant headers, each supplying ___________ and ________ valves. These headers are isolated on _________. The Auxiliary Control Air compressors are cooled by the __________ system.

ANSWER
PZR spray; PORV; Hi-Hi containment pressure; ERCW (+.25 ea)

REFERENCE
Westinghouse PWR Systems Manual "Air Systems", pp 12.3-2
078/000; K1.04 (2.6/2.9) & K1.03 (3.3/3.4) & PWG-10 (3.4/3.7)

TVA COMMENTS

The answers given are correct; however, train A and Train B are also correct for the first two blanks.

(1.50) 3.16 List ALL of the signal inputs to the OT Delta T trip point calculator.

ANSWER
Delta T; Tavg; PZR Pressure; Delta Flux; Delta T at rated power; Tavg at rated power (+.25 ea)

REFERENCE
Westinghouse PWR systems Manual "RPS", pp 9-10
SQNP TS Table 2.2-1
012/000; K6.11 (2.9/2.9) & A2.05 (3.1/3.2)

TVA COMMENT

OTΔT trip point calculator does use the loop ΔT parameter, The ΔT parameter enters the comparator. SEE ATTACHED BLOCK DIAGRAM.

(1.0) 4.02 Which of the following is NOT a Critical Safety Function?

a. Core Cooling

b. Heat Sink

c. Subcriticality

d. Containment

e. Inventory

ANSWER
e

REFERENCE
McG, EP/2/A/5000/10, Status Trees
SQN FR-0, Status Trees
PWG-10: Recognizing EOP Entry-level conditions (4.1/4.5)

<u>TVA COMMENT</u>

All of the above are Critical Safety Function. SEE ATTACHED PAGES.

(1.0) 4.15 a. What is the primary evacuation shelter for contaminated personnel if a total plant evacuation is required?

b. Where is the assembly point for Operations personnel on a Site Emergency?

ANSWER

a.) Watts Bar Nuclear Plant (+.5ea)
b.) Control Building Lunch Room (Evelation 732)

REFERENCE
SQNP IP-7, pp 1 & IP-B, pp5
PWG-36: Actions in Facility E-Plan (2.9/4.7)

<u>TVA COMMENT</u>

Delete this question. This is SRO level knowledge of the REP, RO candidates are taught the REP on a basic level as part of certification training but do not receive detailed REP training in prelicense.

QUESTION 5.09/1.12 (1.50)

List the 3 conditions necessary for brittle fracture to occur in metal.

ANSWER 5.09 (1.50)

Nominal tensile stress (+.5)
Temperature below RTndt (+.5)
Sufficient sized surface defect (+.5)

REFERENCE
SQN TS, B3/4.4.9

002/000; K5.18 (3.3/3.6)

TVA COMMENT

Expand acceptable answer to include PRESSURIZED THERMAL SHOCK (PTS) conditions. Emphasis in training is placed on PTS events which require slightly different conditions for initiation conditions are:

1. Reactor vessel beltline region must have a very large degree of neutron radiation embrittlement.
2. A flaw or crack of critical size.
3. High thermal stress must be induced by cold water cascading by the beltline region of the vessel.
4. The RCS must be pressurized following the thermal shock.

REFERENCE:
SQN WK 3&4 REQUAL LESSON PLAN, Day 10, Page 5 of 15

QUESTION 5.10/1.13 (1.50)

List the three main power producing isotopes in the core at end of life and indicate their approximate contribution (in %) to power.

ANSWER 5.10 (1.50)

U-235 Approx 49% (+.25 for isotope, +.25 for contribution to power +/-2%)
Pu-239 Approx 44%
U-238 Approx 7%

REFERENCE
SQN/WBN License Cert Trng, "Reactor Kinetics" pp 6

001/000; K5.47 (2.9/3.4)

TVA COMMENT

The numbers used on the key and the allowable tolerance implied for an acceptable answer are not necessarily true and may differ from reference to reference. These numbers are discussed in "ball park" terms, usually with the addition of $Pu^{241}$ as the fourth isotope of concern.

Attached are excerpts from three other documents used for training. Any

General Physics Systems Manual
Chapter 15 "Reactor Theory Review"

U-235: $\beta_i = 0.0064 \equiv \beta_{235}$

U-238: $\beta_i = 0.0157 \equiv \beta_{238}$

Pu-239: $\beta_i = 0.0021 \equiv \beta_{239}$

Pu-240: $\beta_i = 0.0053 \equiv \beta_{241}$

2. Fission Sharing Percentage, $\gamma_i$

$\gamma_i \equiv$ the percentage of the total core power produced by an individual type of fuel.

The fission sharing percentages of the individual fuels are a function of core age, due to the production of Plutonium and the depletion of U-235. At BOL, about 7% of the total core power results from fast fissioning of U-238; the remaining 93% is produced by fast and thermal fissioning of U-235. As the core ages, Pu-239, Pu-240 and Pu-241 are produced as follows:

$${}^{238}_{92}U + {}^{1}_{0}n \longrightarrow {}^{239}_{92}U \xrightarrow[23\ \text{min}]{\beta^-} {}^{239}_{93}Np \xrightarrow[2.3\ \text{da}]{\beta^-} {}^{239}_{94}Pu$$

fission (73%)

$${}^{239}_{94}Pu + {}^{1}_{0}n$$

$${}^{240}_{94}Pu \ (27\%)$$

$${}^{240}_{94}Pu + {}^{1}_{0}n \longrightarrow {}^{241}_{94}Pu$$

At EOL, the individual fission sharing percentages are:

$\gamma_{235} \approx 50\%$

$\gamma_{238} \approx 7\%$

$\gamma_{239} \approx 38\%$

$\gamma_{241} \approx 5\%$

3. Core Delayed Neutron Fraction, $\beta$

$\beta \equiv$ the fraction of all fission neutrons which are born as delayed neutrons.

$$\beta = \frac{\text{number of delayed neutrons produced}}{\text{number of fission neutrons produced}}$$

# DELAYED NEUTRON FRACTION FOR REACTOR CORE

SALEM NUCLEAR PLANT REACTOR THEORY TEXT

| | $^{235}U$ | $^{238}U$ | $^{239}Pu$ |
|---|---|---|---|
| Delayed Neutron Fraction, $\beta$ | 0.0064 | 0.0156 | 0.0021 |
| Power (Fission) Fraction, $\gamma$ | | | |
| BOL | 93% | 7% | 0% |
| EOL | 55% | 7% | 38% |

$$\bar{\beta} = (\beta_{235} \cdot \gamma_{235}) + (\beta_{238} \cdot \gamma_{238}) + (\beta_{239} \cdot \gamma_{239})$$

# DELAYED NEUTRON FRACTION FOR REACTOR CORE

$$\overline{\beta} = \beta_{235} \cdot \gamma_{235} + \beta_{238} \cdot \gamma_{238} + \beta_{239} \cdot \gamma_{239}$$

At **BOL:**

$$\overline{\beta}\,(\text{BOL}) = (0.0064)(0.93) + (0.0156)(0.07)$$

$$= 0.0059 + 0.0011$$

$$\overline{\beta}\,(\text{BOL}) = 0.0070$$

At **EOL:**

$$\overline{\beta}\,(\text{EOL}) = (0.0064)(0.55) + (0.0156)(0.07)$$

$$+ (0.0021)(0.38)$$

$$= 0.0035 + 0.0011 + 0.0008$$

$$\overline{\beta}\,(\text{EOL}) = 0.0054$$

The Delayed Neutron Fraction ($\beta$) is a fraction of the total neutrons that are delayed.

$$\beta = \frac{\text{neutrons that are delayed}}{\text{total neutrons from fission}}$$

Each fuel has a different fraction of neutrons that are delayed:

| | |
|---|---|
| U-235 | $\beta$ = .0065 |
| U-238 | $\beta$ = .0157 |
| PU-239 | $\beta$ = .0021 |
| PU-241 | $\beta$ = .0049 |

6.3 To determine what the average neutron lifetime ($\bar{l}$) is, you need to multiply prompt neutron lifetime ($l_p$) by the prompt neutron fraction and multiply the delayed neutron lifetime ($l_d$) by the delayed neutron fraction, and then add these two together.

$$\bar{l} = l_p (1-\beta) + l_d \beta$$

$$= (2 \times 10^{-5} \text{ sec}) (1 - .007) + (12.5 \text{ sec}) (.007)$$

$$= 1.986 \times 10^{-5} \text{ sec} + .0875 \text{ sec.}$$

$$= .087519 \text{ sec.}$$

$$= .09 \frac{\text{seconds}}{\text{generation}}$$

$$\frac{1}{.09 \text{ sec/gen}} = 11 \frac{\text{generations}}{\text{second}}$$

NOTE: This longer lifetime results in 11 generations per second rather than 50,000 generations per second. (If only prompt neutrons were present.) This gives much better control of the reactor.

6.4 To determine what the Weighted Average Delayed Neutron Fraction ($\bar{\beta}$) you need to know what percentage of the total fissions each fuel is providing and the Delayed Neutron Fraction ($\beta$) for each fuel.

6.4.1 At BOL 93% of fissions come from U-235
7% of fissions come from U-238

$$\bar{\beta} = \underset{\text{U-235}}{(.93)(.0065)} + \underset{\text{U-238}}{(.07)(.0157)} = .007144$$

6.4.2 At EOL 49% of fissions come from U-235
7% of fissions come from U-238
38% of fissions come from PU-239
6% of fissions come from PU-241

$$\bar{\beta} = \underset{\text{U-235}}{(.49)(.0065)} + \underset{\text{U-238}}{(.07)(.0157)} + \underset{\text{PU-239}}{(.38)(.0021)} + \underset{\text{PU-241}}{(.06)(.0049)}$$

$$= .003185 + .001099 + .000798 + .000294 = .005376$$

QUESTION 5.15 (1.50)

What are the two factors associated with delayed neutron procursors that influence the value of Beta Bar Effective and what effect do they have?

ANSWER 5.15 (1.50)

1. Delayed neutrons born at lower energies, so less likely to leak out providing a positive effect (+.75)
2. Delayed neutrons are born at an average energy too low to cause fast fission which provides a negative effect (+.75)

REFERENCE
SQN/WBN License Cert Trng, "Neutron Kinetics"

001/000; K5.47 (2.9/3.4)

TVA COMMENT

Question is poorly written, in that the answer key implies the question is addressing knowledge of IMPORTANCE FACTORS. Quite frankly, there is no answer to the question as written and therefore the question should be removed from the examination.

Note: Remove question as written from exam bank. Replace with question directly related to IMPORTANCE FACTOR.

QUESTION 5.16/1.18 (1.25)

Over core life there are two effects that cause differential boron worth to change. List these two effects, their relative impact on differential boron worth and indicate which effect is the overriding factor.

ANSWER 5.15 (1.25)

1. As the fuel burns out, less boron is required, which increases the boron worth (+.5)
2. Fission products build up, decreasing the boron worth (+.5)-this is the overriding effect (+.25)

REFERENCE
SQN/WBN License Cert Trng, "Core Poisons", pp 4

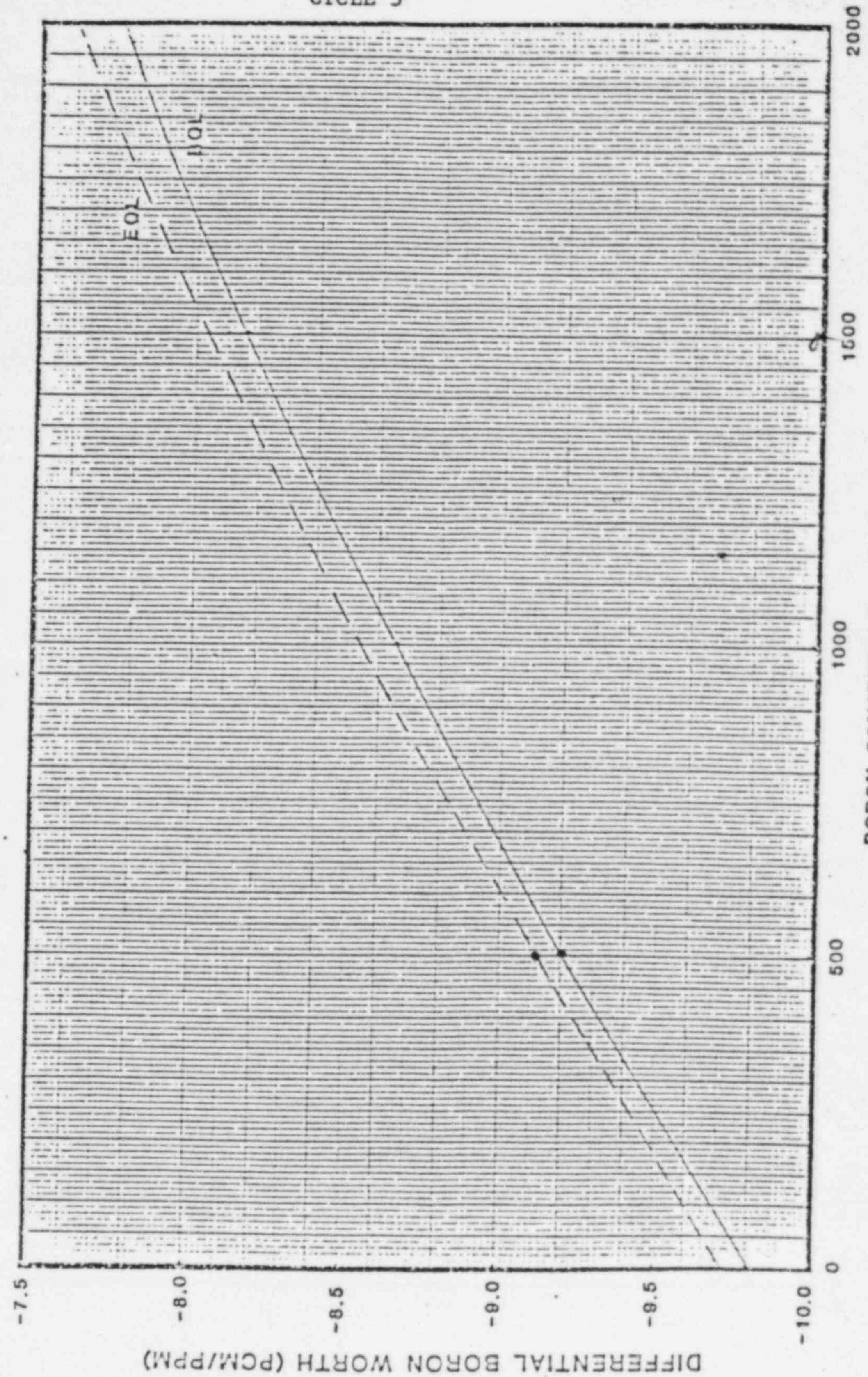
004/000; K5.06 (3.0/3.3)

TVA COMMENT

Reference lesson plan is in error. The differential boron worth increases (becomes more negative) over core life, as shown in SQN Curve Book TI-28, Figure B.9.1 for Unit 1, Cycle 3. Answer is based purely on a theoretical vs real-life answer. Boron worth is less at EOL.

UNIT 1

CYCLE 3




DIFFERENTIAL BORON WORTH VERSUS BORON CONCENTRATION
AT BOL AND EOL, HZP

QUESTION 5.21 (1.50)

The following data was obtained during a core refueling.

| Number of Assemblies Loaded | Neutron Count Rate |
|---|---|
| 0 | 40 cps |
| 5 | 70 cps |
| 10 | 90 cps |
| 15 | 115 cps |

Determine the number of assemblies it will take to reach criticality. Use the attached graph paper if desired. (Assume equal assembly worth)

ANSWER 5.21 (1.50)

for 0-5 assemblies, 1/M=.571 (+.25)
for 0-10 assemblies, 1/M=.444 (+.25)
for 0-15 assemblies, 1/M=.348 (+.25) for 10-15 assemblies, 1/M=.782

See attached graph for curves (+.75)

REFERENCE
NUS, Vol 3, Units 12.2, 12.3
SQN/WBN License Certification Trng, "Neutron Sources and Subcritical Mult"

001/010; K5.16 (2.9/3.5)

TVA COMMENT

EDITORIAL ONLY please refrain from such questions in the future, because of the obviously erroneous use of 1/M during fuel loading. CRITICALITY is not the ultimate goal. This question is applicable to research type facilities only.

QUESTION 5.22/1.21 (1.00)

Using the attached steam tables, what is the amount of primary subcooling if the pressurizer is at 2235 psig and Tavg is 575 degrees F?

ANSWER 5.22 (1.00)

for 2250 psia, sat temp = 652 (+.5)
with Tavg = 575, TH = 607 (+.5) -give +/- 2 degrees in determining TH
45 degrees F

REFERENCE
Steam Tables and SQN PLS

002/000; A1.04 (3.9/4.1)

TVA COMMENT

An alternate answer is acceptable in this case, where power conditions were not specified. If in an accident, $T_c$, $T_h$, $T_{avg}$ may all be the same and in that case subcooling would be $653^oF$ - $575^oF$ = ~78oF.

QUESTION 6.02/3.03 (1.00)

Which statement below regarding Diesel Generator load sequencing is correct if a LOCA occurs AFTER a LOSS OF POWER?

a. Loads already sequentially connected will remain connected.
b. Loads awaiting sequential loading that are required for an accident will have their sequential timers reset to time zero.
c. The non-accident loads not yet connected will be sequenced on once all accident related loads are connected.
d. All loads will be stripped, then ONLY the accident related loads will be sequentially connected.

ANSWER 6.02 (1.00)

b

REFERENCE
SQNP System Descrip, "Electrical Distribution" pp 19/20

064/000; K4.10 & K4.11 (3.5/4.0)

TVA COMMENT

Both answer a. and b. are correct for SQN and therefore full credit should be awarded for either answer. Page 19 of the quoted REFERENCE makes the statement that implies that an SIS will strip loads or block loads--that is in error. The only difference between the listed Nonaccident and Accident Condition Columns in Table 5-2 is the PZR heaters, and the heaters are unaffected by SIS.

TABLE 5-2

## DIESEL GENERATOR LOAD SEQUENTIALLY APPLIED FOLLOWING A LOSS OF NUCLEAR UNIT AND PREFERRED (OFFSITE) POWER

| Equipment Name | Time in Seconds* | Total HP Load | Starting kVA | Load Applied Nonaccident Condition | Load Applied Accident Condition |
|---|---|---|---|---|---|
| Miscellaneous Loads | 0 | 760 | 4360 | Yes | Yes |
| Centrifugal Charging Pump & AHU | 5 | 603 | 3630 | Yes | Yes |
| Safety Injection Pump & AHU | 10 | 403 | 2460 | No | Yes |
| Residual Heat Removal Pump & AHU | 15 | 403 | 2395 | No | Yes |
| Essential Raw Cooling Water Pump | 20 | 600 | 3470 | Yes | Yes |
| Component Cooling System Pump | 25 | 350 | 1905 | Yes | Yes |
| Auxiliary Feedwater Pump | 30 | 500 | 2560 | Yes | Yes |
| Containment Spray Pump & AHU | 35 | 705 | 4060 | No | Yes |
| Pressurizer Heaters | 90 | 485 kw | 485 kw | Yes | No |
| Fire Pump | 120 | 200 | 878 | Yes | Yes |
| Spare Component Cooling System Pump** | 125 | 350 | 1905 | Yes | Yes |

Diesel General Rating: 4000kw continuous or 4400kw for 2 hours

*Time is measured from the time of closing of the breaker connecting the diesel generator to the power train.

**Applies only to diesel generator 1A-A or 2B-B

AHU - Air Handling Unit

QUESTION 6.06/3.09 (1.75)

List the 7 Diesel engine shutdown troubles which are bypassed when there has been an emergency start.

ANSWER 6.06 (1.75)

1. Low Lube Oil Pressure (+.25 ea)
2. High Crankcase Pressure
3. Phase Balance Relay
4. Reverse Power Relay
5. Loss of Field Relay
6. Overcurrent Relay
7. High Jacket Water Temperature

REFERENCE
NA NCRODP 90.4 "EDG"
SQNP Diesel Generator Handout pp 8

064/000; K4.02 (3.9/4.2)

TVA COMMENT

Only 6 of the 7 listed are true. The overcurrent relay is not bypassed. #6 Overcurrent Relay is not an engine shutdown it only trips the feeder bkr to the shutdown bd and is only placed in service when the 6.9k.v. unit bd and 6.9k.v. shutdown bd are paralleled.

Reference 45N765-2

QUESTION 6.07 (1.50)

a. Fill in the blanks in the following statement regarding liquid waste processing:
Liquid, whose tritium concentration is____________% or more of the ________ tritium concentration, is designed to be processed as tritiated liquid.
(0.5)
b. List the flowpath of Radioactive Liquid from the Liquid Waste Processing System starting with the Waste Condensate Tanks and Ending with the Environment. Include the piping through which it passes. (1.0)

ANSWER 6.07 (1.50)

a. 10%; primary coolant (+.25 ea response)
b. Blowdown line from cooling twoers; diffuser pond; diffuser pipes; river (+.25 ea)

REFERENCE
SQNP Sys Descrip, 8.2, "System Design and Operation (Liquid Waste)" pp 4,16

068/000; PWG-4 (3.1/3.3) & K4.01 (3.4/4.1)

TVA COMMENT

The normal interpertation of "the environment" ends with the diffuser pond.

QUESTION 6.08/2.09 (1.25)

a. What is the maximum differential temperature allowed by Tech Specs between the pressurizer spray and the pressurizer?

b. What is the purpose of the loop seal located below each pressurizer safety
valve?
(0.5)

c. What is the driving force for normal spray flow?
(0.5)

ANSWER 6.08 (1.25)

a. 320 deg F (+.25)
b. Inhibit H2 leakage which may wire guide the valve seat (+.5)
c. Delta P between the RCP discharge and the PZR (+.5)

REFERENCE
SQNP PLS pp 42; SQNP Lesson Plan "RCS", pp 27 & 29

010/000; K6.03 (3.2/3.6) & K6.02 (3.2/3.5)

TVA COMMENT

A. T.S. 3/4.4.9.2 lists maximum differential temperature between spray and PZR as 560°F. Surveillance requirement still requires logging of conditions when spray ΔT exceeds 320°F for tracking of cycles in section 5.0 "Design Features."

b. Loop seal is used to prevent steam leakage through safety valves. Loop seal is heat traced to ensure that upon opening of a safety valve the water in the loop seal will flash to steam thus reducing water hammer damage. This information should be accepted as an alternate answer.

QUESTION 6.09 (1.25)

Fill in the blanks to complete the following statements concerning fuel handling interlocks:

a. The refueling canal lifting arm is interlocked with the _______. The lifting arm cannot be lifted unless the _____ is in the _____ poisition or the crane is ____
. (1.0)

b. Bridge and trolley drive operation is prevented except when _____ are actuated.
(0.25)

ANSWER 6.09 (1.25)

a. manipulator crane; manipulator crane gripper tube; fully retracted; over the core (+.25 ea)
b. both gripper tube up position switches (+.25)

REFERENCE
SQNP Sys Descrip. 9.0, "Fuel Handling System" pp 5 & 7

034/000; K4.02 (2.5/3.3)

TVA COMMENT

a. Transfer cart (Trolly); transfer cart; fully down position. The refueling canal lifting arm is also interlocked with the above as well as the manipulator crane.

Reference. FHI-7

QUESTION 6.12/2.13 (1.00)

Describe the flow path of the Containment Spray System when the RWST is too low to support spray operation, assuming there is still ice in the Ice Condenser. (Identify all components, excepting valves in the path)

ANSWER 6.12 (1.00)

Emergency sump+++Containment Spray Pumps+++Containment Spray Ht Exchgrs+++Containment Spray Nozzles+++Upper Containment Compartment+++2 Drains in the bottom of the Refueling Canal+++Lower Compartment+++Emergency Sump (+.15 ea)

REFERENCE
SQNP Sys Descrip. 4.5, "Cont Spray Sys" pp 17/18

026/000; K4.01 (4.2/4.3)

TVA COMMENT

Adequate response to this question would include all components to the containment spray nozzles. Remaining information, however true, is not required to describe flow path.

QUESTION 6.13 (1.50)

What signals will automatically initiate the operation of the Auxiliary Building Gas Treatment System?

ANSWER 6.13 (1.50)

-Phase A Containment Isolation signal from either Unit (+.5 ea)
-High Radiation signal from fuel handling bldg area rad monitors
-High Radiation signal from Aux Bldg exhaust vent rad monitors.

REFERENCE
SQNP Sys Descr. 4.4, "Cont Air Purif and Cleanup Sys" pp 15

EPE-060; PWG-10 (4.1/4.4)

TVA COMMENT

SIS and Auxiliary Building Isolation Signals should also be acceptable, even though they are general.
Another acceptable answer is high temperature in auxiliary building general supply fan suction, either unit, +115$^{o}$F; 1-TS-30-103/103A, 2-TS-30-104/104A - Ref. SQN SOI 30.6A page 6 of 22, Rev. 13.

QUESTION 6.14/2.15 (1.75)

a. List the signals which will cause an automatic isolation of the Feedwater System. (0.75)
b. List the automatic actions that occur due to the feedwater isolation signal. (1.0)

ANSWER 6.14 (1.75)

a. Hi-Hi level in any S/G ( 75%) (+.25 ea)
SI signal
Reactor trip with lo Tavg ( 554 deg F)
b. Both MFP trip (+.25 ea)
MFWRV and Bypasses shut
Condensate system recircs to condenser
Feedwater isolation valves close

REFERENCE
SQNP Lesson Plan "Condensate and Feedwater Review", pp 10

059/000; K4.19 (3.2/3.4)

TVA COMMENT

General agreement with key, except for "condensate recircs to condenser". This action occurs indirectly upon feedwater isolation signal. Ref. SQN Logic Print 47W611-3-2.

QUESTION 6.15 (1.25)

OMIT

Where are thermal sleeves associated with RCS penetrations located?

ANSWER 6.15 (1.25)

-Return lines from RHR loop (SI lines) (+.25 ea)
-PZR Surge line, both ends
-PZR spray into PZR
-Chg line connection
-Aux chg line connection

REFERENCE
SQNP Lesson Plan "RCS", pp 34/35

002/000; K1.06 (3.7/4.0) & K1.08 (4.5/4.6) & K1.09 (4.1/4.1)

<u>TVA COMMENT</u>

<u>Editorial Only</u> This section does question the candidates knowledge of system design, however, this particular point is requesting information that is (in the opinion of the training staff) at best a poor measure of design knowledge.

QUESTION 6.17 (.75)

List three interlocks that would prevent the AUTOMATIC transfer of a 6.9 KV Shutdown Board from its normal supply to its alternate supply.

ANSWER 6.17 (.75)

-alternate feeder has normal voltage (+.25 ea)
-transfer switch is in AUTO
-trip was not due to overcurrent

REFERENCE
SQNP "Review of Electrical Distribution" pp 4

062/000; K4.03 (2.8/3.1)

<u>TVA COMMENT</u>

Answer key lists conditions that would <u>ALLOW</u> transfer, NOT PREVENT transfer.

(1.0) 6.22/3.20 With the pressurizer level control selector switch in position I/II, a failure causes the following plant events. (Assume no operator actions taken.)

1. Charging flow reduced to minimum

2. Pressurizer level decreases

3. Letdown secured and heaters off

4. Level increases until high level trip

Which instrument failed (I or II) and in what direction did it fail?

ANSWER
Level I Channel (+.5) failed high (+.5)

REFERENCE
Westinghouse PWR Systems Manual "Primary System Control", pp 12-14
011/000; K3.01 (3.2/3.4) & K3.03 (3.2/3.7)

TVA COMMENTS

A failure low of the channel II (backup channel) will cause some of the same plant events, effects are close enough to be debatable.

1. Letdown will isolate/heaters will turn off upon low failure.
2. After letdown isolates, as actual pressurizer level increases control circuit will reduce charging flow to minimum.
3. Level will increase until high level trip.
4. Failed channel will indicate pzr level decrease. Either answer should be acceptable.

(1.0) 7.6/4.7 Which of the following describes what is meant by "Nothing Detectable" as it is utilized in determining the existence of Beta-Gamma contamination on skin or clothing surfaces?

a. Less than 100 dpm above background as measured with a pancake probe.

b. Less than 100 dpm above background as measured with a smear.

c. Less than 5 times background counts as measured with a smear as counted for one minute.

d. Less than 3 times the square root of a one minute background count as measured by a smear counted for 1 minute.

ANSWER

d
Reference
SQNP RCI-1, pp12
PWG-15: Knowledge of facility Radcon (3.4/3.9)

TVA COMMENT

Question is inappropriate. If taken in context, "Nothing Detectable" limit is associated with smears and skin smears are not to be used unless totally unavoidable due to possibility of worsening condition. This question is not appropriate based on the duties/responsibilities of local H.P. section utilized at SQN. 10CFR55 does state that operator examinations test knowledge of radiological procedures and controls, however emphasis should be placed on areas of concern to operations personnel. This is DIFINITELY NOT NEED TO KNOW INFORMATION FOR FACILITY SRO PERSONNEL.

(1.0) 7.09/4.11 Fill in the blanks with the appropriate limits listed in the precautions section of the GOIs:

a. A load change of +/-______%/min or a step change of ______% should not be exceeded.

b. The boron concentration difference between the pressurizer and the RCS must not exceed ______ppm.

c. The arming temperature setpoint for UNIT 1's Pzr PORVs is _______deg F.

ANSWER

a. 5; 10 (+.25 ea response)
b. 50
c. 380

REFERENCE

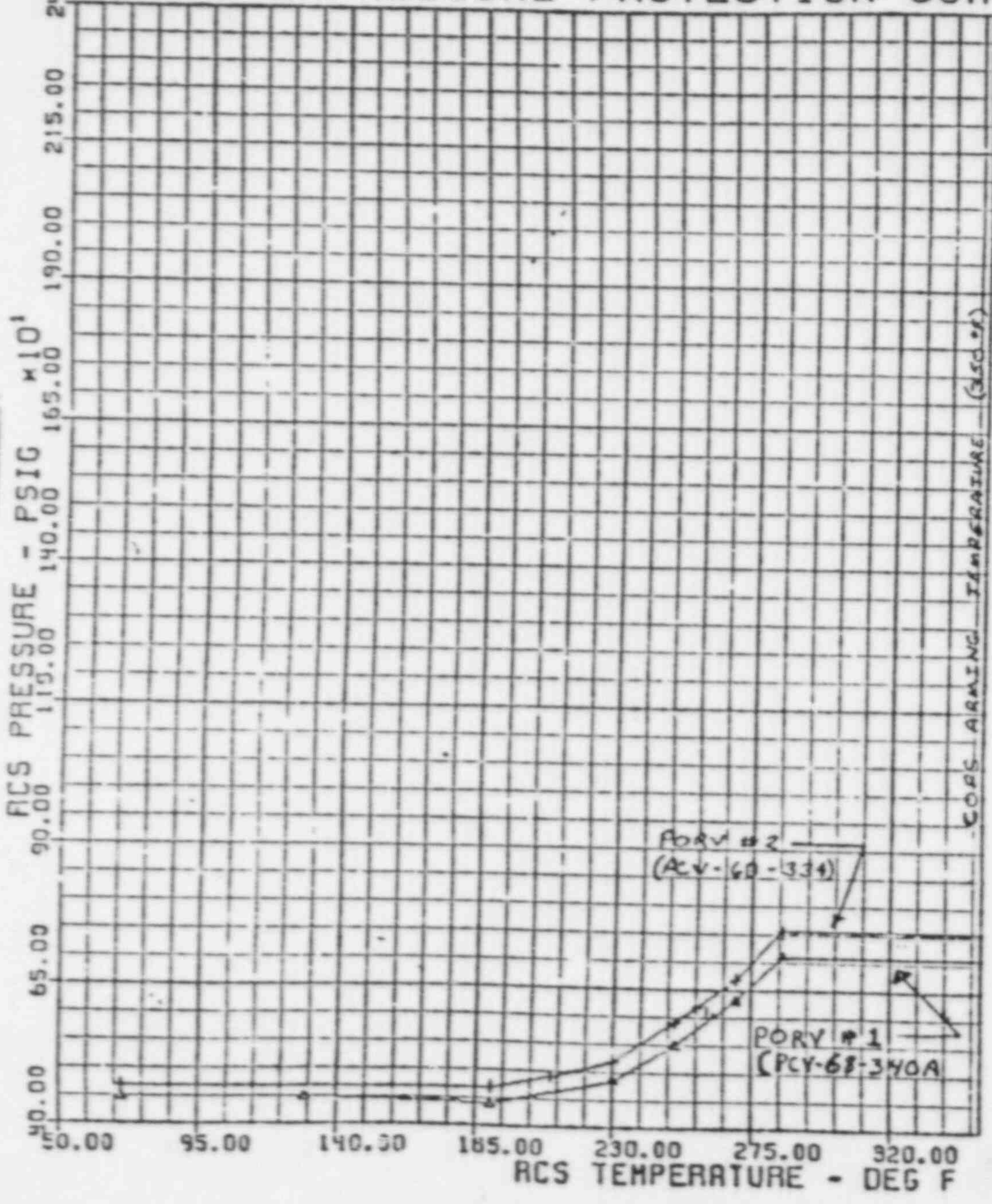
SQN GOI-3B and GOI-5
PWG-7; Limits and Precautions (3.5/4.0)

TVA COMMENT

Answer key for part c.) is in error. Arming setpoint for COPS Function on Unit 1 is 350°F (Refer to attached pg 54 of GOI-1)

* Revised Entire Page
** Renumbered

# COLD OVERPRESSURE PROTECTION CURVE - UNIT 1 ONLY




PORV # 1

| RCS Temp. (°F) | Setpoint (psig) |
|---|---|
| 70 | 450 |
| 130 | 450 |
| 190 | 440 |
| 230 | 485 |
| 250 | 550 |
| 270 | 630 |
| 285 | 710 |
| 350 | 710 |

PORV # 2

| RCS Temp. (°F) | Setpoint (psig) |
|---|---|
| 70 | 470 |
| 190 | 470 |
| 210 | 490 |
| 230 | 520 |
| 250 | 590 |
| 270 | 670 |
| 285 | 755 |
| 350 | 755 |

COMS Arming Temperature 350°F

(2.0) 7.14 a. On a station blackout, whqat are the 8 loads that are sequentially loaded automatically onto the diesels.

b. There is a precaution in the Loss of Offsite Power procedure (AOI-35) to ensure that the diesels are loaded to >1600 KW within 4 hours (assuming the diesels are required that long). What is the purpose of this precaution?

ANSWER

a. 1.) Centrifugal Charging Pump 2.) AHU 3.) ERCW Pump 4.) CCS and Booster Pump. 5.)Spare Component Cooling Pump 6.) AFW Pump 7.) Pressurizer Heaters 8.) Fire pump (+.15 ea)

b. To clear the diesel exhausts and superchargers of accumulated combustibles (+.8)

REFERENCE
SQNP AOI-35, pp 3/4
a.)064/000; K4.10 (3.5/4.0)
b.)064/000; A2.06 (2.9/3.3)

TVA COMMENTS

Part a.) answer is not correctly stated on key - sec attached page 4 of AOI-35.

(1.50) 7.15 List the immediate actions in AOI-7, "Probable Maximum Flood", assuming the plant has been notified by the Division of Water Management that flood producing conditions may develop.

ANSWER
-Notify Management personnel listed for call duty (+.25 ea)
-Refer to IP-1 and implement REP for FLOOD
-Notify load coordinator if unit loaded or scheduled to be loaded
-Make radio contact with Fontana Dam if they are involved in flood warning
-Perform SI-216 (Flood Protection Surveillance)
-Initiate SI-215 (Flood Protection Communication)

REFERENCE
SQNP AOI-7,pp 1/2
PWG-2 (2.7/3.8) & PWG-11 (4.3/4.4)

TVA COMMENT

If this particular instruction is put in proper perspective, immediate operator actions are then some twenty seven hours in advance of any actual flood condition and then actions are not required in a compressed time frame. This question, as asked, is inappropriate and should be deleted from this examination.

IV. SUBSEQUENT OPERATOR ACTION (Cont.)

____ 2. Confirm diesel generators loads are less than 4000 kW each for continuous operation and less than 4400 kW for 2 hours.

____ a. D/G 1A _____ KW
____ b. D/G 1B _____ KW
____ c. D/G 2A _____ KW
____ d. D/G 2B _____ KW

____ 3. Send AUO to the diesel building to check the condition of the D/G's

____ 4. In the event of loss of Unit 1 or Unit 2 station "B" train power supply (6.9-kV shutdown boards 1B-B or 2B-B) verify that ERCW header crosstie valves open:

____ a. 1-FCV-67-223 open
____ b. 2-FCV-67-223 open
____ c. 1-FCV-67-424 closed

____ 5. Following equipment energized and/or operating.
CAUTION Equipment started by blackout will not stop until B.O. is reset. If required to stop equipment "Pull To Lock" control switch.

DIESEL GENERATOR LOAD SEQUENTIALLY APPLIED FOLLOWING A LOSS OF NUCLEAR UNIT AND PREFERRED (OFFSITE) POWER

| Equipment Name | Time in Seconds(1) |
|---|---|
| Miscellaneous Loads | 0 |
| Centrifugal Charging Pump & AHU | 2 |
| Essential Raw Cooling Water Pump | 15 |
| CCS Pump & Booster Pump | 20 |
| Spare Component Cooling System Pump(2) | 20 |
| Auxiliary Feedwater Pump | 25 |
| Pressurizer Heaters | 90 |
| Fire Pump | 120 |

Diesel Generator Rating: 4000 kw continuous or 4400 kw for 2 hours

[1] Time is measured from the time of closing of the breaker connecting the diesel generator to the power train.

[2] Applies only to diesel generator 1A-A or 2B-B

(1.0) 7.20/4.23 What are the three parameters that are monitored to determine RCS cooldown in accordance with ES-0.3, "Natural Circulation Cooldown"?

ANSWER
Core Exit T/C (+.33 ea)
T-Hot
RCS Subcooling

REFERENCE
SQN ES-0.3, pp6
EPE-074; EA1.02 (3.9/4.2)

TVA COMMENT

Actually there are five parameters listed in ES-0.3, any of which are acceptable answers. Se attached excerpt from ES-0.3.

(1.0) 7.23/4.25 Place the steps listed below, which are performed during a plant startup, in the proper sequential order.

1.) Transfer 6.9 kv unit board 1A from Start Bus 1A to unit station transformer 1A.
2.) Transfer S/G feedwater regulating valve control to AUTO.
3.) Transfer steam dumps to Tavg mode.
4.) Transfer rod control to AUTO

ANSWER

4 (+.25 ea in correct order)
3
1
2

REFERENCE
SQNP GOI-2, pp 22/23
PWG-12: Performance of Integrated Operations (3.5/3.4)

TVA COMMENT

Question is not valid. Startup steps listed above are NOT sequence critical during plant operations. Actual sequence is dependent on plant conditions and will vary from startup to startup. Question should be removed from the examination.

## 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

| STEP | ACTION/EXPECTED RESPONSE | RESPONSE NOT OBTAINED |
|---|---|---|
| 1 | Try To Restart An RCP<br>a. Loop 2 preferred<br>b. Refer to SOI-68.2<br>c. Start an RCP and go to appropriate plant instruction | IF an RCP can NOT be started, THEN verify natural circulation<br>RCS subcooling<br>S/G press stable or decreasing<br>T-hot stable or decreasing<br>Core exit T/C stable or decreasing<br>T-cold at saturation temp for S/G press<br>IF natural circulation NOT verified, THEN increase dumping steam |

(1.0) 8.03 While in Mode 1, a Pressurizer Code Safety Valve is determined to be INOPERABLE. How long do you have to restore the Code Safety to operability before Tech Specs require you to initiate shutdown to Hot Standby?

a. You must immediately start your shutdown procedure

b. 15 minutes

c. 30 minutes

d. 1 hours

ANSWER
c

REFERENCE
FNP/SQNP TS 3.4.3

010/000; PWG-5 (2.9/4.1)

TVA COMMENT

Answer Key is in error. Correct answer is b. 15 minutes. See attached Tech. Spec. LCO 3/4.4.3.

(2.0) 8.07 Indicate WHETER or NOT the following conditions REQUIRE that the plant be in Hot Standby within one hour.

a. In Mode 1 with one cold leg injection valve failed in the closed position.

b. In Mode 1 with UHI accumulator at 1850 ppm boron.

c. In Mode 1 with RCS pressure having exceeded 280 psig.

d. In Mode 1 without primary containment integrity.

ANSWER
a. NO
b. NO
c. YES
d. NO

REFERENCE
CAT & SQNP TS, pps. 2-1, 3/4 5-1, 5-3, & 6-1
PWG-8: Recognition of TS entry level conditions (3.5/4.5)

TVA COMMENT

a. Is also a condition which requires plant shutdown so proper answer is YES. See attached sheet 3/4.5.1.

## 3/4.4.3 SAFETY AND RELIEF VALVES - OPERATING

### SAFETY VALVES - OPERATING

### LIMITING CONDITION FOR OPERATION

3.4.3.1 All pressurizer code safety valves shall be OPERABLE with a lift setting of 2485 PSIG ± 1%.*

APPLICABILITY: MODES 1, 2 and 3.

ACTION:

With one pressurizer code safety valve inoperable, either restore the inoperable valve to OPERABLE status within 15 minutes or be in at least HOT STANDBY within 6 hours and in at least HOT SHUTDOWN within the following 6 hours.

### SURVEILLANCE REQUIREMENTS

4.4.3.1 No additional Surveillance Requirements other than those required by Specification 4.0.5.

*The lift setting pressure shall correspond to ambient conditions of the valve at nominal operating temperature and pressure.

## 3/4.5 EMERGENCY CORE COOLING SYSTEMS

### 3/4.5.1 ACCUMULATORS

### COLD LEG INJECTION ACCUMULATORS

### LIMITING CONDITION FOR OPERATION

3.5.1.1 Each cold leg injection accumulator shall be OPERABLE with:

a. The isolation valve open,

b. A contained borated water volume of between 7857 and 8071 gallons of borated water,

c. Between 1900 and 2100 ppm of boron, and

d. A nitrogen cover-pressure of between 385 and 447 psig.

APPLICABILITY: MODES 1, 2 and 3.*

ACTION:

a. With one cold leg injection accumulator inoperable, except as a result of a closed isolation valve, restore the inoperable accumulator to OPERABLE status within one hour or be in at least HOT STANDBY within the next 6 hours and in HOT SHUTDOWN within the following 6 hours.

b. With one cold leg injection accumulator inoperable due to the isolation valve being closed, either immediately open the isolation valve or be in HOT STANDBY within one hour and be in HOT SHUTDOWN within the next 12 hours.

### SURVEILLANCE REQUIREMENTS

4.5.1.1.1 Each cold leg injection accumulator shall be demonstrated OPERABLE:

a. At least once per 12 hours by:

1. Verifying, by the absence of alarms or by measurement of levels and pressures, the contained borated water volume and nitrogen cover-pressure in the tanks, and

2. Verifying that each cold leg injection accumulator isolation valve is open.

*Pressurizer pressure above 1000 psig.

(1.50) 8.08 Match the following reactor trips with the condition each is designed to protect against.

| | |
|---|---|
| a. Overpower Delta T | 1. Power excursions during low power operation |
| b. Intermediate Range High Flux | 2. Control rod drop |
| c. Undervoltage RCP Bus | 3. DNB |
| d. Overtemperature ΔT | 4. Control rod drive housing rupture |
| e. Power Range Positive Rate | 5. No fuel pellet melting |
| | 6. Loss of heat sink |
| | 7. Uncontrolled rod cluster assembly withdrawal from subcritical conditions |
| | 8. No credit taken for this in accident analysis |

ANSWER
a. 8
b. 8
c. 3
d. 3
e. 4

REFERENCE
CAT/SQNP TS, pp 8 2-3 to 7
012/000; pwg-5 (3.2/4.0)

<u>TVA COMMENT</u>

Multiple answers are accepted for a. an b.

a. 8 and 5
b. 8 and 1

BASES

## Manual Reactor Trip

The Manual Reactor Trip is a redundant channel to the automatic protective instrumentation channels and provides manual reactor trip capability.

## Power Range, Neutron Flux

The Power Range, Neutron Flux channel high setpoint provides reactor core protection against reactivity excursions which are too rapid to be protected by temperature and pressure protective circuitry. The low set point provides redundant protection in the power range for a power excursion beginning from low power. The trip associated with the low setpoint may be manually bypassed when P-10 is active (two of the four power range channels indicate a power level of above approximately 9 percent of RATED THERMAL POWER) and is automatically reinstated when P-10 becomes inactive (three of the four channels indicate a power level below approximately 9 percent of RATED THERMAL POWER).

## Power Range, Neutron Flux, High Rates

The Power Range Positive Rate trip provides protection against rapid flux increases which are characteristic of rod ejection events from any power level. Specifically, this trip complements the Power Range Neutron Flux High and Low trips to ensure that the criteria are met for rod ejection from partial power.

The Power Range Negative Rate trip provides protection to ensure that the minimum DNBR is maintained above 1.30 for control rod drop accidents. At high power a single or multiple rod drop accident could cause local flux peaking which, when in conjunction with nuclear power being maintained equivalent to turbine power by action of the automatic rod control system, could cause an unconservative local DNBR to exist. The Power Range Negative Rate trip will prevent this from occurring by tripping the reactor for all single or multiple dropped rods.

## Intermediate and Source Range, Nuclear Flux

The Intermediate and Source Range, Nuclear Flux trips provide reactor core protection during reactor startup. These trips provide redundant protection to the low setpoint trip of the Power Range, Neutron Flux channels. The Source Range Channels will initiate a reactor trip at about $10^{+5}$ counts per second unless manually blocked when P-6 becomes active. The Intermediate

(.75) 8.18 Recent failures of PK-2 test block terminal posts utilized during routine testing of circuits has occurred recently at Sequoyah Nuclear Power Plant. Though the root cause of this problem is as yet undetermined, what are the potential problems associated with a terminal post failure?

ANSWER
-result in an open circuit making equipment unavailable, which may go undetected, (+.5) Potential personnel safety hazard if an open circuit is developed on a current transformer cirucit during testing. (+.25)

REFERENCE
USNRC I&E Notice #85-83 of 30 October 1985.

TVA COMMENT

Accept a broader answer than on key. The answer, if it includes comments on potential damage to equipment and/or personnel or damage to the circuit, should be accepted.

(1.0) 8.19 What are the tolerances within which the following control systems must be maintained while in manual control in a steady state condition?

a. Pressurizer pressure

b. Pressurizer level

c. Tavg

d. Steam Generator level

ANSWER
a.) +/-30 psig (+.25 ea)
b.) +/-5% span
c.) +/-4 deg F
d.) +/-5% span

REFERENCE
SQNP PLS, ppl
PWG-7: Explain/apply Limits & Precautions (3.5/4.0)

TVA COMMENTS

Some of these spans are outside of allowable Tech Spec or procedural limits. Specifically

a. Pressurizer Pressure DNB $\geq$2220 psia
b. All procedural references state maintain on program - no tolerance is specified
c. Tavg $\pm$ 3°F is given as tolerence in GOI-2 step 60

This question is not valid and should be removed from the examination.

(1.0) 8.23 What is the factor W(z) a function of and what does it account for as it applies to the heat flux hot channel factor Fq(z) determination?

ANSWER

It is a cycle dependent function (+.25) that accounts for power distribution transients encountered during normal operations (+.75)

REFERENCE
SQNP TS 3/4.2.2
001/000; K5.45 (2.3/3.6)

TVA COMMENTS

Question asked is not pertinent. This is not handled by the SRO, but by the NUCLEAR ENGINEERS when the related surveillance performed. Question should be deleted.

MASTER

## ENCLOSURE 3

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

| | |
|---|---|
| FACILITY: | SEQUOYAH 1&2 |
| REACTOR TYPE: | PWR-WEC4 |
| DATE ADMINISTERED: | 85/11/12 |
| EXAMINER: | DEAN, W M |
| APPLICANT: | ______________________ |

INSTRUCTIONS TO APPLICANT:

Use separate paper for the answers. Write answers on one side only. Staple question sheet on top of the answer sheets. Points for each question are indicated in parentheses after the question. The passing grade requires at least 70% in each category and a final grade of at least 80%. Examination papers will be picked up six (6) hours after the examination starts.

| CATEGORY VALUE | % OF TOTAL | APPLICANT'S SCORE | % OF CATEGORY VALUE | CATEGORY |
|---|---|---|---|---|
| 28.5 ~~[illegible]~~ | 24.5 ~~[illegible]~~ | ________ | ________ | 5. THEORY OF NUCLEAR POWER PLANT OPERATION, FLUIDS, AND THERMODYNAMICS |
| 29.5 ~~[illegible]~~ | 25.3 ~~[illegible]~~ | ________ | ________ | 6. PLANT SYSTEMS DESIGN, CONTROL, AND INSTRUMENTATION |
| 28.5 ~~[illegible]~~ | 24.5 ~~[illegible]~~ | ________ | ________ | 7. PROCEDURES - NORMAL, ABNORMAL, EMERGENCY AND RADIOLOGICAL CONTROL |
| 30.00 | 25.7 ~~[illegible]~~ | ________ | ________ | 8. ADMINISTRATIVE PROCEDURES, CONDITIONS, AND LIMITATIONS |
| 116.5 ~~[illegible]~~ | 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)

The reactor is critical at 10,000 cps when a S/G PORV fails open. Assuming BOL conditions, no rod motion, and no reactor trip, choose the answer below that best describes the values of Tavg and nuclear power for the resulting new steady state. (POAH = point of adding heat).

a. Final Tavg greater than initial Tavg, Final power above POAH.

b. Final Tavg greater than initial Tavg, Final power at POAH.

c. Final Tavg less than initial Tavg, Final power at POAH.

d. Final Tavg less than initial Tavg, Final power above POAH.

QUESTION 5.02 (1.50)

A motor driven centrifugal pump is operating at a low flow condition. You then start opening the throttle valve on the discharge side. How will each of the following be affected? (Increase, Decrease or No Change)

a) Discharge Pressure (0.5)

b) Available NPSH (0.5)

c) Motor Amps (0.5)

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

QUESTION 5.03 (2.00)

An ECP is calculated for a startup 4 hours after a shutdown from 100% steady state power. Indicate whether the actual critical position will be GREATER THAN, LESS THAN or the SAME as the ECP for the following conditions.

1) The steam dump pressure setpoint is increased by 35 psig (0.5)

2) All steam generator levels are increased by 5% one minute before the calculated ECP is to be reached (0.5)

3) Condenser vacuum is reduced 3 " Hg due to a small air leak (0.5)

4) Reactor startup is delayed for 6 hours (0.5)

QUESTION 5.04 (2.00)

Indicate whether the following will cause the differential rod worth to INCREASE, DECREASE or have NO EFFECT.

a) An adjacent rod is inserted to the same height

b) Moderator temperature is INCREASED

c) Boron concentration is DECREASED

d) An adjacent burnable poison rod depletes

QUESTION 5.05 (1.00)

In order to achieve the highest NPSH at the suction of a pump, indicate where the most advantageous location of the heat source and the heat sink would be relative to the pump. (i.e. upstream or downstream)

QUESTION 5.06 (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?

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

QUESTION 5.07 (.50)

Attached is a curve showing the moderator to fuel ratio vs. Keff with the optimum point identified. This is the point when the Moderator Temperature coefficient would be just zero. If we were to add boron how would the optimum point shift on this curve?

QUESTION 5.08 (1.50)

Attached are curves showing the Fuel Temperature Coefficient at BOL and EOL. Compared to the BOL curve, explain why the FTC is more negative at low temperatures/EOL and less negative at high temperatures/EOL.

QUESTION 5.09 (1.50)

List the 3 conditions necessary for brittle fracture to occur in metal.

QUESTION 5.10 (1.50)

List the three main power producing isotopes in the core at end of life and indicate their approximate contribution (in %) to power.

QUESTION 5.11 (1.[illegible])

When performing a reactor startup to full power that commenced 5 hours after a trip from full power equilibrium conditions, a 2%/min ramp rate was used. If a 0.5%/min ramp rate was used instead, how would that effect the magnitude and time of occurrence of the xenon concentration dip?

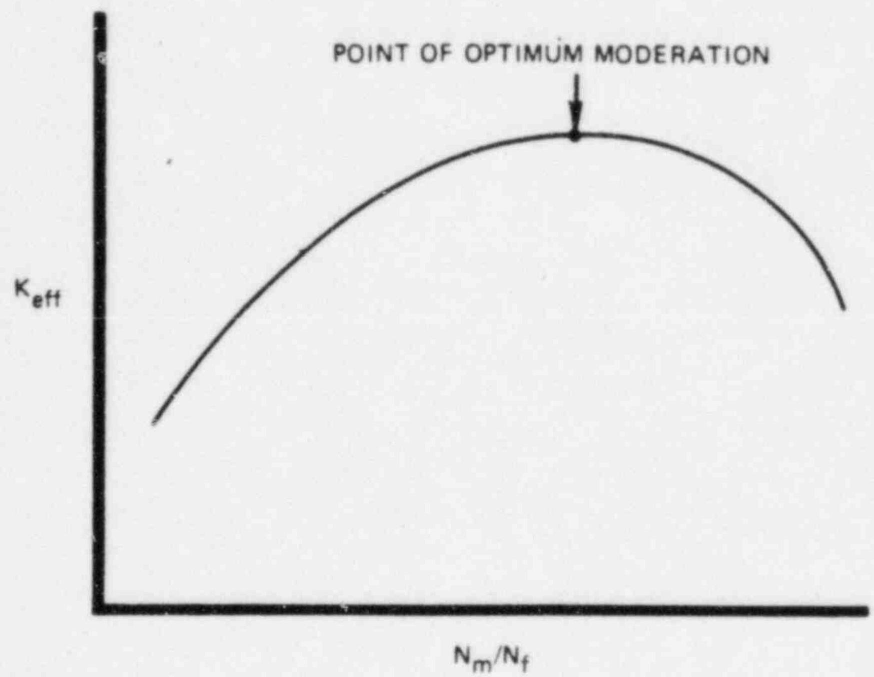
QUESTION 5.12 (1.[illegible])

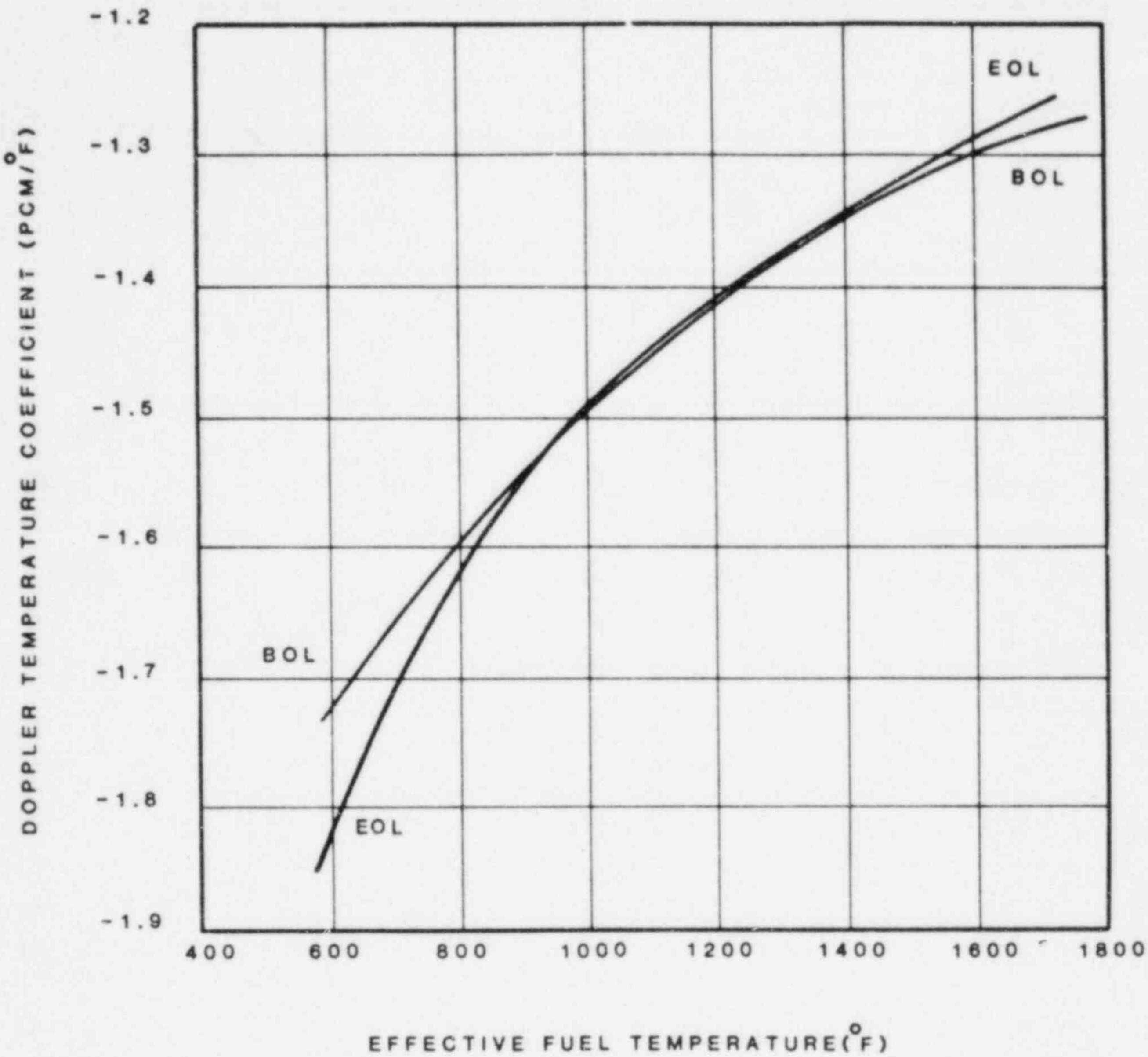
What are the reasons for shifting the SI mode from cold leg recirculation to hot leg recirculation approximately 24 hours after a LOCA?

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

REACTOR OPERATION

8. Coeffecients and Control (continued)






DOPPLER TEMPERATURE COEFFICIENT BOL,EOL

QUESTION 5.13 (1.00)

What is the reason that Tech Specs allow up to two hours of operation with a Quadrant Power Tilt Ratio in excess of 1.02?

QUESTION 5.14 (1.00)

Identify the nuclides composing the secondary source utilized in your reactor and describe how this source is 'regenerated'.

~~QUESTION 5.15 (1.50)~~ – Deleted

~~What are the two factors associated with delayed neutron precursors that influence the value of Beta Bar Effective and what effect do they have?~~

QUESTION 5.16 (1.25)

Over core life there are two effects that cause differential boron worth to change. List these two effects, their relative impact on differential boron worth and indicate which effect is the overriding factor.

QUESTION 5.17 (1.00)

The reactor is operating at 100% power with all rods out, near EOL with equilibrium Xenon conditions when power is to be reduced to 50%. The operator observe that AFD is within its band and decides to lower power by borating, leaving rods in the ARO position. Actual Tavg follows programmed Tavg. Describe the change that will occur in AFD and why it occurs, prior to changes in Xenon having a noticeable effect.

QUESTION 5.18 (1.00)

Provide the definitions for the following terms:

a) DNBR
b) Specific Entropy

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

QUESTION 5.19 (1.50)

Sketch the K(z) height correction factor curve used in the heat flux hot channel factor calculation and explain the basis behind any changes in the curve's deviation from 1.0.

QUESTION 5.20 (1.75)

Sketch the reactor coolant channel Boiling Water curve, indicating the four main boiling regions and the point of DNB. Ensure you label the axes correctly.

QUESTION 5.21 (1.50)

The following data was obtained during a core refueling.

| Number of Assemblies Loaded | Neutron Count Rate |
| --- | --- |
| 0 | 40 cps |
| 5 | 70 cps |
| 10 | 90 cps |
| 15 | 115 cps |

Determine the number of assemblies it will take to reach criticality. Use the attached graph paper if desired. (Assume equal assembly worth)

QUESTION 5.22 (1.00)

Using the attached steam tables, what is the amount of primary subcooling if the pressurizer is at 2235 psig and Tavg is 575 degrees F?

QUESTION 5.23 (1.00)

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

***** END OF CATEGORY 05 *****

QUESTION 6.01 (1.00)

The pressurizer safety valves are designed to limit RCS pressure to within the safety limit of 2735 psig following a complete loss of turbine generator load while at rated thermal power. Which of the following mitigating events is assumed to have occurred in the analysis for this design basis?

a. Reactor trip due to turbine loss of load
b. PORV operation
c. Hi PZR pressure trip
d. Both spray valves actuate
e. Relief valves on all 3 S/Gs actuate

QUESTION 6.02 (1.00)

Which statement below regarding Diesel Generator load sequencing is correct if a LOCA occurs AFTER a LOSS OF POWER?

a. Loads already sequentially connected will remain connected.

b. Loads awaiting sequential loading that are required for an accident will have their sequential timers reset to time zero.

c. The non-accident loads not yet connected will be sequenced on once all accident related loads are connected.

d. ALL loads will be stripped, then ONLY the accident related loads will be sequentially connected.

QUESTION 6.03 (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

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

QUESTION 6.04 (2.00)

Indicate whether the following situations will ARM ONLY, ARM AND ACTUATE or HAVE NO EFFECT on the steam dump system.

a) 50% power, 18% step load increase, Tavg<Tref by 5 degrees F, steam dumps in Tavg mode of operation

b) 80% power, 7.5%/min ramp decrease in turbine load for 3 minutes, Tavg>Tref by 7 degrees F, steam dumps in Tavg mode of operation

c) Hot Zero Power, Tavg=549 degrees F, steam dumps in STM PRESS mode with 1005 psig set into the steam pressure controller

d) Turbine trip, Tavg=542 degrees, steam dumps in Tavg mode

QUESTION 6.05 (1.50)

Indicate whether the following CVCS valves will FAIL OPEN, CLOSED or AS IS on a Loss of Instrument Air.

a) Low Pressure Letdown Valve (PCV-62-81)
b) Charging Flow Control Valve (FCV-62-93
c) Letdown Orifice Isolation Valves (FCV-62-73, -74 and -75)

QUESTION 6.06 ~~(1.75)~~ (1.50)

List the ~~7~~ 6 Diesel engine shutdown troubles which are bypassed when there has been an emergency start.

QUESTION 6.07 (1.50)

a. Fill in the blanks in th following statement regarding liquid waste processing:
Liquid, whose tritium concentration is _____% or more of the _____ tritium concentration, is designed to be processed as tritiated liquid. (0.5)

b. List the flowpath of Radioactive Liquid from the Liquid Waste Processing System starting with the Waste Condensate Tanks and ending with the environment. Include the piping through which it passes. (1.0)

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

QUESTION 6.08 (1.[illegible])

a) What is the maximum differential temperature allowed by Tech Specs between the pressurizer spray and the pressurizer?

b) What is the purpose of the loop seal located below each pressurizer safety valve? (0.5)

c) What is the driving force for normal spray flow? (0.5)

QUESTION 6.09 (1.25)

Fill in the blanks to complete the following statements concerning fuel handling interlocks:

a) The refueling canal lifting arm is interlocked with the _____. The lifting arm cannot be lifted unless the _____ is in the _____ position or the crane is _____. (1.0)

b) Bridge and trolley drive operation is prevented except when _____ are activated. (0.25)

QUESTION 6.10 (1.50)

Fill in the blanks in the statement below concerning the Containment Air Return System:

Both fans are actuated upon an _____ actuation signal but are delayed starting for _____ minutes. They continuously draw air from the dome of the containment vessel and from the following pocketed spaces _____, _____, _____ and _____.

QUESTION 6.11 (1.25)

What are the reactor trips which are enabled/blocked by the reactor trip system interlock P-7?

QUESTION 6.12 (1.00)

Describe the flow path of the Containment Spray System when the RWST is too low to support spray operation, assuming there is still ice in the Ice Condenser. (Identify all components, excepting valves in the path)

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

QUESTION 6.13 (1.50)

What signals will automatically initiate the operation of the Auxiliary Building Gas Treatment System?

QUESTION 6.14 ~~(1.75)~~ (1.50)

a) List the signals which will cause an automatic isolation of the Feedwater System. (0.75)

b) List the automatic actions that occur due to the feedwater isolation signal. ~~(1.0)~~ (0.75)

QUESTION 6.15 (1.25)

Where are thermal sleeves associated with RCS penetrations located?

QUESTION 6.16 (1.00)

List the conditions required for Automatic Swapover from the Injection Mode to the Recirculation Mode following an SI and which valves are AUTOMATICALLY repositioned.

QUESTION 6.17 ([illegible].75)

List three interlocks that would prevent the AUTOMATIC transfer of a 6.9 KV Shutdown Board from its normal supply to its alternate supply.

QUESTION 6.18 (2.00)

Describe the 4 flow paths within the reactor vessel which BYPASS the fuel rods.

QUESTION 6.19 (1.00)

What feature associated with the control rod drive shaft unlatching tool prevent accidental dropping of the control rod if a loss of air occurs?

***** CATEGORY 06 CONTINUED ON NEXT PAGE *****

QUESTION 6.20 (1.50)

a) Describe the order of processing elements in the Air Cleanup Units through which air is drawn by the Air Cleanup Subsystem. (1.0)

b) How are the processing elements in an INACTIVE air cleanup unit loaded with radioactive material kept cool? (0.5)

QUESTION 6.21 (1.25)

The Detector Current Comparator receives input from all 4 upper and lower power range detectors. How are these inputs compared, what is the alarm setpoint and when is this circuitry in operation?

QUESTION 6.22 (1.00)

With the pressurizer level control selector switch in position I/II, a failure causes the following plant events. (Assume no operator actions taken.)

1. Charging flow reduced to minimum
2. Pressurizer level decreases
3. Letdown secured and heaters off
4. Level increases until high level trip

Which instrument failed (I or II) and in what direction did it fail?

QUESTION 6.23 (1.00)

What is the overall purpose of the 6.9 KV Utility Bus?

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

QUESTION 7.01 (1.00)

Which of the following would NOT require Emergency Boration?

a. Excessive control rod withdrawal while at power.

b. Uncontrolled reactor heatup following a reactor trip.

c. Failure of the Boric Acid Flow Controller FC-62-139 to function while performing a boration to reduce power.

d. Excessive control rod insertion while at power.

QUESTION 7.02 (1.00)

With the reactor trip breakers SHUT and the S/Gs under Nitrogen pressure, the nitrogen must be vented off prior to opening the MSIVs. Which of the following is the reason for this precaution?

a. To prevent SIS actuation on S/G High Differential Pressure

b. To prevent damage to the MSIV seats

c. To prevent ESFAS actuation on high steamline flow

d. To prevent EST actuation on S/G Lo-Lo Level

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

QUESTION 7.03 (1.00)

Which of the following statements describes the correct action to take if, on a reactor startup, criticality is achieved ABOVE the zero power rod insertion limit, but BELOW the +/- 1000 pcm criticality band?

a. Insert rods to the zero power insertion limit and recalculate the ECP.

b. Discontinue the startup, calculate and then conduct the necessary boration to ensure that criticality is achieved within the 1000 pcm band.

c. Continue with the startup, logging the conditions at which criticality was achieved and notify the nuclear engineering dept.

d. Insert ONLY the control bank rods to the bottom of the core and recalculate the ECC.

e. Insert ONLY the control banks to the bottom of the core and recommence the startup using a 1/M plot to approach criticality.

QUESTION 7.04 (1.00)

Which of the following statements regarding the Faulted Steam Generator Isolation procedure, E-2, is correct?

a. If the faulted S/G cannot be identified from observation of S/G pressure, then ALL MSIVs & MSIV bypasses are shut and AFW to the S/Gs is isolated.

b. A faulted S/G cannot be used for RCS cooldown.

c. The pressure difference between the RCS and the faulted S/G should not exceed 1000 psid.

d. High radiation levels on either the S/G Blowdown monitors or the condenser exhaust monitors are primary symptoms that a faulted S/G exists.

***** CATEGORY 07 CONTINUED ON NEXT PAGE *****

QUESTION 7.05 (1.00)

Which of the following would cause the greatest biological damage to a man?

a. 0.1 Rad of Fast Neutron.

b. 10 Rad of Gamma.

c. 20 Rad of Beta.

d. 0.5 Rad of Alpha.

QUESTION 7.06 (1.00)

Which of the following describes what is meant by 'Nothing Detectable' as it is utilized in determining the existence of Beta-Gamma contamination on skin or clothing surfaces?

a. Less than 100 dpm above background as measured with a pancake probe.

deleted

b. Less than 100 dpm above background as measured with a smear.

c. Less than 3 times background counts as measured with a smear as counted for one minute.

d. Less than 3 times the square root of a one minute background count as measured by a smear counted for 1 minute.

QUESTION 7.07 (2.00)

Prior to a reactor startup, with the RCS at normal operating pressure and temperature, the following RCS leakages exist. For each leak listed below, indicate whether you could STARTUP or would have to remain SHUTDOWN. (Treat each leak below as an independent event)

a) A leak from an unknown source of 1.0 GPM.

b) 5.0 GPM from a manual valve packing gland.

c) 0.4 GPM from one S/G.

d) 0.1 GPM from the reactor vessel head INNER seal.

***** CATEGORY 07 CONTINUED ON NEXT PAGE *****

QUESTION 7.08 (1.00)

Fill in the blanks in the following statements regarding the monitoring of AFD and actions to be taken if specifications are not met.

> The AFD shall be considered outside of its limits when at least _____ OPERABLE excore channel(s) is/ are indicating the AFD to be outside its limit. When the indicated AFD is outside its allowable limit it must be restored to specifications within _____ (time) or Thermal Power must be reduced to less than _____% of Rated Thermal power within _____ (time).

QUESTION 7.09 (1.00)

Fill in the blanks with the appropriate limits listed in the precautions section of the GOIs!

a) A load change of +/- ______%/min or a step change of _____% should not be exceeded.

b) The boron concentration difference between the pressurizer and the RCS must not exceed _____ppm.

c) The arming temperature setpoint for UNIT 1's Pzr PORVs is _____deg F.

QUESTION 7.10 (1.00)

Fill in the blanks for the following statements regarding operator actions in abnormal situations.

a) When the AFD monitor alarm is INOPERABLE, the AFD must be logged every _____ hour(s) by performing SI-44.

b) Any off-frequency turbine operation is to be avoided to prevent the probable occurrence of _____.

c) When the QPTR alarm is INOPERABLE, the QPTR must be calculated every _____ hour(s) by performing SI-135.

d) For UNIT 1, holding the turbine at approximately 90% load is to be avoided to prevent ______.

QUESTION 7.11 (.50)

In order to bypass a Fuel Handling equipment interlock, whose permission is required?

QUESTION 7.12 (1.50)

Fill in the blanks below to complete the statement regarding solid water operations:

Whenever the plant is utilizing letdown from RHR, the _____ control valve should be used to maintain pressure, while the _____ control valve should be fully open. Power to the _____, the _____ and _____ should be tagged out to minimize the possibility of overpressurizing due to an SI signal. Whenever the reactor coolant temperature is above _____ deg F, at least one RCP must be in operation.

QUESTION 7.13 (1.50)

List the required actions on an ATWS if the trip breakers can NOT be opened as listed in Function Restoration Guideline FR-S.1. For any action that requires local operation of devices, include the location from which the device must be operated.

QUESTION 7.14 (2.00)

a) On a station blackout, what are the 3 loads that are sequentially loaded automatically onto the diesels. (1.2)

b) There is a precaution in the Loss of Offsite Power procedure (AOI-35) to ensure that the diesels are loaded to > 1600 KW within 4 hours (assuming the diesels are required that long). What is the purpose of this precaution? (0.8)

QUESTION 7.15 ~~1.50~~ (1.00)

List the immediate actions in AOI-7, 'Probable Maximum Flood', assuming the plant has been notified by the Division of Water Management that flood producing conditions may develop.

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

QUESTION 7.16 (1.25)

As stated in the facility's ALARA program, what are the FIVE MINIMUM requirements to be included in pre-job ALARA planning and which should be included by the cognizant supervisor on the pre-job ALARA planning report?

QUESTION 7.17 (1.50)

a) List the two radiologically oriented limits that, if exceeded, would prompt the Site Emergency Director to move the assembly point for plant personnel to the employee parking lot? (0.5)

b) Where is the preferred evacuation site for on-site personnel if evacuation to an off-site location is required? (0.5)

c) What emergency conditions (ie. what classifications) require activation of the Technical Support Center? (0.5)

QUESTION 7.18 (1.50)

a) What conditions must be met for the ECCS suction to be shifted automatically to the containment sump following an SI initiation? (0.5)

b) If a containment sump valve [illegible] can NOT be fully opened when an automatic swapover [illegible] what operator actions are required? (1.0)

QUESTION 7.19 [illegible]

List ALL the [illegible] steps from [illegible] 'Reactor Trip or Safety Injection' that allow you to accomplish the following immediate actions?

a) Verify [illegible] (0.5)

b) Verify Containment Isolation [illegible] alignment (0.5)

c) Verify AFW status (0.5)

***** CATEGORY 07 CONTINUED ON NEXT PAGE *****

QUESTION 7.20 (1.00)

What are the three parameters that are monitored to determine RCS cooldown in accordance with ES-0.3, 'Natural Circulation Cooldown'?

QUESTION 7.21 (1.00)

Prior to commencing a Natural Circulation Cooldown per ES-0.3, it is necessary to increase the RCS boric acid addition by 15%. Why is this required?

QUESTION 7.22 (1.25)

On a control room evacuation, AOI-27A has various checklists that must be completed in locations throughout the plant. The procedure identifies the following personnel as available to the shift engineer to perform specific tasks in the plant: assistant shift engineer and 4 assistant unit operators. Where are the 5 locations to which these personnel go to carry out their assigned duties? (Only include locations applicable to a single unit)

QUESTION 7.23 (1.00)

Place the steps listed below, which are performed during a plant startup, in the proper sequential order.

1. Transfer 6.9 kV unit board 1A from Start Bus 1A to unit station transformer 1A.
2. Transfer S/G feedwater regulating valve control to AUTO.
3. Transfer steam dumps to Tavg mode.
4. Transfer rod control to AUTO.

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

QUESTION 8.01 (1.00)

Prior to unbolting the reactor vessel head, the minimum boron concentration must meet which of the following requirements?

a. 2000 ppm OR enough to ensure keff is less than 0.95, whichever is LESS.

b. 2000 ppm WITHOUT regard to keff.

c. Enough to ensure keff is less than 0.95 WITHOUT regard to concentration.

d. 2000 ppm OR enough to ensure keff is less than 0.95, whichever is GREATER.

QUESTION 8.02 (1.00)

Which of the following statements concerning Shutdown Margin (SDM) considerations is correct?

a. With Tavg less than 200 degrees, the SDM requirements are increased because of the possibility of a positive MTC.

b. The most restrictive condition for SDM requirements occurs at EOL, with Tavg at no load temperature, and is associated with a rod ejection accident.

c. When in Mode 2 with keff less than 1.0, adequate SDM is ensured by verifying the predicted critical rod position is above the rod insertion limits.

d. If one rod is known to be partially inserted and untrippable, an increased allowance for the entire rod worth shall be made to the SDM requirements.

QUESTION 8.03 (1.00)

While in Mode 1, a Pressurizer Code Safety Valve is determined to be INOPERABLE. How long do you have to restore the Code Safety to operability before Tech Specs require you to initiate shutdown to Hot Standby?

a. You must immediately start your shutdown procedure
b. 15 minutes
c. 30 minutes
d. 1 hour

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

QUESTION 8.04 (1.00)

Technical Specifications require two RHR loops to be OPERABLE during cold shutdown. Certain equipment may be substituted for one of the RHR loops. Which condition below will satisfy this substitution requirement?

a. Four filled RCS loops with two S/Gs > 10% level(Wide)

b. Four filled RCS loops with one SI pump and RWST > 50% level

c. Four filled RCS loops with two OPERABLE RCPs and one OPERABLE AFW Pump with CST level > 10%

d. Four filled RCS loops with one OPERABLE RCP and one SI pump

QUESTION 8.05 (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) 0-M-27A (ERCW)
b) 0-M-26A (Cooling Tower Pump Controls)
c) 0-M-25 (Meteorological/Environs Monitoring)

QUESTION 8.06 (1.00)

Answer TRUE or FALSE to the following.

a. If a component covered by Technical Specifications is INOPERABLE due solely to the fact that its Emergency Power supply is INOPERABLE, then surveillance requirements on that component still must be satisfactorily completed within the proper time frame.

b. If a LCO is NOT met and the ACTION statements are NOT applicable, then the Senior Reactor Operator has the authority to disregard that particular LCO.

QUESTION 8.07 (2.00)

Indicate WHETHER or NOT the following conditions REQUIRE that the plant be in Hot Standby within one hour.

a. In Mode 1 with one cold leg injection valve failed in the closed position.

b. In Mode 1 with UHI accumulator at 1950 ppm boron.

c. In Mode 1 with RCS pressure having exceeded 2800 psig.

d. In Mode 1 without primary containment integrity.

QUESTION 8.08 (1.50)

Match the following reactor trips with the condition each is designed to protect against.

| REACTOR TRIP | ACCIDENT |
|---|---|
| a. Overpower Delta T | 1. Power excursions during low power operation |
| b. Intermediate Range High Flux | 2. Control rod drop |
| | 3. DNB |
| c. Undervoltage RCP Bus | 4. Control rod drive housing rupture |
| d. Overtemperature Delta T | 5. [illegible] fuel pellet melting |
| | 6. [illegible] of heat sink |
| e. Power Range Positive Rate | 7. Uncontrolled rod cluster assembly withdrawal from subcritical conditions |
| | 8. No credit taken for this in accident analysis |

QUESTION 8.09 (1.50)

Match the RCS leakage types in Column A to the Technical Specification limits in Column B. (Assume plant is in [illegible]) 1.5

| COLUMN A | COLUMN B |
|---|---|
| a. Through pzr PORV to PRT | 1. [illegible] gpm |
| b. From RCS into steam generators | 2. 1 gpm |
| c. From unknown location | 3. [illegible] gpm |
| d. To RCP seal supply | 4. 30 gpm |
| e. Unisolable fault on RTD bypass line | 5. 40 gpm |
| | 6. 50 gpm |

QUESTION 8.10 (1.00)

Complete the following statements concerning refueling operations by filling in the correct number.

a) At least ______ feet of water shall be maintained over the top of irradiated fuel assemblies seated in the storage racks.

b) Prior to movement of irradiated fuel in the reactor pressure vessel the reactor shall have been subcritical for at least ______ hours.

QUESTION 8.11 (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 8.12 (1.00)

If a yellow 'Controlled Copy' of an instruction is NOT available to perform a task and the maintenance scheduling office is NOT staffed, what must be done for a worker to obtain a 'Controlled Copy'?

QUESTION 8.13 ( .75)

According to SQNP AI-2, what three personnel (by title) can relieve the Shift Engineer of his licensed functions, assuming they have a valid SRO license?

QUESTION 8.14 ( .75)

The SE is responsible for issuing clearances at Sequoyah Nuclear Plant through his representatives. List the authorized representatives of the SE who may issue clearances.

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

QUESTION 8.15 (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 _____ 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 8.16 (1.00)

a) Where/from whom can keys for containment access be obtained? (0.75)

b) Prior to entry into the lower containment, on what component must the SE initiate a hold order clearance? (0.25)

QUESTION 8.17 (1.00)

Technical Specification 3/4.2.5, DNB Parameters, gives limits for two DNB related parameters. What are these two parameters?

QUESTION 8.18 (0.75)

Recent failures of FK-2 test block terminal posts utilized during routine testing of circuits has occurred recently at Sequoyah Nuclear Power Plant. Though the root cause of this problem is as yet undetermined, what are the potential problems associated with a terminal post failure?

QUESTION 8.19 (1.00)

What are the tolerances within which the following control systems must be maintained while in manual control in a steady state condition?

a) Pressurizer pressure
b) Pressurizer level
c) Tavg
d) Steam Generator level

***** CATEGORY 08 CONTINUED ON NEXT PAGE *****

QUESTION 8.20 (1.50)

List the FIVE bases for the minimum temperature for criticality limit of the Technical Specifications.

QUESTION 8.21 (1.00)

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 two conditions are met. List these TWO conditions.

QUESTION 8.22 ( .75)

While in Mode 3, under WHAT CONDITIONS may that Unit's Assistant Shift Engineer (ASE) leave the control room FOR WHAT REASONS?

QUESTION 8.23 (1.00)

What is the factor $W(z)$ a function of and what does it account for as it applies to the heat flux hot channel factor $F_Q(z)$ determination?

QUESTION 8.24 ([illegible])

What are the bases for the primary to secondary tech spec leakage limits?

QUESTION 8.25 ([illegible])

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

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

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

QUESTION 8.26 (.50)

Why must a nitrogen blanket be provided in the pressurizer and reactor vessel head during the early stages of a reactor coolant drain operation?

QUESTION 8.27 (1.00)

What are the bases for the following precautions associated with the UHI System:

a) Do not allow the Nitrogen pressure to increase above the high alarm setpoint.

b) When testing the hydraulic isolation valves in the AUTO mode, place a wood block under the hydraulic accumulator.

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

ANSWER 5.01 (1.00)

d

REFERENCE

Westinghouse Reactor Physics, Section I-5, MTC and Power Defect
DPC, Fundamentals of Nuclear Reactor Engineering

039/000; A2.05(3.3/3.6)

ANSWER 5.02 (1.50)

a) Decrease (+.5 ea)
b) Decrease
c) Increase

REFERENCE

Nuclear Power Plant Operator Trng Prgrm, HTFF and Thermo, Sect 2E

App A: Pumps/Centrifugal, Pump characteristic relationships (2.6/2.6)

ANSWER 5.03 (2.00)

1) Higher (Tavg increases adds negative reactivity)
2) Lower (Tavg decreases due to cold feedwater addition)
3) No effect
4) Higher (Xenon concentration increases adding negative reactivity)

REFERENCE

NUS, Vol 3, Unit 11

001/000; K5.39 (3.7/3.9) & K5.38 (3.5/4.1)

ANSWER 5.04 (2.00)

a) Decrease (+.5 ea)
b) Increase
c) Increase
d) Increase

ANSWERS -- SEQUOYAH 1&2 -85/11/12-DEAN, W M

REFERENCE
SQN/WBN License Requal Training, 'Core Poisons'

001/000; K5.09 (3.5/3.7) & K5.02 (2.9/3.4) & K5.10 (3.9/4.1)

ANSWER 5.05 (1.00)

Heat source- downstream (+.5 ea)
Heat sink- upstream

REFERENCE
Nuclear Power Plant Operator Training Program, HTFF and Thermo; Sect 2E

App A: pumps/centrifugal, NPSH (3.4/3.6)

ANSWER 5.06 (2.00)

1) Control rods within + or - 12 steps of group demand position (+.5 ea)
2) Proper sequencing and overlap of rod groups
3) Control rod insertion limits are maintained
4) AFD is maintained within limits

REFERENCE
SQN TS B 3/4 1-2

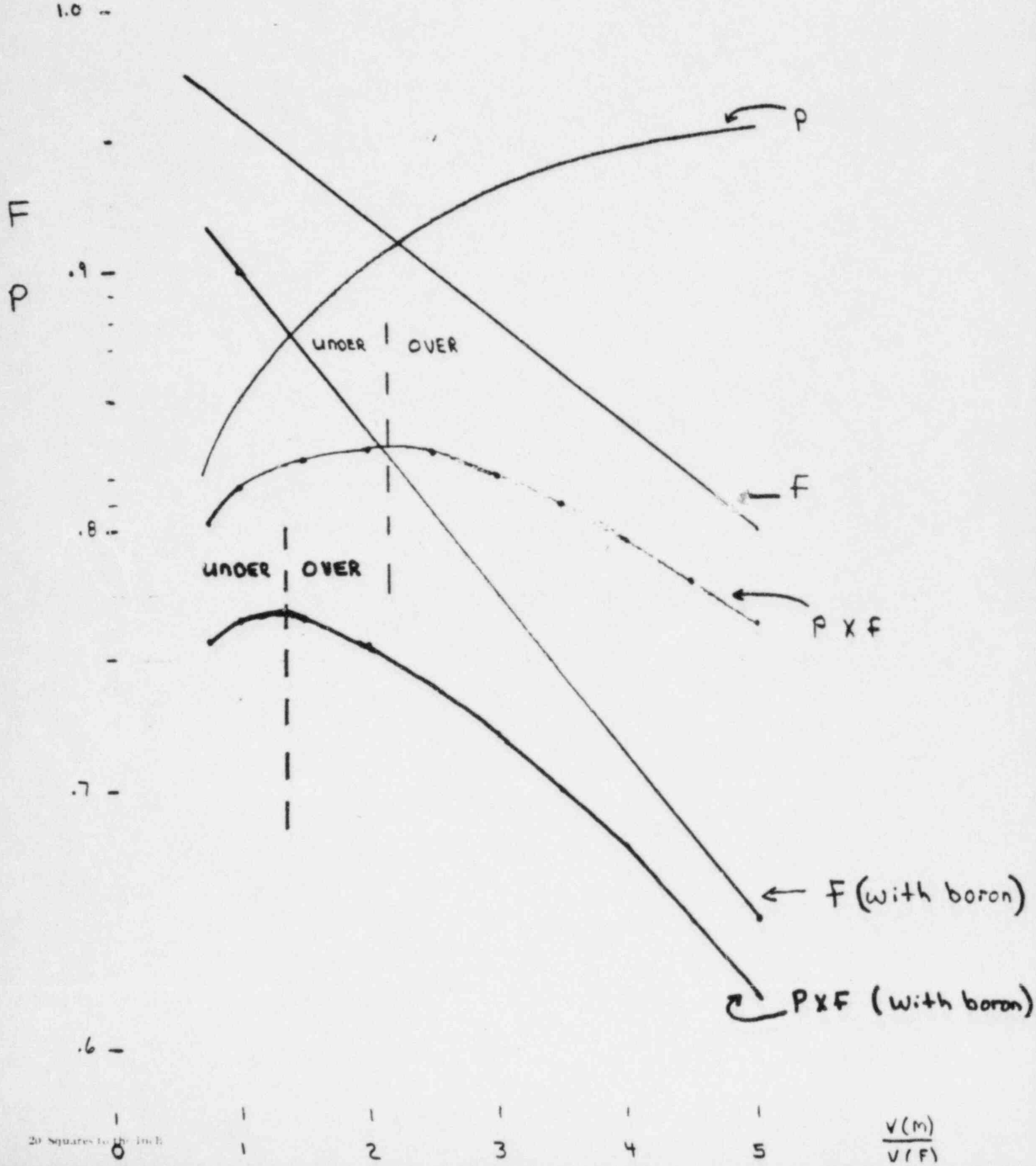
001/000; K5.08 (3.9/4.4) & K5.28 (2.7/3.2)

ANSWER 5.07 ( .50)

Optimum point would move down and to the left (+.5)

REFERENCE
SQN/WBN License Cert Trng, 'Reactivity Coefficients'

004/000; K5.15 (3.3/3.5)



20 Squares to the Inch

ANSWERS -- SEQUOYAH 1&2 -85/11/12-DEAN, W M

ANSWER 5.08 (1.50)

1) At EOL/Low temp, Pu-240 buildup and increases the number of resonance peaks (+.50)
2) At EOL/High temp, the Pu-240 buildup is counteracted by the effects of clad creep and pellet expansion increasing the thermal conductivity of across the fuel rod gap hence the fuel is at a lower temperature for a given RCS temperature. (+1.0)

REFERENCE
SQN/WBN License Cert Trng, 'Reactivity Coefficients', pp 7/8

001/000; K5.48 (3.3/3.5)

ANSWER 5.09 (1.50)

Nominal tensile stress (+.5)
Temperature below RTndt (+.5)
Sufficient sized surface defect (+.5)

REFERENCE
SQN TS, B 3/4.4.9

002/000; K5.18 (3.3/3.8)

ANSWER 5.10 (1.50)

U-235 Approx ~~[illegible]~~ 47-57% (+.25 for isotope, +.25 for contribution to power ~~+/- 2%~~)
Pu-239 " ~~[illegible]~~ 36-46%
U-238 " 7%

REFERENCE
SQN/WBN License Cert Trng, 'Reactor Kinetics', pp 8

001/000; K5.47 (2.9/3.4)

ANSWER 5.11 (1.00)

The xenon dip would be larger (+.5) and occur later (+.5)

REFERENCE
SQN/WBN Inst. Guide 'Review of Core Poisons', pp 5/6
Westinghouse Nuclear Training Operations, pp I-5.76

001/000; K5.38 (3.5/4.1)

ANSWER 5.12 (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

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

ANSWER 5.13 (1.00)

Allows for time to identify and correct a dropped or misaligned rod (+1.0)

REFERENCE
SQN TS B 3 4.2.4

EPE-003; PWG-5 (2.7/3.9)

ANSWER 5.14 (1.00)

Sb-Be Source (+.25)
when Sb-123 is activated by a neutron it produces a gamma (+.25) that
interacts with Be-9 (+.25) that produces Be-8 and another neutron (+.25)

REFERENCE
SQN/WBN License Certification Training, 'Neutron Sources and Subcrt Mult'

004/000; K5.05 (2.3/2.8)

ANSWERS -- SEQUOYAH 1&2 -85/11/12-DEAN, W H

Deleted

~~ANSWER 5.15 (1.50)~~

~~1) Delayed neutrons born at lower energies, so less likely to leak out providing a positive effect (+.75)~~
~~2) Delayed neutrons are born at an average energy too low to cause fast fission which provides a negative effect (+.75)~~

~~REFERENCE~~
~~SQN/WBN License Cert Trng, 'Neutron Kinetics'~~

~~001/000; K5.47 (2.9/3.4)~~

ANSWER 5.16 (1.25)

1) As the fuel burns out, less boron is required, which increases the boron worth (+.5) This is the overriding effect (+.25)
2) Fission products build up, decreasing the boron worth (+.5) ~~this is the overriding effect (+.25)~~

REFERENCE
SQN/WBN License Cert Trng, 'Core Poisons', pp 4

004/000; K5.06 (3.0/3.3)

ANSWER 5.17 (1.00)

Due to the greater decrease in the temperature of the coolant exiting the core relative to the decrease of the inlet coolant, (+.5) more positive reactivity will be added in the upper core regions, resulting in a more positive (less negative) AFD (+.5)

REFERENCE
Westinghouse Nuclear Training Operations, Ch 5

001/000; K5.29 (3.7/3.9)

ANSWER 5.18 (1.00)

a) Ratio of Critical Heat Flux to Local Heat Flux (+.5 ea)
b) BTU/lbm-deg F(or R)

REFERENCE
Nuclear Power Plant Operator Training Program, 'HTFF and Thermo'

001/000; K5.45 (2.4/2.9) & K5.46 (2.3/3.6)

ANSWER 5.19 (1.50)

-see attached curve
1) first deviation is to account for the fact that the upper core region is uncovered first and refilled last on a LOCA. (+.5)

2) the second deviation is due to the resistance encountered in refilling the core following a small break LOCA. (+.5)

REFERENCE
SQN TS 3/4.2.2 and SQN FSAR CH 15

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

ANSWER 5.20 (1.75)

See attached curve

REFERENCE
Nuclear Power Plant Oper Trng Prgm, HTFF and Thermo, Figure 18, pp 202

002/000; K5.01 (3.1/3.4)

With the first "tweak" of the heat control knob, the partial vapor blanket spreads over the entire pan surface. We then find a thin layer of steam everywhere on the pan surface. As shown in a previous table of thermal conductivities, steam is an excellent INSULATOR; hence, the pan surface now presents an extremely large resistance to heat transfer. Assuming again that the electric heater can MAINTAIN the desired heat flux, we know from the equation;

$$\dot{Q}/A = U(T_{surf} - T_{liq})$$

that if $\dot{Q}/A$ is held constant and U decreases drastically and $T_{liq}$ is constant, then $T_{surf}$ must increase rather substantially (on the order of 1,000°F).

If the pan surface had been a fuel rod in the reactor core and we allowed full film boiling to take place, the metal of the fuel rod might have melted or been seriously deformed or cracked. Radioactivity would then leak from the damaged rod into the coolant with severe ramifications. DNB, transition boiling, and full film boiling are NEVER permitted in an operating reactor under ordinary conditions.

Now, we should make a plot of the results of our simple experiment. If the heat flux is plotted against the temperature difference between the pan surface and liquid temperature, a figure similar to the one below is obtained.

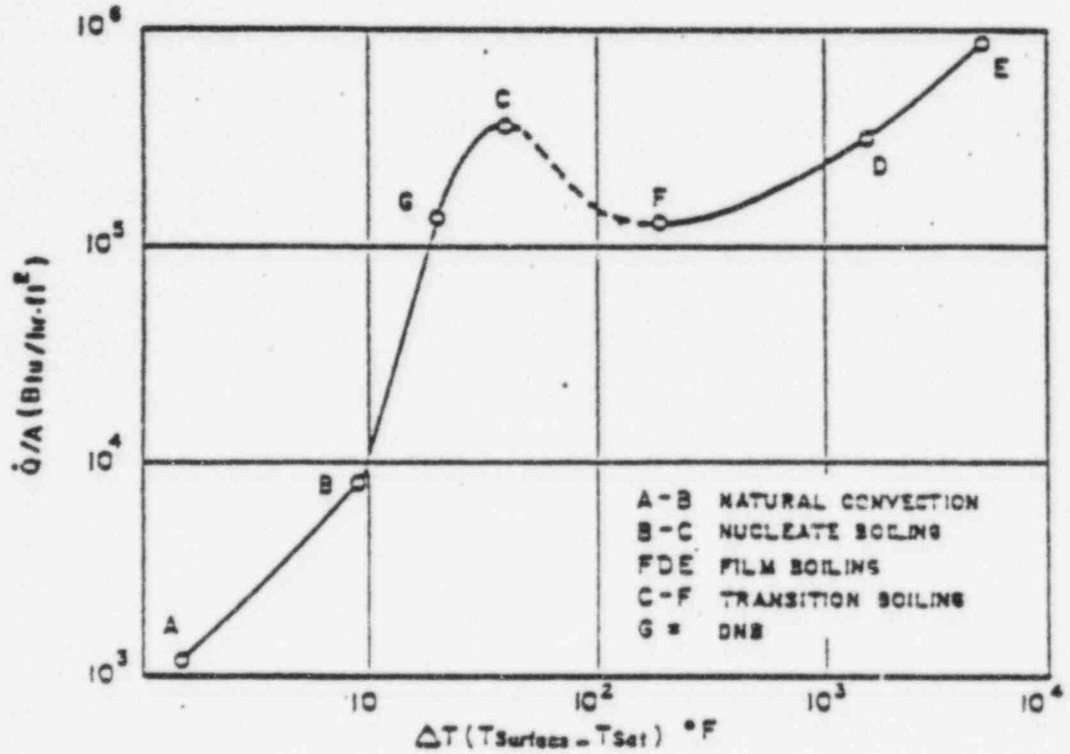



FIGURE 18 BOILING WATER CURVE

ANSWERS -- SEQUOYAH 1&2 -85/11/12-DEAN, W M

ANSWER 5.21 (1.50)

for 0-5 assemblies, 1/M=.571 (+.25)
for 0-10 assemblies, 1/M=.444 (+.25)
for 0-15 assemblies, 1/M=.348; (+.25) for 10-15 assemblies, 1/M=.783

See attached graph for curves (+.75)

REFERENCE
NUS, Vol 3, Units 12.2, 12.3
SQN/WBN License Certification Trng, 'Neutron Sources and Subcritical Mult'

001/010; K5.16 (2.9/3.5)

ANSWER 5.22 (1.00)

for 2250 psia, sat temp = 652 (+.5)
with Tavg = 575, Th = 607 (+.5) -give +/- 2 degrees in determining Th
----
45 degrees F

REFERENCE
Steam Tables and SQN FLS

002/000; A1.04 (3.9/4.1)

ANSWER 5.23 (1.00)

margin to criticality decreases by 2/3 (+1.0)

REFERENCE
SQN/WBN License Certification Trng, 'Neutron Sources and Subcritical Mult'

001/000; K5.18 (4.2/4.3)

ANSWER 6.01 (1.00)

c

REFERENCE
NA NCRODP 88.1, 'RCS-PZR and Press Relief'
SQNP TS B3/4 4-2

010/000; PWG-5(2.9/4.1)

ANSWER 6.02 (1.00)

b or a

REFERENCE
SQNP System Descrip. 'Electrical Distribution' pp 19-20

064/000; K4.10 & K4.11 (3.5/4.0)

ANSWER 6.03 (1.00)

a

REFERENCE
SQNP System Descrip. 'RPS', pp 10 & RPS Mechanical Logic Drawing

012/000; K6.03 (3.1/3.5)

ANSWER 6.04 (2.00)

a) No effect
b) Arm and actuate
c) Arm and actuate
d) Arm only

REFERENCE
Farley SD, 'Steam Dump System', pp 23-28
SQNP System Descrip. 'Steam Dump System', pp 6-8

041/020; K4.11 (2.8/3.1) & K4.14 (2.5/2.8) & K4.17 (3.7/3.9)]

ANSWER 6.05 (1.50)

a) Open (+.5 ea)
b) Open
c) Closed

REFERENCE
NA NCRODP 88.3, 'CVCS'
SQNP AOI-10A, pp 3-5

078/000; K3.02(3.4/3.6)

ANSWER 6.06 ~~(1.75)~~ (1.5)

1) Low Lube Oil Pressure (+.25 ea)
2) High Crankcase Pressure
3) Phase Balance Relay
4) Reverse Power Relay
5) Loss of Field Relay
~~6) Overcurrent Relay~~
7) High Jacket Water Temperature

REFERENCE
NA NCRODP 90.4 'EDG'
SQNP Diesel Generator Handout pp 9

064/000; K4.02(3.9/4.2)

ANSWER 6.07 (1.50)

a) 10%; primary coolant (+.25 ea response)
b) Blowdown line from cooling towers; diffuser pond; diffuser pipes; river (+.25 ea)

REFERENCE
SQNP Sys Descrip. 8.2, 'System Design and Operation(Liquid Waste)' pp 4,15

068/000; PWG-4 (3.1/3.3) & K4.01 (3.4/4.1)

ANSWER 6.08 (1.25)

a) ~~320~~ 560 deg F (+.25)
b) Inhibit H2 leakage or steam leakage which may wire guide the valve seat (+.5)
c) Delta P between the RCP discharge and the PZR (+.5)

REFERENCE
SQNP PLS pp 42; SQNP Lesson Plan 'RCS', pp 27 & 29

010/000; K6.03 (3.2/3.6) & K6.02 (3.2/3.5)

ANSWER 6.09 (1.25)

a) manipulator crane; manipulator crane gripper tube; fully retracted; over the core (+.25 ea)
b) both gripper tube up position switches (+.25)

REFERENCE
SQNP Sys Descrip. 9.0, 'Fuel Handling System' pp 5 & 7

034/000; K4.02 (2.5/3.3)

ANSWER 6.10 (1.50)

Containment Hi-Hi pressure; [illegible] and [illegible] enclosure; accumulator spaces; instrument room (+.25 ea)

REFERENCE
Westinghouse PWR Systems Manual, sect 4.[illegible], pp 14

022/000; PWG-[illegible] (3.5/3.8)

ANSWER 6.11 (1.25)

-PZR high water level (+.25 ea)
-PZR lo pressure
-Lo primary coolant flow
-RCP bus undervoltage or underfrequency
-Loss of flow in at least two loops

REFERENCE
SQNP PLS, pp 4

ANSWERS -- SEQUOYAH 1&2 -85/11/12-DEAN, W M

012/000; K4.06 (3.2/3.5)

ANSWER 6.12 (1.00)

Emergency sump>>>Containment Spray Pumps>>>Containment Spray Ht Exchgrs>>>Containment Spray Nozzles>>>Upper Containment Compartment>>>2 Drains in the bottom of the Refueling Canal>>>Lower Compartment>>>Emergency Sump(+.15 ea)

REFERENCE
SQNP Sys Descrip, 4.5, 'Cont Spray Sys' pp 17/13

026/000; K4.01 (4.2/4.3)

ANSWER 6.13 (1.50)

(+.375 ea)

-Phase A Containment Isolation signal from either Unit ~~(+.5 ea)~~
-High Radiation signal from fuel handling bldg area rad monitors
- " " " " Aux Bldg exhaust vent rad monitors
— High Temp in Aux Bldg Supply Fan Suction

REFERENCE
SQNP Sys Descr, 4.4, 'Cont Air Purif and Cleanup Sys' pp 15

EPE-060; PWG-10 (4.1/4.4)

ANSWER 6.14 ~~(1.25)~~ (1.50)

a) Hi-Hi level in any S/G (>75%) (+.25 ea)
SI signal
Reactor trip with lo Tavg (<554 deg F)
b) Both MFP trip (+.25 ea)
MFWRV and Bypasses shut
~~Condensate system recircs to condenser~~
Feedwater isolation valves close

REFERENCE
SQNP Lesson Plan 'Condensate and Feedwater Review', pp 10

059/000; K4.19 (3.2/3.4)

ANSWER 6.15 (1.25)

-Return lines from RHR loop(SI lines) (+.25 ea)
-PZR Surge line, both ends
-PZR spray into PZR
-Chg line connection
-Aux chg line connection

REFERENCE
SQNP Lesson Plan 'RCS', pp 34/35

002/000; K1.06 (3.7/4.0) & K1.08 (4.5/4.6) & K1.09 (4.1/4.1)

ANSWER 6.16 (1.00)

RWST Lo Level (<29%) and Containment Sump Level > 10% (+.5)
Containment Sump Valves (FCV-63-72 &-73) and RWST to RHR suction(FCV-74-3 & -21) (+0.5)

REFERENCE
SQNP ES 1.2, pp 3

006/020; K4.03 (3.2/3.6)

ANSWER 6.17 (.75)

-alternate feeder does not have ~~has~~ normal voltage (+.25 ea)
-transfer switch is not in AUTO
-trip was ~~not~~ due to overcurrent

REFERENCE
SQNP 'Review of Electrical Distribution' pp 4

062/000; K4.00 (2.8/3.1)

ANSWER 6.18 (2.00)

1) To upper head plenum via holes in core barrel flange (.5 ea)
2) Between hot leg discharge nozzles and upper core barrel outlets
3) Between baffle plates and core barrel
4) Around inserts in guide thimble tubes in the fuel assemblies

REFERENCE
NA NCRODP 38.1, 'RCS-Reactor Vessel/Core Construction'
Westinghouse PWR Systems Manual 'RCS', pp 2.1-39

002/000; K6.13(2.3/2.9)

ANSWER 6.19 (1.00)

The air cylinder actuating the drive shaft latching fingers are spring loaded (+.5) causing them to lock in the shaft latch position (+.5)

REFERENCE
SQNP FHI-10, pp 2

034/000; K6.01 (2.1/3.0)

ANSWER 6.20 (1.5)

a) demister [illegible] HEPA filter bank [illegible] carbon [illegible] electric heating [illegible] carbon adsorber bank [illegible] HEPA filter [illegible] (+.125 ea)
b) Two cross [illegible] flow [illegible] air from the active air cleanup unit (+.5)

REFERENCE
SQNP [illegible] 'Containment Air [illegible]' pp [illegible]

[illegible] A1.01 [illegible]

ANSWER 6.21 (1.25)

The highest reading upper/lower detector is compared to the average of the upper/lower detectors(+.5) and generates an alarm at 1.02 increasing(+.25). The circuit auto defeats below 50% power on ALL channels (+.5)

REFERENCE
SQNP System Descrip. 'Excore NIS', pp 17

015/000; K5.04 (3.1/3.2) & A1.04 (3.5/3.7)

ANSWER 6.22 (1.00)

Level I Channel (+.5) failed high (+.5)

REFERENCE
Westinghouse PWR Systems Manual 'Primary System Control', pp 12-14

011/000; K3.01 (3.2/3.4) & K3.03 (3.2/3.7)

ANSWER 6.23 (1.00)

Provides increased flexibility by allowing ANY 6.9 KV shutdown board (+.5) to be connected to ANY or ALL other 6.9 KV shutdown boards.

REFERENCE
SQNP 'Review of Electrical Distribution' pp 5

062/000; A2.05 (2.9/3.1)

ANSWERS -- SEQUOYAH 1&2 -85/11/12-DEAN, W M

ANSWER 7.01 (1.00)

b

REFERENCE
SQN AOI-34A, pp 1

004/020; PWG-10 (4.3/4.5)

ANSWER 7.02 (1.00)

d

REFERENCE
SQN GOI-1, pp 4

035/010; PWG-7 (3.5/3.9)

ANSWER 7.03 (1.00)

d

REFERENCE
SQNP GOI-2, pp 11

001/010; A2.07 (3.6/4.2)

ANSWER 7.04 (1.00)

a

REFERENCE
SQNP E-2

035/010; A2.01 (4.5/4.6) & PWG-[illegible] (4.1/4.2)

ANSWER 7.05 (1.00)

c

REFERENCE
10CFR20.5

PWG-15: 10 CFR20 Knowledge (3.4/3.9)

~~ANSWER 7.06 (1.00)~~

~~d~~

~~REFERENCE~~
~~SQNP RCI-1, pp 12~~

~~PWG-15: Knowleddge of facility Radcon (3.4/3.9)~~

deleted

ANSWER 7.07 (2.00)

a) Shutdown (+.5 ea)
b) Startup
c) Shutdown
d) Shutdown

REFERENCE
SQN TS 3.4.6.2

002/020; PWG-8 (3.5/4.4)

ANSWER 7.08 (1.00)

2: 15 minutes; 50: 30 minutes (+.25 ea)

REFERENCE
SQN TS 3/4.2.1

015/020; PWG-8 (3.3/4.3)

ANSWERS -- SEQUOYAH 1&2 -85/11/12-DEAN, W M

ANSWER 7.09 (1.00)

a) 5; 10 (+.25 ea response)
b) 50
c) ~~300~~ 350

REFERENCE
SQN GOI-3B and GOI-5

PWG-7:Limits and Precautions (3.5/4.0)

ANSWER 7.10 (2.00)

a) every hour (+.5 ea)
b) turbine blade resonances which could generate fatigue cracking
c) every 12 hours
d) #3 governor valve vibration

REFERENCE
SQN GOI-5A, pp 2/3 & SQN TS 3.2.4.1, 4.2.1.1

015/020; PWG-5 (2.8/3.9) & 045/050; PWG-7 (2.9/3.3)

ANSWER 7.11 (.50)

Fuel Handling SRO

REFERENCE
SQNP FHI-7, pp 2

034/000; PWG-3 (2.9/3.2)

ANSWER 7.12 (1.50)

low pressure letdown; RHR letdown; SI Accumulator Isolation Valves; SI pumps; one of two centrifugal charging pumps; 150; (+.25 ea)

REFERENCE
SQNP GOI-1, pp 3/4

004/000; K6.02 (3.8/4.1) & 006/000; A1.01 (3.1/3.4)

ANSWER 7.13 (1.50)

1) Decrease turbine load (+.25 ea response)
2) Verify auto rod insertion OR,
3) Manually insert rods to maintain Tavg at Tref
4) Open rx trip breakers at MG Set Room Aux Bldg 759
5) Open breakers to control rod MG sets at 480V Unit Boards A and B
6) Notify Inst to close P-4 contact

REFERENCE
SQNP FR-S.1, pp 2

EPE-029: PWG-11 (4.5/4.7)

ANSWER 7.14 (2.00)

a) 1) Centrifugal Charging Pump 2) AHU 3) ERCW Pump 4) CCS and Booster Pump
5) Spare Component Cooling Pump 6) AFW Pump 7) Pressurizer Heaters
8) Fire pump (+.15 ea)

b) To clear the diesel exhausts and supercharger of accumulated combustibles (+.8)

REFERENCE
SQNP AOI-35, pp 3/4

a) 064/000; K4.10 (3.7/4.0)
b) 064/000; A2.06 (2.9/3.3)

ANSWER 7.15 ~~(1.50)~~ (1.00)

-Notify Management personnel listed for call duty (+.25 ea)
-Refer to IP-1 and implement REP for FLOOD
-Notify load coordinator if unit loaded or scheduled to be loaded
-Make radio contact with Fontana Dam if they are involved in flood warning
~~-Perform SI-216 (Flood Protection Surveillance)~~
~~-Initiate SI-215 (Flood Protection Communication)~~

REFERENCE
SQNP AOI-7, pp 1-7

PWG-2 (2.7/3.8) & PWG-11 (4.3/4.4)

ANSWER 7.16 (1.25)

1) Description of job involving significant radiation,etc (+.25 ea)
2) Anticipated # of personnel to do job
3) Anticipated # of man-hours to do job
4) Estimated radiation exposure in Man-Rem
5) Ways considered to reduce exposure and contamination spread

REFERENCE
SQNP RCI-10, pp 5

PWG-16: Knowledge of facility ALARA program (3.4/3.7)

ANSWER 7.17 (1.50)

a) > 100 mrem/hr at assembly area (+.25 ea)
 > MPC airborne " " "
b) Chattanooga Power Services Center (+.5)
c) Alert, Site Area Emergency or General Emergency (+.5)

REFERENCE
SQNP IP-6, pp 1 & IP-8, pp 5

PWG-16: Actions in facility E-Plan (2.9/4.7)

ANSWER 7.18 (1.50)

a RWST level < 29% and Containment Sump level > 10% (+.5)
b Stop the corresponding RHR pump and CNTMT Spray Pump (+1.0)

REFERENCE
SQN ES-1.2, pp 3

EPE-011: EK3.12 (4.3/4.4) & PWG-11(4.5/4.2)

ANSWER 7.19 (2.50)

a) -CHG, SI & RHR pumps running (+.25 ea response)
   -Flow through the BIT
   -If RCS press < 1500 psig, verify SI pump flow
   -If RCS press < 180 psig, verify RHR pump flow
b) -Verify Panels 6E & 6F light except in outlined areas
   -Verify Panels 6C, 6D and 6H dark & 6G dark except outlined areas
c) -Verify AFW pumps running
   -AFW level control valves in AUTO
   -If S/G level < 33%, verify AFW flow
   -S/G Blowdown valves closed

REFERENCE
SQN ES-0, pp 3-4

013/000; A3.02 (4.1/4.2)

ANSWER 7.20 (1.00)

Core Exit T/C (+.33 ea)
T-Hot
RCS Subcooling

REFERENCE
SQN ES-0.3, pp 6

EPE-074; EA1.02 (3.9/4.2)

ANSWER 7.21 (1.00)

This is to compensate for the inability to vent the pressurizer

REFERENCE
SQN ES-0.3, pp 3

EPE-074; EK1.11 (4.0/4.4)

ANSWER 7.22 (1.25)

ASE-480v & 6.9kv Shutdown Board Room (+.25 ea)
AUOs-MOV and Vent Board Room
-Diesel Generator Bldg
-6.9kv Unit Boards in Turb Bldg
-Blending area

REFERENCE
SQNP AOI-27A, pp 3

EPE-068: EK3.12 (4.1/4.5)

ANSWER 7.23 (1.00)

4 (+.25 ea in correct order)
3
1 OR 4
2 3
2
1

REFERENCE
SQNP GOI-2, pp 22/23

PWG-12: Performance of Integrated Operations (3.5/3.4)

ANSWER 8.01 (1.00)

d

REFERENCE
McG/CAT/FNP/SQNP, TS, P. 3/4 9-1

004/020; PWG-8 (3.6/4.4)

ANSWER 8.02 (1.00)

c

REFERENCE
McG/CAT/FNP/SQNP, TS, pp. 3/4 1-1 and B 3/4 1-1

004/020; PWG-5 (2.9/4.1) & PWG-8 (3.6/4.4)

ANSWER 8.03 (1.00)

~~e~~ b

REFERENCE
FNP/SQNP TS 5.4.3

010/000; PWG-5 (2.9/4.1)

ANSWER 8.04 (1.00)

a

REFERENCE
SQNP TS 3/4.3.1.4

005/000; PWG-5 (2.5/4.2)

ANSWERS -- SEQUOYAH 1&2 -85/11/12-DEAN, W M

ANSWER 8.05 (1.50)

a) Unit 2
b) Unit 2
c) Unit 1

REFERENCE
SQNP AI-2, pp 10

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

ANSWER 8.06 (1.00)

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

REFERENCE
McG, TS, pp. 3/4 0-1 - 2 and TS Interpretation 3.0.3
FNP TS 3.0.3, 3.0.4
SQNP TS 3.03, 3.04

PWG-5: TS Knowledge (2.9/3.8)

ANSWER 8.07 (2.00)

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

REFERENCE
CAT & SQNP TS, pp. 2-1, 3/4 5-1, 5-3, [illegible]

PWG-8: Recognition of TS entry level conditions (3.5/4.5)

ANSWER 8.08 (1.50)

a. 8 or 5 (0.3)
b. 8 or 7 (0.3)
c. 3 (0.3)
d. 3 (0.3)
e. 4 (0.3)

REFERENCE
CAT/SQNP TS, pp B 3-3 to 7
012/000; PWG-5 (3.2/4.0)

ANSWER 8.09 (1.50)

a. 3 (0.3)
b. 2 (0.3)
c. 2 (0.3)
d. 5 (0.3)
e. 1 (0.3)

REFERENCE
McG/CAT/SQNP/WBN/FNP TS 3/4.4.6.2
002/020; PWG-5 (3.5/4.4)

ANSWER 8.10 (1.00)

a. 23 (+.5 ea)
b. 100 (150 at NA)

REFERENCE
a. SQNP/NA UI TS 1.9.10
b. SQNP/NA UI TS 1.9.3
034/000; PWG-5 (3.5/3.7)

ANSWER 8.11 (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 8.12 (1.00)

-Use the SE Office copy to make reproduction (+.25)
-SRO reviews ALL pages and stamps 'Controlled Copy' on each page (+.5)
-SRO signs and dates the Front Page (+.25)

REFERENCE
SQNP AI-4, pp 16

PWG-21: Obtain/Verify controlled procedure copy (3.3/4.1)

ANSWER 8.13 ( .75)

1) Another SE (+.25 ea)
2) Asst Operations Section Spvsr
3) Ops Section Spvsr

REFERENCE
SQNP AI-2, pp 1

PWG-23: Procedures/Directives for Plant Staffing activities (2.8/3.5)

ANSWER 8.14 ( .75)

-ASEs (+.25 ea)
-Outage Coordinator
-Any SE assigned to his shift

REFERENCE
SQNP AI-3, pp 2

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

ANSWER 8.15 (1.00)

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

REFERENCE
SQNP AI-3, pp 2

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

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ANSWER 8.16 (1.00)

a) SE on duty (+.25 ea)
   Public Safety
   Special locked glass enclosure in SE office

b) Incore flux drive motor control power

REFERENCE
SQNP AI-8, pp 1/2

103/000; A2.02 (2.2/3.2) & A2.05 (2.9/3.9)

ANSWER 8.17 (1.00)

RCS Tavg & PZR Press (+.5 ea)

REFERENCE
SQNP TS 3/4 2.5

PWG-8: Entry level conditions for T/S (3.5/4.5)

ANSWER 8.18 (.75)

-result in an open circuit making equipment unavailable, which may go undetected. (+.5) Potential personnel safety hazard if an open circuit is developed on a current transformer circuit during testing. (+.25)

REFERENCE
USNRC I&E Notice #85-83 of 30 October 1985

ANSWER 8.19 (1.00)

a) +/- ~~[illegible]~~ 15 psig (+.25 ea)
b) +/- 5% span
c) +/- 3 deg F
d) +/- 5% span

REFERENCE
SQNP PLS, pp 1

PWG-7: Explain/apply Limits & Precautions (3.5/4.0)

ANSWER 8.20 (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, T3, p. 3/4 1-17
FNP/SQNP TS B3/4.1.1.4

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

ANSWER 8.21 (1.00)

1. Its corresponding normal or emergency source is operable, and
2. All its redundant components are operable.

REFERENCE
NA TS 3.0.5
SQNP TS 3.0.5

[illegible]; PWG-5 [illegible]

ANSWER 8.22 (.75)

-The ASE needs to identify an SRO licensed individual to assume control room command (+.25)
-as. leave to make routine inspections of [illegible] equipment [illegible] maintenance (+.5)

REFERENCE
SQNP AI-2, pg [illegible]

PWG-23: Procedures/Station Directives applicable to running [illegible]

ANSWER 8.23 (1.00)

It is a cycle dependent function (+.25) that accounts for power distribution transients encountered during normal operations (+.75)

REFERENCE
SQNP TS 3/4.2.2

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

ANSWER 8.24 (1.50)

1) 1 gpm ensures dosage contribution will be small fraction of Part 100 limits (+.5) in event of a tube rupture or steam line break (+.25)

2) 500 gpd ensures S/G tube integrity is maintained (+.5) in the event of a main steam line rupture or under LOCA conditions (+.25)

REFERENCE
SQNP TS B3/4 4.4

EPE-037; PWG-5 (3.1/4.0)

ANSWER 8.25 (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

086/000; K4.06 (3.0/3.3) & PWG-36 (2.8/3.7)

ANSWER 8.26 ( .50)

To prevent a potentially hazardous situation involving H2 (+.25) when air is initially admitted to the primary via the vents. (+.25)

REFERENCE
SQNP PLS, pp 40

004/020; K5.16 (2.7/3.3)

ANSWER 8.27 (1.00)

a) To avoid inadvertant initiation of flow from the system during inadvertant RCS depressurization transients. (+.5 ea)

b) To protect the load cell from possible damage.

REFERENCE
SQNP PLS, pp 84

006/050; PWG-7 (3.8/4.2)

MASTER

ENCLOSURE 3

U. S. NUCLEAR REGULATORY COMMISSION
REACTOR OPERATOR LICENSE EXAMINATION

FACILITY: SEQUOYAH 1&2

REACTOR TYPE: PWR-WEC4

DATE ADMINISTERED: 85/11/12

EXAMINER: DEAN, W H

APPLICANT: ____________________

INSTRUCTIONS TO APPLICANT:

Use separate paper for the answers. Write answers on one side only. Staple question sheet on top of the answer sheets. Points for each question are indicated in parentheses after the question. The passing grade requires at least 70% in each category and a final grade of at least 80%. Examination papers will be picked up six (6) hours after the examination starts.

| CATEGORY VALUE | % OF TOTAL | APPLICANT'S SCORE | % OF CATEGORY VALUE | CATEGORY |
|---|---|---|---|---|
| 30.00 | 25.5 ~~25.00~~ | ________ | ________ | 1. PRINCIPLES OF NUCLEAR POWER PLANT OPERATION, THERMODYNAMICS, HEAT TRANSFER AND FLUID FLOW |
| 29.75 ~~30.00~~ | 25.3 ~~25.00~~ | ________ | ________ | 2. PLANT DESIGN INCLUDING SAFETY AND EMERGENCY SYSTEMS |
| 29.75 ~~30.00~~ | 25.3 ~~25.00~~ | ________ | ________ | 3. INSTRUMENTS AND CONTROLS |
| 28.00 ~~30.00~~ | 23.9 ~~25.00~~ | ________ | ________ | 4. PROCEDURES - NORMAL, ABNORMAL, EMERGENCY AND RADIOLOGICAL CONTROL |
| 117.5 ~~120.00~~ | 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)

The reactor is critical at 10,000 cps when a S/G PORV fails open. Assuming BOL conditions, no rod motion, and no reactor trip, choose the answer below that best describes the values of Tavg and nuclear power for the resulting new steady state. (POAH = point of adding heat).

a. Final Tavg greater than initial Tavg, Final power above POAH.

b. Final Tavg greater than initial Tavg, Final power at POAH.

c. Final Tavg less than initial Tavg, Final power at POAH.

d. Final Tavg less than initial Tavg, Final power above POAH.

QUESTION 1.02 (1.00)

Which of the following conditions would cause a 1/M curve to predict criticality earlier than it will actually occur?

a. Source located too near detector.

b. Fuel assemblies loaded too far from detector.

c. Highest worth fuel assemblies loaded first.

d. Control rod located between fuel assemblies loaded and detector.

QUESTION 1.03 (1.50)

A motor driven centrifugal pump is operating at a low flow condition. You then start opening the throttle valve on the discharge side. How will each of the following be affected? (Increase, Decrease or No Change)

a. Discharge Pressure (0.5)

b. Available NPSH (0.5)

c. Motor Amps (0.5)

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

QUESTION 1.04 (1.50)

Indicate whether the following conditions will cause the Fuel Temperature Coefficient (pcm/deg F) to become MORE or LESS negative or have NO EFFECT. (assume all other parameters are constant)

1) The relative ratio of Pu-240 to U-238 increases
2) Moderator temperature decreases (fuel temperature remains constant)
3) Fuel temperature increases

QUESTION 1.05 (2.50)

The plant is operating at 30% power, turbine in AUTO(IMP IN), when loop #1 reactor coolant pump trips. Assuming a reactor trip does not occur, there is no operator action and rod control is in MANUAL, indicate whether the following parameters will be HIGHER, LOWER or the SAME at the end of the transient compared to their initial values.

1) #2 S/G steam pressure (0.5)
2) #3 RCS loop flow (0.5)
3) Tc in loop #1 (0.5)
4) Th in loop #2 (0.5)
5) Nuclear Power (0.5)

QUESTION 1.06 (2.00)

An ECP is calculated for a startup 4 hours after a shutdown from 100% steady state power. Indicate whether the actual critical position will be GREATER THAN, LESS THAN or the SAME as the ECP for the following conditions.

1) The steam dump pressure [illegible] increased [illegible] (0.5)
2) All steam generator [illegible] increased [illegible] before [illegible] is reached. (0.5)
3) Condenser vacuum is reduced 2 [illegible] hg due to a small air leak (0.5)
4) Reactor startup is delayed for 2 hours (0.5)

***** CATEGORY [illegible] CONTINUED ON NEXT PAGE *****

QUESTION 1.07 (1.50)

Describe what happens to the following when their condition at the inlet to a REAL turbine is compared to their condition at the turbine outlet. (i.e. Increase, Decrease or No Change)

a) Enthalpy (0.5)

b) Entropy (0.5)

c) Qurlity (0.5)

QUESTION 1.08 (2.00)

Indicate whether the following will cause the differential rod worth to INCREASE, DECREASE or have NO EFFECT.

a) An adjacent rod is inserted to the same height

b) Moderator temperature is INCREASED

c) Boron concentration is DECREASED

d) An adjacent burnable poison rod depletes

QUESTION 1.09 (1.50)

Indicate the most significant type of heat transfer that is taking place in each of the following conditions. (i.e. Conduction, Convection or Radiation)

a) Nucleate boiling on the cladding surface of the fuel assembly. (0.5)

b) Accident condition in which steam is passing through the coolant channels. (0.5)

c) Heat from fission across a fuel pellet. (0.5)

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

QUESTION 1.10 (1.00)

In order to achieve the highest NPSH at the suction of a pump, indicate where the most advantageous location of the heat source and the heat sink would be relative to the pump. (i.e. upstream or downstream)

QUESTION 1.11 ( .50)

The atmospheric PORV for 'B' S/G partially opens to a throttling position during operations at 85% power. Describe the quality of the steam on the downstream side of the PORV.

QUESTION 1.12 (1.50)

List the 3 conditions necessary for brittle fracture to occur in metal.

QUESTION 1.13 (1.50)

List the three main power producing isotopes in the core at end of life and indicate their approximate contribution (in %) to power.

QUESTION 1.14 (1.00)

When performing a reactor startup to full power that commenced 5 hours after a trip from full power equilibrium conditions, a 2%/min ramp rate was used. If a 0.5%/min ramp rate was used instead, how would that affect the magnitude and time of occurrence of the xenon concentration dip?

QUESTION 1.15 (1.00)

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

QUESTION 1.16 (1.00)

Describe the effect the production of Pu-239 has on Beta effective and why this change occurs?

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

QUESTION 1.17 (1.00)

Identify the nuclides composing the secondary source utilized in your reactor and describe how this source is 'regenerated'.

QUESTION 1.18 (1.25)

Over core life there are two effects that cause differential boron worth to change. List these two effects, their relative impact on differential boron worth and indicate which effect is the overriding factor.

QUESTION 1.19 (1.00)

Provide the definitions for the following terms:

a) DNBR
b) Specific Entropy

QUESTION 1.20 (1.75)

Sketch the reactor coolant channel Boiling Water curve, indicating the four main boiling regions and the point of DNB. Ensure you label the axes correctly.

QUESTION 1.21 (1.00)

Using the attached steam tables, what is the amount of primary subcooling if the pressurizer is at 2235 psig and Tavg is 575 degrees F?

QUESTION 1.22 (1.00)

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

QUESTION 1.23 (1.00)

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

***** END OF CATEGORY 01 *****

QUESTION 2.01 (1.00)

Which of the following components served by the Component Cooling Water System (CCW) could NOT cause an increase in both CCW surge tank level and CCW radiation monitor indication if a failure of the component being cooled occurred?

a. RCP bearing coolers
b. RHR pump seal coolers
c. Spent Fuel Pit Heat Exchanger
d. Seal Water Heat Exchanger

QUESTION 2.02 (1.00)

RHR inlet isolation valves 74-1 and 74-2 each have an independent RCS pressure transmitter associated with them. Which of the following statements describing the effects of the transmitter associated with 74-1 failing high is correct?

a. If both 74-1 and 74-2 are open, they will shut.

b. If open, 74-1 will shut and if closed, 74-2 will not be able to be opened.

c. If both 74-1 and 74-2 are shut, neither one will be able to be opened.

d. If open, 74-1 will shut, but 74-2 can be positioned as desired.

e. 74-1 can be positioned as desired by the operator, but 74-2 will not be able to be opened if it is shut.

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

QUESTION 2.03 (1.00)

Which of the following is the preferred order of valve operation for initiation of Emergency Boration as stated in AOI-34?

a. 62-135 & 136(RWST Suction Valves), BIT Injection Valves, HCV-62-929(Emergency Borate Manual Valve), FCV-62-138(Emergency Borate MOV)

b. FCV-62-138, HCV-62-929, 62-135 & 136, BIT Injection Valves

c. FCV-62-929, FCV-62-138, 62-135 & 136, BIT Injection Valves

d. FCV-62-138, 62-135 & 136, BIT Injection Valves, FCV-62-929

e. HCV-62-929, BIT Injection Valves, 62-135 & 136, FCV-62-138

QUESTION 2.04 (1.50)

Indicate whether the following CVCS Valves will FAIL OPEN, CLOSED or AS IS on a Loss of Instrument Air.

a) Low Pressure Letdown Valve (PCV-62-81)
b) Charging Flow Control Valve (FCV-62-93)
c) Letdown Orifice Isolation Valves (FCV-62-72, -74 and -75)

QUESTION 2.05 (1.50)

Indicate whether the statements below concerning the operation of the turbine trip fluid systems are TRUE or FALSE.

a. If the reactor trip breakers are open, the EH fluid system is depressurized and the autostop oil system is pressurized. (0.5)

b. A mechanical overspeed will trip the turbine by dumping the EH fluid without effecting the autostop oil. (0.5)

c. On an electrical overspeed signal, as sensed by the OPC circuit, only the EH fluid to the intercept and govenor valves is dumped. (0.5)

***** CATEGORY 02 CONTINUED ON NEXT PAGE *****

QUESTION 2.06 (1.00)

What are the RCS piping penetrations made BELOW the horizontal centerline of the piping? (penetrations with a similar purpose are to be treated as one group)

QUESTION 2.07 (1.50)

Fill in the blanks in the statements below concerning the Emergency Gas Treatment System:

a) The annulus Vacuum Control Subsystem is used to establish and keep a _____ pressure within the _____. In emergencies, in which containment isolation is required, this subsystem is _____ and _____. (1.0)

b) The Air Cleanup System performs two functions during a LOCA. One is to maintain _____ and the second function is to _____ from air drawn from the annulus. (0.5)

QUESTION 2.08 (2.50)

Indicate where the following RCS penetrations occur by loop segment. (eg. Loop 2 intermediate leg) more than one loop segment may be required.

a) Normal Letdown
b) Pzr Surge Line
c) Pzr Spray Line
d) RHR Inlet
e) Excess Letdown Heat Exchanger Inlet

QUESTION 2.09 (1.25)

a) What is the maximum differential temperature allowed between the pressurizer spray and the pressurizer? (0.25)

b) What is the purpose of the loop seal located below each pressurizer safety valve? (0.5)

c) What is the driving force for normal spray flow? (0.5)

(***** CATEGORY 2 CONTINUED ON NEXT PAGE *****)

QUESTION 2.10 (1.00)

Fill in the blanks in the statement below regarding the Condensate Storage Tank:

The CST minimum water volume of _____ gallons is sufficient to maintain the plant in hot standby for _____ hours.

QUESTION 2.11 (2.00)

List the four AUTOMATIC trips of the AFW Terry Turbine trip and throttle valve and whether the trip has to be reset MANUALLY or NOT.

QUESTION 2.12 (1.00)

Fill in the blanks below to complete the statement concerning Auxiliary Control Air:

The Containment Building is supplied with redundant headers, each supplying _____ and _____ valves. These headers are isolated on _____. The Auxiliary Control Air compressors are cooled by the _____ System.

QUESTION 2.13 (1.00)

Describe the flow path of the Containment Spray System when the RWST is too low to support spray operation, assuming there is still ice in the Ice Condenser. (Identify all components, excepting valves in the path)

QUESTION 2.14 (1.00)

What signals will cause the VCT outlet isolation valves (LCV-62-132 and -133) to automatically shut?

QUESTION 2.15 ~~1.75~~ (1.50)

a) List the signals which will cause an automatic isolation of the Feedwater System. (0.75)

b) List the automatic actions that occur due to the feedwater isolation signal. ~~1.00~~ (0.75)

QUESTION 2.16 (2.00)

List the eight ESF related loads supplied by the ERCW System. (Treat common or redundant components as one load-eg:several like heat exchangers)

QUESTION 2.17 (1.25)

Where are thermal sleeves associated with RCS penetrations located?

QUESTION 2.18 (1.50)

List the THREE RCS leakage monitoring systems that must be OPERABLE when the plant is operating at 100% power.

QUESTION 2.19 (1.00)

What ECCS related components are tagged out at low pressures to help prevent inadvertant over pressurization at low temperatures?

QUESTION 2.20 (1.00)

What is the purpose of the interlock that prevents the letdown isolation valves from opening or shutting unless all three orifice isolation valves are shut?

QUESTION 2.21 (2.00)

a) Describe the runback process that occurs with the main Turbine when the OT Delta T setpoint is exceeded? (1.0)

b) List the two secondary runback causes and the process by which their runback occurs (1.0)

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

QUESTION 2.22 (1.25)

Place the following events that occur in the diesel start sequence in the proper sequential order.

a) Engine running alarm
b) ERCW to Ht Exchgr 1 opens
c) Field Flash
d) Diesel muffler room Exhaust Fan starts
e) Lube Oil pumps start to turn

***** END OF CATEGORY 02 *****

QUESTION 3.01 (1.00)

Which of the following would be the INITIAL response of the feedwater flow due to the response of the S/G Water Level Control System if the steam pressure transmitter controlling the SGWLCS failed HIGH at 50% power?

a. Feed flow would INCREASE due to the maximum steam pressure input to the steam flow signal.

b. Feed flow would INCREASE due to the level mismatch error between actual and programmed level caused by the pressure instrument failure.

c. Feed flow would DECREASE due to the mismatch between steam and feed flow signals caused by the pressure instrument failure.

d. Feed flow would remain THE SAME due to the dominance of the level error signal over the flow error signal.

e. Feed flow would remain THE SAME as steam pressure will not affect the steam flow signal.

QUESTION 3.02 (1.00)

Which statement below regarding pressurizer pressure control is correct?

a. ALL 4 channels provide input to the SI low pressure signal.

b. ALL 4 channels can be utilized to control the operation of the spray valves.

c. ALL 4 channels send their signals through an Isolation Amplifier after supplying input to their respective protective circuit.

d. ALL 4 channels can supply input to PORV Interlock circuitry to prevent PORVs lifting at low pressures.

QUESTION 3.03 (1.00)

Which statement below regarding Diesel Generator load sequencing is correct if a LOCA occurs AFTER a LOSS OF POWER?

a. Loads already sequentially connected will remain connected.

b. Loads awaiting sequential loading that are required for an accident will have their sequential timers reset to time zero.

c. The non-accident loads not yet connected will be sequenced on once all accident related loads are connected.

d. ALL loads will be stripped, then ONLY the accident related loads will be sequentially connected.

QUESTION 3.04 (1.00)

Which statement below regarding Steam Dump control is correct?

a. The FIRST 2 banks to modulate open are the LAST 2 banks to modulate open on a reactor trip.

b. The FIRST steam dump bank modulates open from 0 to 40% demand and the remaining 3 banks modulate to fully open in subsequent 20% demand increments.

c. There is a 5% overlap in the modulation sequence of successive banks that are opening.

d. The last bank to modulate open is the first bank to modulate shut.

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

QUESTION 3.05 (1.00)

Which of the following ststements concerning the operation of the Reactor Trip breakers aud Reactor Trip Bypass breakers is correct?

a. Tripping is accomplished by an undervoltage relay, normally held closed by 15 VDC power from the logic cabinet.

b. A Train B trip signal will trip both RT breaker B and Bypass breaker B.

c. The alarm 'BYA (or BYB) in OPERATE' indicates the Bypass breaker is racked to the 'Test' position but is NOT closed.

d. Control Power for the Reactor Trip breakers comes from 120 VAC channels I and III for UNIT 2's RTA and RTB respectively.

QUESTION 3.06 (2.00)

Indicate whether the following situations will ARM ONLY, ARM AND ACTUATE or HAVE NO EFFECT on the steam dump system.

a) 50% power, 10% step load increase, Tavg>Tref by 5 degrees F, steam dumps in Tavg mode of operation

b) 80% power, 7.5%/min ramp decrease in turbine load for 3 minutes, Tavg>Tref by 7 degrees F, steam dumps in Tavg mode of operation

c) Hot Zero Power, Tavg=547 degrees F, steam dumps in STM PRESS mode with 1005 psig set into the steam pressure controller

d) Turbine trip, Tavg=542 degrees, steam dumps in Tavg mode

QUESTION 3.07 (1.50)

Indicate whether the following rod withdrawal blocking permissives are effective when Rod Control is in AUTO, MANUAL or BOTH.

a) Intermediate Range Overpower (C-1)
b) Power Range Overpower (C-2)
c) Turbine Load Interlock (C-5)

QUESTION 3.08 (2.50)

Match the following reactor protection and control signals in Column A to their associated logic coincidence in Column B.

| COLUMN A | COLUMN B |
|---|---|
| a. 2 loop loss of flow trip (per loop) | 1. 1/2 |
| | 2. 2/2 |
| b. P-6 (SRM turn-on on power decrease) | 3. 1/3 |
| | 4. 2/3 |
| c. P-12 (Lo-Lo Tavg on temperature decrease) | 5. 1/4 |
| | 6. 2/4 |
| d. Pzr high pressure trip (pressure increase) | 7. 3/4 |
| e. PRM high power rod stop (power increase) | |

QUESTION 3.09 ~~(1.75)~~ (1.50)

List the 6 Diesel engine shutdown troubles which are bypassed when there has been an emergency start.

QUESTION 3.10 (1.50)

List the 6 operating criteria that must be satisfied to successfully start a Reactor Coolant Pump.

QUESTION 3.11 (1.00)

a) What is/are the input(s) to the UNIT 2 Main Feedwater Bypass Valve controllers? (+.5)

b) To place the Main Feedwater Bypass Valves in AUTOMATIC control while at low power, what controller-related conditions must be established? (+.5)

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

QUESTION 3.12 (1.00)

What automatic control action occurs when a high radiation condition is detected by the following radiation monitors?

a) Fuel Pool radiation monitors (0-RE-90-102 & -103)
b) S/G Blowdown monitors (1/2-RE-90-120 & -121)

QUESTION 3.13 (1.50)

When nuclear power has been increased above the setpoint for permissive P-10, the operator can manually block three protective features. List these THREE features that can be blocked.

QUESTION 3.14 (1.25)

What are the reactor trips which are enabled/blocked by the reactor trip system interlock P-7?

QUESTION 3.15 (1.50)

What signals will automatically initiate the operation of the Auxiliary Building Gas Treatment System?

QUESTION 3.16 (1.50)

List ALL of the signal inputs to the OT Delta T trip point calculator.

QUESTION 3.17 (1.00)

List the conditions required for Automatic Swapover from the Injection Mode to the Recirculation Mode following an SI and which valves are AUTOMATICALLY repositioned.

QUESTION 3.18 (1.50)

List the THREE power supplies to the Vital 120 VAC distribution system and identify them by their priority.

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

QUESTION 3.19 (1.25)

The Detector Current Comparator receives input from all 4 upper and lower power range detectors. How are these inputs compared, what is the alarm setpoint and when is this circuitry in operation?

QUESTION 3.20 (1.00)

With the pressurizer level control selector switch in position I/II, a failure causes the following plant events. (Assume no operator actions taken.)

1. Charging flow reduced to minimum
2. Pressurizer level decreases
3. Letdown secured and heaters off
4. Level increases until high level trip

Which instrument failed (I or II) and in what direction did it fail?

QUESTION 3.21 (1.75)

What are the Main Steam Isolation Signals and what are their setpoints?

QUESTION 3.22 (1.50)

Sketch the rod speed program by indicating rod speed versus error signal.

(***** END OF CATEGORY 03 *****)

QUESTION 4.01 (1.00)

On a unit startup, when reactor power reaches 10%, several indications must be verified. Without any operator action, which of the following is NOT observed at 10%.

a. "P-7 Lo Pwr Rx Trip Blocked" light off
b. "I/R Train A Trip Blocked" light illuminated
c. "P-10 Nuclear At Power" permissive light illuminated
d. "P-13 Turbine Not At Power" permissive light off

~~QUESTION 4.02 (1.00)~~

~~Which of the following is NOT a Critical Safety Function?~~

~~a. Core Cooling~~
~~b. Heat Sink~~
~~c. Subcriticality~~
~~d. Containment~~
~~e. Inventory~~

Deleted

QUESTION 4.03 (1.00)

Which of the following would NOT require Emergency Boration?

a. Excessive control rod withdrawal while at power.

b. Uncontrolled reactor heatup following a reactor trip.

c. Failure of the Boric Acid Flow Controller FC-62-139 to function while performing a boration to reduce power.

d. Excessive control rod insertion while at power.

(***** CATEGORY 04 CONTINUED ON NEXT PAGE *****)

QUESTION 4.04 (1.00)

Which of the following statements describes the correct action to take if, on a reactor startup, criticality is achieved ABOVE the zero power rod insertion limit, but BELOW the +/- 1000 pcm criticality band?

a. Insert rods to the zero power insertion limit and recalculate the ECP.

b. Discontinue the startup, calculate and then conduct the necessary boration to ensure that criticality is achieved within the 1000 pcm band.

c. Continue with the startup, logging the conditions at which criticality was achieved and notify the nuclear engineering dept.

d. Insert ONLY the control bank rods to the bottom of the core and recalculate the ECP.

e. Insert ONLY the control banks to the bottom of the core and recommence the startup using a 1/M plot to approach criticality.

QUESTION 4.05 (1.00)

Which of the following statements regarding the Faulted Steam Generator Isolation procedure, E-2, is correct?

a. If the faulted S/G cannot be identified from observation of S/G pressure, then ALL MSIV's & MSIV bypasses are shut and AFW to the S/Gs is isolated.

b. A faulted S/G cannot be used for RCS cooldown.

c. The pressure difference between the RCS and the faulted S/G should not exceed 1000 psid.

d. High radiation levels on either the S/G blowdown monitors or the condenser exhaust monitors are primary symptoms that a faulted S/G exists.

***** CATEGORY 04 CONTINUED ON NEXT PAGE *****

QUESTION 4.06 (1.00)

Which of the following would cause the greatest biological damage to a man?

a. 0.1 Rad of Fast Neutron.

b. 10 Rad of Gamma.

c. 20 Rad of Beta.

d. 0.5 Rad of Alpha.

~~QUESTION 4.07 (1.00)~~

~~Which of the following describes what is meant by 'Nothing Detectable' as it is utilized in determining the existence of Beta-Gamma contamination on skin or clothing surfaces?~~

~~a. Less than 100 dpm above background as measured with a pancake probe.~~

deleted

~~b. Less than 100 dpm above background as measured with a smear.~~

~~c. Less than 2 times background counts as measured with a smear as counted for one minute.~~

~~d. Less than [illegible] times the square root of a one minute background count as measured by a smear counted for 1 minute.~~

QUESTION 4.08 (2.00)

Prior to a reactor startup, with the RCS at normal operating pressure and temperature, the following RCS leakages exist. For each leak listed below, indicate whether you could STARTUP or would have to remain SHUTDOWN. (Treat each leak below as an independent event)

a. A leak from an unknown source of 1.7 GPM.

b. [illegible] GPM from a manual valve packing gland.

c. [illegible] GPM from one S/G.

d. 0.1 GPM from the reactor vessel head INNER seal.

***** CATEGORY 04 CONTINUED ON NEXT PAGE *****

QUESTION 4.09 (1.00)

Fill in the blanks in the following statements regarding the monitoring of AFD and actions to be taken if specifications are not met.

The AFD shall be considered outside of its limits when at least _____ OPERABLE excore channel(s) is/ are indicating the AFD to be outside its limit. When the indicated AFD is outside its allowable limit it must be restored to specifications within _____ (time) or Thermal Power must be reduced to less than _____% of Rated Thermal power within _____ (time).

QUESTION 4.10 ( .50)

If an individual had already received a whole body dose of 1000 mrem this quarter, the maximum additional exposure to the skin that he could receive this quarter without exceeding 10CFR20 limits is _____ mrem.

QUESTION 4.11 (1.00)

Fill in the blanks with the appropriate limits listed in the precautions section of the GOIs:

a) A load change of +/- _____%/min or a step change of _____% should not be exceeded.

b) The boron concentration difference between the pressurizer and the RCS must not exceed _____ppm.

c) The arming temperature setpoint for UNIT 1's Pzr PORVs is _____deg F.

QUESTION 4.12 (1.00)

Put the following actions associated with starting the FIRST Control Rod Drive MG set in the correct order:

1) Flash the field
2) Close the Auxiliary 150 VAC supply breaker to rod drives
3) Adjust generator voltage
4) Close the motor circuit breaker
5) Close the generator circuit breaker

(***** CATEGORY 04 CONTINUED ON NEXT PAGE *****)

QUESTION 4.13 (.50)

Following a reactor trip, how many gallons of BORON must be added for each control rod that is not fully inserted?

QUESTION 4.14 (1.50)

Fill in the blanks below to complete the statement regarding solid water operations:

Whenever the plant is utilizing letdown from RHR, the _____ control valve should be used to maintain pressure, while the _____ control valve should be fully open. Power to the _____, the _____ and _____ should be tagged out to minimize the possibility of overpressurizing due to an SI signal. Whenever the reactor coolant temperature is above _____ deg F, at least one RCP must be in operation.

QUESTION 4.15 (1.00)

a) What is the primary evacuation shelter for contaminated personnel if a total plant evacuation is required?
b) Where is the assembly point for Operations personnel on a Site Emergency?

QUESTION 4.16 (1.50)

List the required actions in an ATWS if the trip breakers can NOT be opened as listed in Function Restoration Guideline FR-S.1. For any action that requires local operation of devices, include the location from which the device must be operated.

QUESTION 4.17 ([illegible])

Following a valid reactor trip and safety injection, what are the Reactor Coolant Pump Trip Criteria?

***** CATEGORY 04 CONTINUED ON NEXT PAGE *****

QUESTION 4.18 (2.00)

a) On a station blackout, what are the 8 loads that are sequentially loaded automatically onto the diesels. (1.2)

b) There is a precaution in the Loss of Offsite Power procedure (AOI-35) to ensure that the diesels are loaded to > 1600 KW within 4 hours (assuming the diesels are required that long). What is the purpose of this precaution? (0.8)

QUESTION 4.19 (1.50)

a) What are operating personnel supposed to do upon hearing 'Reactor Trip, abandoning control room' over the public address system? (0.7)

b) Certain controlled instructions/plant referenced material is kept in the auxiliary control room to assist the operator in safely shutting/cooling down the plant. List 8 of these 10 items. (0.8)

QUESTION 4.20 (1.50)

What are the Automatic Actions associated with a loss of 125 VDC Vital Battery Board I on Unit 1? Ensure you include the cause of any protective actions that occur.

QUESTION 4.21 (1.50)

a) What conditions must be met for the ECCS suction to be shifted automatically to the containment sump following an SI initiation? (0.5)

b) If a containment sump valve (FCV-63-72 or -73) can NOT be fully opened when an automatic swapover is to occur, what operator actions are required? (1.0)

(***** CATEGORY 04 CONTINUED ON NEXT PAGE *****)

QUESTION 4.22 (2.50)

List ALL the immediate action sub-steps from E-0, 'Reactor Trip or Safety Injection' that allow you to accomplish the following immediate actions:

a) Verify ECCS status (1.0)

b) Verify Containment Isolation and ECCS Alignment (0.5)

c) Verify AFW status (1.0)

QUESTION 4.23 (1.00)

What are the three parameters that are monitored to determine RCS cooldown in accordance with ES-0.3, 'Natural Circulation Cooldown'?

QUESTION 4.24 (1.00)

Prior to commencing a Natural Circulation Cooldown per ES-0.3, it is necessary to increase the RCS boric acid addition by 15%. Why is this required?

QUESTION 4.25 (1.00)

Place the steps listed below, which are performed during a plant startup, in the proper sequential order.

1) Transfer 6.9 kv unit board 1A from Start Bus 1A to unit station transformer 1A.
2) Transfer S.G feedwater regulating valve control to AUTO.
3) Transfer steam dumps to Tavg mode.
4) Transfer rod control to AUTO.

(***** END OF CATEGORY 04 *****)
(************* END OF EXAMINATION ***************)

$f = ma$

$v = s/t$

Cycle efficiency = (Net work out)/(Energy in)

$w = mg$

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

$E = mc^2$

$KE = 1/2\ mv^2$

$a = (V_f - V_o)/t$

$A = \lambda N$

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

$PE = mgh$

$V_f = V_o + at$

$w = \theta/t$

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

$W = v\ \Delta P$

$A = \frac{\pi D^2}{4}$

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

$\Delta E = 931\ \Delta m$

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

$\dot{Q} = \dot{m} \Delta h$

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

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

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

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

$Pwr = W_f \Delta h$

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

$TVL = 1.3/\mu$

$HVL = -0.693/\mu$

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

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

$SUR = 26.06/T$

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

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

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

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

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

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

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

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

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

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

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

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

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

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

$I_1 d_1 = I_2 d_2$

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

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

$\Sigma = \sigma N$

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

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

**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 = $3.7 \times 10^{10}$ dps
1 kg = 2.21 lbm
1 hp = $2.54 \times 10^3$ Btu/hr
1 mw = $3.41 \times 10^6$ Btu/hr
1in = 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 Water $v_f$ | Evap $v_{fg}$ | Steam $v_g$ | Enthalpy, Btu/lb Water $h_f$ | Evap $h_{fg}$ | Steam $h_g$ | Entropy, Btu/lb x F Water $s_f$ | Evap $s_{fg}$ | Steam $s_g$ | Temp F |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 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 | 0.5196 | 1.3330 | 600 |
| 620 | 1786.9 | 0.0247 | 0.1962 | 0.2208 | 646.9 | 506.3 | 1153.2 | 0.8403 | 0.4689 | 1.3092 | 620 |
| 640 | 2059.9 | 0.0260 | 0.1543 | 0.1802 | 679.1 | 454.6 | 1133.7 | 0.8666 | 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 | 0.3 | 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 | 0.6059 | 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 | [illegible] | 1199.4 | 0.7111 | 0.7051 | 1.4163 | 506.7 | 1115.2 | 800 |
| 900 | 531.95 | 0.0212 | 0.47965 | 0.5009 | 526.7 | [illegible] | 1196.4 | 0.7279 | 0.6753 | 1.4032 | 523.2 | 1113.0 | 900 |
| 1000 | 544.58 | 0.0216 | 0.42436 | 0.4460 | [illegible] | [illegible] | 1192.9 | 0.7434 | 0.6476 | 1.3910 | 538.6 | 1110.4 | 1000 |
| 1100 | 556.28 | 0.0220 | 0.37863 | 0.4006 | [illegible] | [illegible] | 1189.1 | 0.7578 | 0.6216 | 1.3794 | 553.1 | 1107.5 | 1100 |
| 1200 | 567.19 | 0.0223 | 0.34013 | 0.3625 | [illegible] | [illegible] | 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 | 0.8625 | 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | v | 0.0161 | 392.5 | 452.3 | 511.9 | 571.5 | 631.1 | 690.7 | | | | | | | | |
| | 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 | | | | | | | | |
| 5 | 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 |
| | 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 |
| 10 | 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 |
| | 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 |
| 15 | 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 |
| | 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 |
| 20 | 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 |
| | 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 |
| 40 | v | 0.0161 | 0.0166 | 11.035 | 12.624 | 14.165 | 15.685 | 17.195 | 18.699 | 20.199 | 21.697 | 23.194 | 24.689 | 26.183 | 27.676 | 29.168 |
| | 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 |
| 60 | 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 |
| | 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 |
| 80 | 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 |
| | 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 |
| 100 | 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 |
| | 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 |
| 120 | v | 0.0161 | 0.0166 | 0.0175 | 4.0786 | 4.6341 | 5.1637 | 5.6831 | 6.1928 | 6.7006 | 7.2060 | 7.7096 | 8.2119 | 8.7130 | 9.2134 | 9.7130 |
| | 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 |
| 140 | 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 |
| | 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 | 1.8828 | 1.9176 | 1.9508 | 1.9825 | 2.0129 | 2.0421 |
| 160 | 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 |
| | 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 |
| 180 | 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 |
| | 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 |
| (373.06) | 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 |
| 200 | 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 |
| | 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 |
| 250 | 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 |
| | h | 68.66 | 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 | 0.5667 | 1.5951 | 1.6502 | 1.6976 | 1.7405 | 1.7801 | 1.8173 | 1.8524 | 1.8858 | 1.9177 | 1.9482 | 1.9776 |
| 300 | 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 |
| | 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 | 0.5665 | 1.5703 | 1.6274 | 1.6758 | 1.7192 | 1.7591 | 1.7964 | 1.8317 | 1.8652 | 1.8972 | 1.9278 | 1.9572 |
| 350 | v | 0.0161 | 0.0166 | 0.0174 | 0.0186 | 1.4913 | 1.7028 | 1.8970 | 2.0332 | 2.2652 | 2.4445 | 2.6219 | 2.7980 | 2.9730 | 3.1471 | 3.3205 |
| | h | 68.92 | 168.85 | 270.24 | 375.21 | 1251.5 | 1311.4 | 1366.2 | 1419.2 | 1471.6 | 1524.7 | 1578.2 | 1632.3 | 1687.1 | 1742.6 | 1798.9 |
| (431.73) | s | 0.1293 | 0.2936 | 0.4367 | 0.5664 | 1.5483 | 1.6077 | 1.6571 | 1.7009 | 1.7411 | 1.7787 | 1.8141 | 1.8477 | 1.8798 | 1.9105 | 1.9400 |
| 400 | v | 0.0161 | 0.0166 | 0.0174 | 0.0162 | 1.2841 | 1.4763 | 1.6490 | 1.8151 | 1.9759 | 2.1339 | 2.2901 | 2.4450 | 2.5987 | 2.7515 | 2.9037 |
| | 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 | 0.5663 | 1.5282 | 1.5901 | 1.6406 | 1.6850 | 1.7255 | 1.7632 | 1.7988 | 1.8325 | 1.8647 | 1.8955 | 1.9250 |
| 500 | 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 |
| | 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 | 0.5660 | 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) | | 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 | 1.6711 | 1.7252 | 1.8284 | 1.9309 |
| 600 | h | 69.58 | 169.42 | 270.70 | 375.49 | 1215.9 | 1290.8 | 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 | 1.5329 | 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 | 0.0206 | 0.7928 | 0.9072 | 1.0102 | 1.1078 | 1.2023 | 1.2948 | 1.3858 | 1.4757 | 1.5647 | 1.6530 |
| 700 | h | 69.84 | 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 | 0.6889 | 1.5090 | 1.5673 | 1.6154 | 1.6580 | 1.6970 | 1.7335 | 1.7679 | 1.8005 | 1.8318 | 1.8617 |
| | v | 0.0161 | 0.0166 | 0.0174 | 0.0186 | 0.0204 | 0.6774 | 0.7829 | 0.8759 | 0.9631 | 1.0470 | 1.1289 | 1.2093 | 1.2825 | 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 |
| (518.21) | 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 | 0.0204 | 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 | 0.0204 | 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 | 0.1269 | 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 | 0.0203 | 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 | 0.1269 | 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 | 0.0203 | 0.4016 | 0.4905 | 0.5615 | 0.6250 | 0.6845 | 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 | 1449.4 | 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 | 0.0203 | 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 | 0.0202 | 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 | 0.0202 | 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 | 0.0201 | 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 | 0.0200 | 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 | 0.0200 | 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 | 0.0199 | 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 | 0.6768 | 0.7994 | 0.9708 | 1.3515 | 1.4300 | 1.4866 | 1.5335 | 1.5749 | 1.6126 | 1.6477 | 1.6806 |
| | v | 0.0160 | 0.0154 | 0.0172 | 0.0183 | 0.0199 | 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 | 0.0198 | 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 | 0.0196 | 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 | 1364.6 | 1452.1 | 1529.1 | 1600.9 | 1670.0 | 1737.4 |
| | s | 0.1265 | 0.2861 | 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 | 0.0160 | 0.0195 | 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 | 1168.8 | 1323.6 | 1422.3 | 1505.9 | 1582.0 | 1654.2 | 1724.7 |
| | s | 0.1258 | 0.2670 | 0.4271 | 0.5528 | 0.6693 | 0.7826 | 0.9026 | 1.0176 | 1.2615 | 1.3574 | 1.4229 | 1.4748 | 1.5194 | 1.5593 | 1596.2 |
| | v | 0.0158 | 0.0163 | 0.0170 | 0.0180 | 0.0193 | 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 | 1.4406 | 1.4938 | 1.53[illegible]5 | 1.5735 |

TABLE A.4 PROPERTIES OF SUPERHEATED STEAM AND COMPRESSED WATER (TEMPERATURE AND PRESSURE) (CONTINUED)

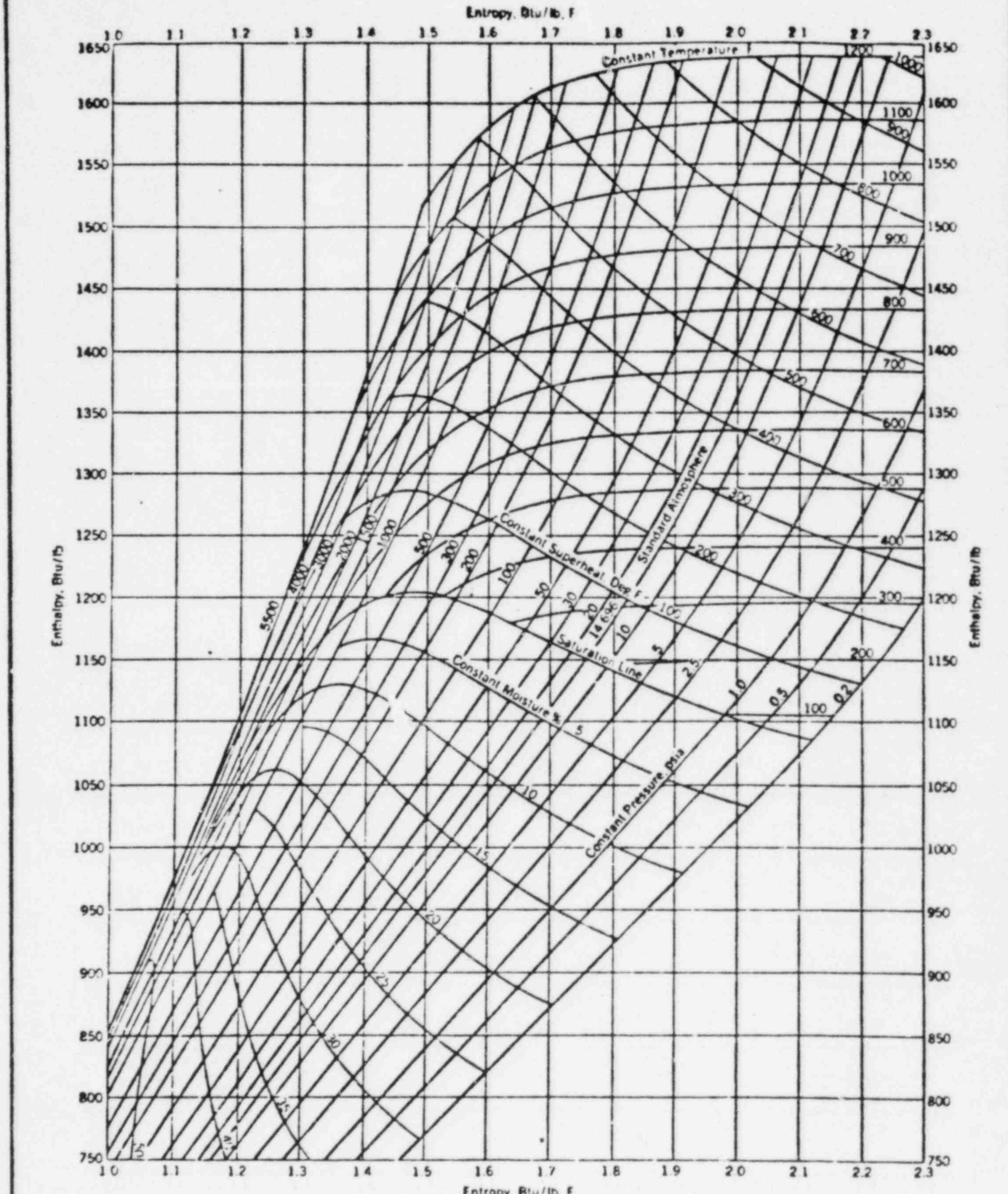



FIGURE A.5 MOLLIER ENTHALPY-ENTROPY DIAGRAM

## 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 | | | | | | | | 34.638 |
| 690 | 30.516 | | | | | | | | 32.144 |

TABLE A.6 PROPERTIES OF WATER, DENSITY

ANSWERS -- SEQUOYAH 1&2 -85/11/12-DEAN, W M

ANSWER 1.01 (1.00)

d

REFERENCE
Westinghouse Reactor Physics, Section I-5, MTC and Power Defect
DPC, Fundamentals of Nuclear Reactor Engineering

039/000; A2.05(3.3/3.6)

ANSWER 1.02 (1.00)

c

REFERENCE
Westinghouse Nuclear Training Operations, pp. I-4.19 - 21

001/010; K5.16 (2.9/3.5)

ANSWER 1.03 (1.50)

a) Decrease (+.5 ea)
b) Decrease
c) Increase

REFERENCE
Nuclear Power Plant Operator Trng Prgrm, HTFF and Thermo, Sect 2E

App A; Pumps/Centrifugal, Pump characteristic relationships (2.6/2.6)

ANSWER 1.04 (1.50)

1) more negative
2) less negative
3) less negative

REFERENCE
NUS, Vol 3, Unit 9.1
SQN/WBN License Cert Trng, 'Reactivity Coefficients'

001/000; K5.49 (3.4/3.7)

ANSWER 1.05 (2.50)

1) Lower (Higher Stm Flow >> P stm decreases)
2) Higher (Less resistance to flow >> Other RCPs speed up)
3) Lower (Less total flow across core >> delta T increases, Tc goes down with rods in manual)
4) Higher (as above, delta T increases, Th increases)
5) Same (Primary power = secondary load)

REFERENCE
NUS, Vol 4, Units 1.3, 3.2

ANSWER 1.06 (2.00)

1) Higher (Tavg increases >> adds negative reactivity)
2) Lower (Tavg decreases due to cold feedwater addition)
3) No effect
4) Higher (Xenon concentration increases adding negative reactivity)

REFERENCE
NUS, Vol 3, Unit 11
001/000; K5.29 (3.7/3.9) & K5.35 (3.5/4.1)

ANSWER 1.07 (1.50)

a) Decrease (+.5 ea)
b) Increase
c) Decrease

REFERENCE
Nuclear Power Plant Trng Prgrm, HTFF and Thermo, Sect 2C

App A: Working Properties of Water (2.2/2.5)

ANSWER 1.08 (2.00)

a) Decrease (+.5 ea)
b) Increase
c) Increase
d) Increase

REFERENCE
SQN/WBN License Requal Training, 'Core Poisons'

001/000; K5.09 (3.5/3.7) & K5.02 (2.9/3.4) & K5.10 (3.9/4.1)

ANSWER 1.09 (1.50)

a) Convection (+.5 ea)
b) Radiation or Convection
c) Conduction

REFERENCE
Nuclear Power Plant Oper Trng Prgm, HTFF & Thermo, pp 193-206

002/000; K5.01 (3.1/3.4)

ANSWER 1.10 (1.00)

Heat source- downstream (+.5 ea)
Heat sink- upstream

REFERENCE
Nuclear Power Plant Operator Training Program, HTFF and Thermo; Sect 2E

App A; pumps/centrifugal, NPSH (3.4/3.6)

ANSWER 1.11 (.50)

Superheated Steam (+.5)

REFERENCE
Steam Tables/ Mollier Diagram

010/000; K5.02 (2.6/3.0)

ANSWER 1.12 (1.50)

Nominal tensile stress (+.5)
Temperature below RTndt (+.5)
Sufficient sized surface defect (+.5)

REFERENCE
SQN TS, B 3/4.4.9

002/000; K5.18 (3.3/3.6)

ANSWER 1.13 (1.50)

U-235 Approx ~~49%~~ 47-57% (+.25 for isotope, +.25 for contribution to power ~~+/- 2%)~~
Pu-239 " ~~44%~~ 36-46%
U-238 " 7%

REFERENCE
SQN/WBN License Cert Trng, 'Reactor Kinetics', pp 6

001/000; K5.47 (2.9/3.4)

ANSWER 1.14 (1.00)

The xenon dip would be larger (+.5) and occur later (+.5)

REFERENCE
SQN/WBN Inst. Guide 'Review of Core Poisons', pp 5/6
Westinghouse Nuclear Training Operations, pp I-5.76

001/000; K5.38 (3.5/4.1)

ANSWER 1.15 (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

EPE-011; EK3.12 (3.8/4.2)

ANSWER 1.16 (1.00)

Beta effective decreases (+.25) due to Pu-239 producing more of the core's power(+.25) and having a smaller Beta fraction of approx. .0020 (+.5)

REFERENCE
SQN/WBN Instr. Guide, 'Neutron Kinetics', pp 6

001/000; K5.47 (2.9/3.4)

ANSWER 1.17 (1.00)

Sb-Be Source (+.25)
when Sb-123 is activated by a neutron it produces a gamma (+.25) that interacts with Be-9 (+.25) that produces Be-8 and another neutron (+.25)

REFERENCE
SQN/WBN License Certification Training, 'Neutron Sources and Subcrt Mult'

004/000; K5.05 (2.3/2.8)

ANSWER 1.18 (1.25)

1) As the fuel burns out, less boron is required, which increases the boron worth (+.5) - this is the overriding effect (+.25)
2) Fission products build up, decreasing the boron worth (+.5) ~~this is the overriding effect (+.25)~~

REFERENCE
SQN/WBN License Cert Trng, 'Core Poisons', pp 4

004/000; K5.06 (3.0/3.3)

ANSWER 1.19 (1.00)

a) Ratio of Critical Heat Flux to Local Heat Flu (+.5 ea)
b) BTU/lbm-deg F(or R)

REFERENCE
Nuclear Power Plant Operator Training Program, 'HTFF and Thermo'

ANSWERS -- SEQUOYAH 1&2 -85/11/12-DEAN, W H

001/000; K5.45 (2.4/2.9) & K5.46 (2.3/3.6)

ANSWER 1.20 (1.75)

See attached curve

REFERENCE
Nuclear Power Plant Oper Trng Prgm, HTFF and Thermo, Figure 18, pp 202

002/000; K5.01 (3.1/3.4)

ANSWER 1.21 (1.00)

```
for 2250 psia, sat temp = 652 (+.5)
with Tavg = 575, Th =     607 (+.5) -give +/- 2 degrees in determining Th
                          ----
                           45 degrees F
```

REFERENCE
Steam Tables and SQN PLS

002/000; A1.04 (3.9/4.1)

ANSWER 1.22 (1.00)

```
.1 (10000 pcm); Delta p = k2-k1
                          -----
                           k1k2
```

REFERENCE
SQN/WBN License Certification Trng, 'Reactor Kinetics', pp 3

001/000; A1.05 (4.1/4.4)

ANSWER 1.23 (1.00)

margin to criticality decreases by 2/3 (+1.0)

REFERENCE
SQN/WBN License Certification Trng, 'Neutron Sources and Subcritical Mult'

001/000; K5.18 (4.2/4.3)

With the first "tweak" of the heat control knob, the partial vapor blanket spreads over the entire pan surface. We then find a thin layer of steam everywhere on the pan surface. As shown in a previous table of thermal conductivities, steam is an excellent INSULATOR; hence, the pan surface now presents an extremely large resistance to heat transfer. Assuming again that the electric heater can MAINTAIN the desired heat flux, we know from the equation;

$$\dot{Q}/A = U(T_{surf} - T_{liq})$$

that if $\dot{Q}/A$ is held constant and U decreases drastically and $T_{liq}$ is constant, then $T_{surf}$ must increase rather substantially (on the order of 1,000°F).

If the pan surface had been a fuel rod in the reactor core and we allowed full film boiling to take place, the metal of the fuel rod might have melted or been seriously deformed or cracked. Radioactivity would then leak from the damaged rod into the coolant with severe ramifications. DNB, transition boiling, and full film boiling are NEVER permitted in an operating reactor under ordinary conditions.

Now, we should make a plot of the results of our simple experiment. If the heat flux is plotted against the temperature difference between the pan surface and liquid temperature, a figure similar to the one below is obtained.

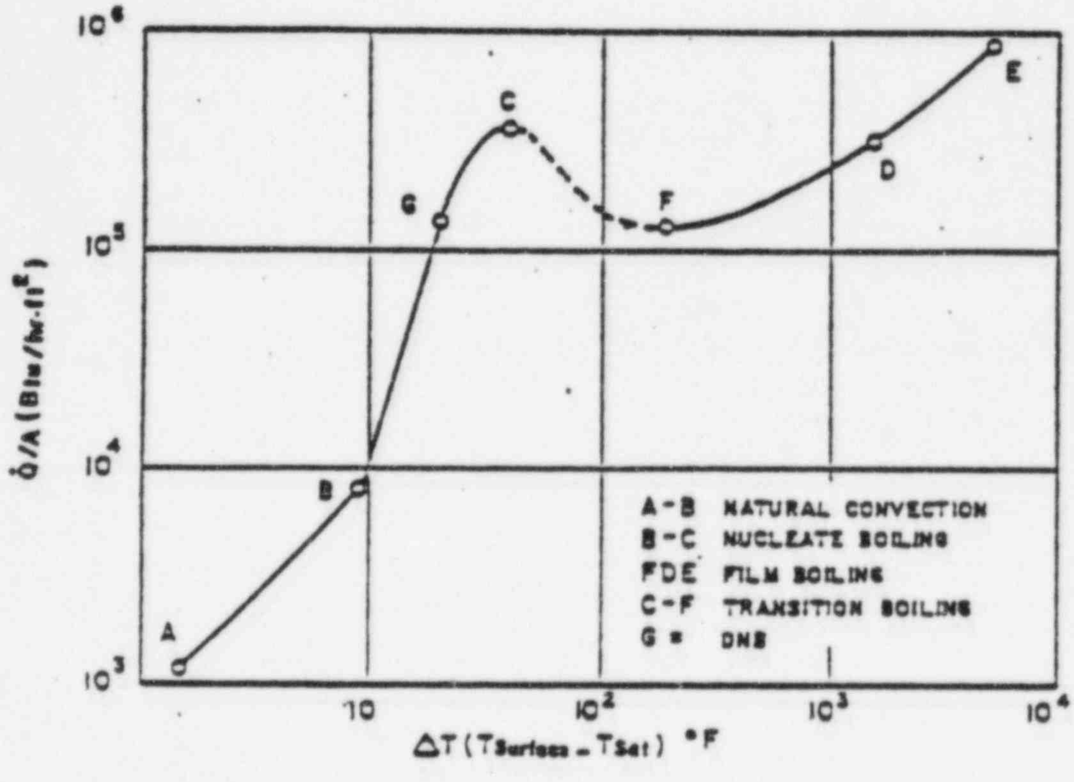



FIGURE 18 BOILING WATER CURVE

ANSWER 2.01 (1.00)

a

REFERENCE
SQNP System Descrip. 'CCWS', pp 7.1-4

008/000; K1.04 (3.3/3.3)

ANSWER 2.02 (1.00)

d

REFERENCE
FNP, RHR Lesson Plan, pp. 8 & 9
NA NCRODP 88.2, 'RHR System'
SQNP lesson plan 'RHR System' pp 5

005/000-K4.07 (3.2/3.5)

ANSWER 2.03 (1.00)

b

REFERENCE
SQNP Lesson Plan 'CVCS' pp 14 & AOI-34A

EPE-024: PWG-11(4.0/4.0) & EA2.02 (3.9/4.4)

ANSWER 2.04 (1.50)

a) Open (+.5 ea)
b) Open
c) Closed

REFERENCE
NA NCRODP 88.3, 'CVCS'
SQNP AOI-10A, pp 3-5

078/000: K3.02(3.4/3.6)

ANSWER 2.05 (1.50)

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

REFERENCE
FNP, Main Turbine and Auxiliaries, pp. 28 - 37
Westinghouse PWR Systems Manual, 'Turbine EHC System' pp 3-6

045/000; A3.05 (2.6/2.9)

ANSWER 2.06 (1.00)

-RHR System Inlet (+.25 ea)
-Loop Drain Lines
-Differential Pressure taps for RCS flow indication
-Tygon hose connections

REFERENCE
NA NCRODP 88.1, 'RCS-Piping and Instrumentation'
SQNP Lesson Plan 'RCS', pp 34 & 37

002/000; K4.01(2.7/3.0) & 005/000; K1.09(3.4/3.6)

ANSWER 2.07 (1.50)

a) negative; annular space between the two reactor containments; isolated; shutdown (+.25 ea)
b) secondary containment annulus air volume below atmospheric pressure; remove airborne particulates and vapors (+.25 ea)

REFERENCE
SQNP Sys descrip 4.4, 'Containment Air Purif and Cleanup System' pp 3-5

103/000; K1.07 (2.5/3.7) & K1.03(3.1/3.5)

ANSWER 2.08 (2.50)

a) Loop 3 Intermediate (+.5 ea)
b) Loop 2 Hot
c) Loops 1 & 2 Cold
d) Loop 4 Hot
e) Loop 3 Cold

REFERENCE
SQNP Lesson Plan 'RCS', pp 6/7

002/000; K1.06(3.7/4.0) & K1.08(4.5/4.6) & K1.09(4.1/4.1)

ANSWER 2.09 (1.25)

a) ~~[illegible]~~ 360 deg F (+.25)
b) Inhibit H2 leakage or steam leakage which may wire guide the valve seat (+.5)
c) Delta P between the RCP discharge and the PZR (+.5)

REFERENCE
SQNP PLS pp 42; SQNP Lesson Plan 'RCS', pp 27 & 29

010/000; K6.03 (3.2/3.6) & K6.02 (3.1/3.5)

ANSWER 2.10 (1.00)

-190,000 (+.5 ea)
-2

REFERENCE
SQNP System Descrip. 'AFW', pp 4 & SQNP TS 3 4.7.1.2 B3/4.7.1.2

061/000; PWG-5 (3.3/4.1)

ANSWER 2.11 (2.00)

-Mechanical Overspeed (+.4), manual reset (+.1)
-Electrical Overspeed (+.4), NO manual reset (+.1)
-Thermal Overload (+.4), manual reset (+.1)
-Steam Supply Transfer (+.4), NO manual reset (+.1

REFERENCE
SQNP System Descrip. 'AFW', pp 6

061/000; K4.07 (3.1/3.3)

ANSWER 2.12 (1.00)

(TRAIN A) (TRAIN B)
PZR spray; PORV; Hi-Hi containment pressure; ERCW (+.25 ea)

REFERENCE
Westinghouse PWR Systems Manual 'Air Systems', pp 12.3-2

078/000; K1.04 (2.6/2.9) & K1.03 (3.3/3.4) & PWG-10 (3.4/3.7)

ANSWER 2.13 (1.00)

Emergency sump>>Containment Spray Pumps>>Containment Spray Ht Exchgrs>>Containment Spray Nozzles>>Upper Containment Compartment>>2 Drains in the bottom of the Refueling Canal>>Lower Compartment>>Emergency Sump(+.15 ea)

REFERENCE
SQNP Sys Descrip. 4.5, 'Cont Spray Sys' pp 17/18

026/000; K4.01 (4.2/4.3)

ANSWER 2.14 (1.00)

- [illegible] Level from BOTH VCT level controllers (+.5 ea)
-SI signal

REFERENCE
SQNP Lesson Plan, 'CVCS' pp 32

004/000; K4.04 (3.1/3.4) & K1.15 (3.8/4.0)

ANSWER 2.15 ~~(1.75)~~ (1.50)

a) Hi-Hi level in any S/G (>75%) (+.25 ea)
SI signal
Reactor trip with lo Tavg (<554 deg F)
b) Both MFP trip (+.25 ea)
MFWRV and Bypasses shut
~~Condensate system recircs to condenser~~
Feedwater isolation valves close

REFERENCE
SQNP Lesson Plan 'Condensate and Feedwater Review', pp 10

059/000; K4.19 (3.2/3.4)

ANSWER 2.16 (2.00)

CCW Heat Xchgrs; Containment Spray Heat Xchngrs; EDGs; AFW Backup;
CCW Emer. Makeup; Control Bldg A/C System; Aux Bldg Ventilation Coolers;
Aux Control Air Compressors (+.25 ea)

REFERENCE
Westinghouse PWR System manual, 'ERCW', pp 1

EPE-026; EK3.02 (3.6/3.9)

ANSWER 2.17 (1.25)

-Return lines from RHR loop(SI lines) (+.25 ea)
-PZR Surge line, both ends
-PZR spray into PZR
-Chg line connection
-Aux chg line connection

REFERENCE
SQNP Lesson Plan 'RCS', pp 34-35

002/000; K1.06 (3.7/4.0) & K1.08 (4.5/4.6) & K1.09 (4.1/4.1)

ANSWER 2.18 (1.50)

-Lower containment atmosphere particulate RMS (+.5 ea)
-Containment pocket sump level Monitoring System
-Lower containment atmosphere gaseous RMS

REFERENCE
SQN TS 3/4.4.6

072/000; PWG-8 (3.2/4.0)

ANSWER 2.19 (1.00)

-SI Pumps (+.25 ea)
-ONE Centrifugal Charging Pump
-UHI Gags
-Cold leg Accumulator Isolation Valves

REFERENCE
SQNP System Descrip. 'RCS', pp 9

010/000; K1.02 (3.9/4.1)

ANSWER 2.20 (1.00)

prevent water from flashing on the shell side of the regenerative Ht Exchgr
(ie. maintain RCS pressure in the Ht Exchgr with the high temp water)

REFERENCE
SQNP System Descrip, 'CVCS', pp 9

004/000; K4.03 (3.0/3.4)

ANSWER 2.21 (2.00)

a) Turbine is runback for 1.5 seconds (+.25) at 200% per minute (+.25) waits 28.5 seconds (+.25) and repeats cycle if setpoint not clear(+.25)

b) -One of two MFPs trip > 80% power (+.25)
-#3 Heater Drain tank bypass to condenser valve leaves its seat > 85% load (+.25)
Turbine is runback using the valve position limiter (+.25) to 75% or 80% respectively (+.25)

REFERENCE
SQNP System Descrip. 'Turbine Control', pp 15

045/000; K4.12 (3.3/3.6)

ANSWER 2.22 (1.25)

e-b-d-c-a (+.25 for each in correct place)

REFERENCE
SQNP Diesel Generator Handout, pp 3

064/000; A3.06 (3.3/3.4)

ANSWER 3.01 (1.00)

a

REFERENCE
Westinghouse PWR Systems Manual, 'SGLCS' pp 1-5

035/010; A2.03 (3.4/3.6)

ANSWER 3.02 (1.00)

c

REFERENCE
Westinghouse PWR Systems Manual, Sect 9.2 'PZR Pressure Contarol'

010/000; K4.03 (3.8/4.1) & K6.01 (2.7/3.1) & PWG-4 (3.6/3.7)

ANSWER 3.03 (1.00)

b or a

REFERENCE
SQNP System Descrip. 'Electrical Distribution' pp 19/20

064/000; K4.10 & K4.11 (3.5/4.0)

ANSWER 3.04 (1.00)

d

REFERENCE
SQNP FLS pp 23-24

041/020; PWG-7 (3.1/3.4)

ANSWER 3.05 (1.00)

c

REFERENCE
SQNP System Descrip. 'RPS', pp 6

012/000; K2.01 (3.3/3.7) & K6.04 (3.3/3.6) & A4.06 (4.3/4.3)

ANSWER 3.06 (2.00)

a) No effect
b) Arm and actuate
c) Arm and actuate
d) Arm only

REFERENCE
Farley SD, 'Steam Dump System', pp 23-28
SQNP System Descrip. 'Steam Dump System', pp 6-8

041/020; K4.11 (2.3/3.1) & K4.14 (2.5/2.6) & K4.17 (3.7/3.9)]

ANSWER 3.07 (1.50)

a) Both (+.5 ea)
b) Both
c) Auto

REFERENCE
SQNP System Descrip. 'Rod Control System', pp 8-9

001/000; K4.07 (3.7/3.8)

ANSWERS -- SEQUOYAH 1&2 -85/11/12-DEAN, W H

ANSWER 3.08 (2.50)

a. 4 (0.5)
b. 2 (0.5)
c. 6 (0.5)
d. 6 (0.5)
e. 5 (0.5)

REFERENCE
CAT, PSM, CN-IC-IPE, pp. 2, 6, & 7 (Ans-4, 2, 6, 6, 5)
FNP, SD, 'Reactor Protection System', tables 1, 5, 6 (Ans-4, 2, 4, 4, 5)
SQNP System Descrip, 'RPS', pp 9-12 (Ans-4,2,6,6,5)

012/000-K6.03 (3.1/3.5)
012/000-K6.10 (3.3/3.5)

ANSWER 3.09 ~~(1.75)~~ (1.5)

1) Low Lube Oil Pressure (+.25 ea)
2) High Crankcase Pressure
3) Phase Balance Relay
4) Reverse Power Relay
5) Loss of Field Relay
~~6) Overcurrent Relay~~
7) High Jacket Water Temperature

REFERENCE
NA NCRODP 90.4 'EDG'
SQNP Diesel Generator Handout pp 8

064/000; K4.02(3.9/4.2)

ANSWER 3.10 (1.50)

-> 17 psig in the VCT (+.25 ea)
-Bearing lift pump running with >700 psig discharge
-Bubble in the pressurizer
-> 0.2 gpm seal flow
-Seal Delta P > 200 psid
-Reactor Power < 10%

REFERENCE
NA NCRODP 88.1, 'RCS-RCPs'
SQNP System Descrip, 'RCS', pp 19 & SQNP SOI 68.2, pp 2-4

ANSWERS -- SEQUOYAH 1&2 -85/11/12-DEAN, W M

003/000; K6.14(2.6/2.9)

ANSWER 3.11 (1.00)

a) Inputs are the S/G level instruments (+.5)

b) The output and demand signals must be approximately 0 (+.5)

REFERENCE
SQNP GOI-2 pp 13

059/000; A4.08 (3.0/2.9)

ANSWER 3.12 (1.00)

a) Isolates the auxiliary building ventilation (+.5 ea)
b) Closes the discharge valve to the cooling tower blowdown

REFERENCE
SQNP Requal Training Lesson Plan, Week 3 & 4, Day 7, pp 47-51

072/000; K2.03 (3.6/3.7) & 073/000; K4.01 (4.0/4.3)

ANSWER 3.13 (1.50)

1. IRM High Flux Reactor Trip (0.5)
2. IRM High Flux Rod Stop (0.5)
3. PRM High Flux Reactor Trip - Low Setpoint (0.5)

REFERENCE
Cat, SD-IPE, p. 19
SQNP PLS pp 5

015/000; A4.03 (3.8/3.9)

ANSWER 3.14 (1.25)

-PZR high water level (+.25 ea)
-PZR lo pressure
-Lo primary coolant flow
-RCP bus undervoltage or underfrequency
-Loss of flow in at least two loops

REFERENCE
SQNP PLS, pp 4

012/000; K4.06 (3.2/3.5)

ANSWER 3.15 (1.50)

-Phase A Containment Isolation signal from either Unit (+.5 ea)
-High Radiation signal from fuel handling bldg area rad monitors
- " " " " Aux Bldg exhaust vent rad monitors

REFERENCE
SQNP Sys Descr. 4.4, 'Cont Air Purif and Cleanup Sys' pp 15

EPE-060; PWG-10 (4.1/4.4)

ANSWER 3.16 (1.50)

~~Delta T~~; Tavg; PZR Pressure; Delta Flux; Delta T at rated power; Tavg at rated power (+.~~25~~ .3 ea)

REFERENCE
Westinghouse PWR Systems Manual 'RPS', pp 9-11
SQNP TS Table 2.2-1

012/000; K5.11 (2.9/3.3) & A2.05 (3.1/3.2)

ANSWER 3.17 (1.00)

RWST Lo Level (<29%) and Containment Sump Level > 10% (+.5)
Containment Sump Valves (FCV-63-72 &-73) and RWST to RHR suction(FCV-74-3 & -21) (+0.5)

REFERENCE
SQNP ES 1.3, pp 3

006/020; K4.03 (3.2/3.6)

ANSWER 3.18 (1.50)

-Normal: 480 VAC Vital (+.5 ea)
-Standby: 125 VDC Battery
-Maintenance: 120 VAC

REFERENCE
SQNP 'Review of Electrical Distribution' pp 9

062/000; K4.09 (2.4/2.9)

ANSWER 3.19 (1.25)

The highest reading upper/lower detector is compared to the average of the upper/lower detectors(+.5) and generates an alarm at 1.02 increasing(+.25). The circuit auto defeats below 50% power on ALL channels (+.5)

REFERENCE
SQNP System Descrip. 'Excore NIS', pp 17

015/000; K6.04 (3.1/3.2) & A1.04 (3.5/3.7)

ANSWER 3.20 (1.00)

Level I Channel (+.5) failed high (+.5)

REFERENCE
Westinghouse PWR Systems Manual 'Primary System Control', pp 12-14

011/000; K3.01 (3.2/3.4) & K5.03 (2.5/2.7)

ANSWER 3.21 (1.75)

Hi-Hi containment pressure > 2.81 psig (+.5)
High Steam Line Flow Coincident with Low Steam Line Pressure <600 psig
or Lo-Lo Tavg <540 deg F. (+.75)
High Steam Flow setpoint is at 40% flow from 0-20% load (+.25) then
linearly from 40-110% flow from 20-100% load (+.25)

REFERENCE
SQNP PLS pp 9-11

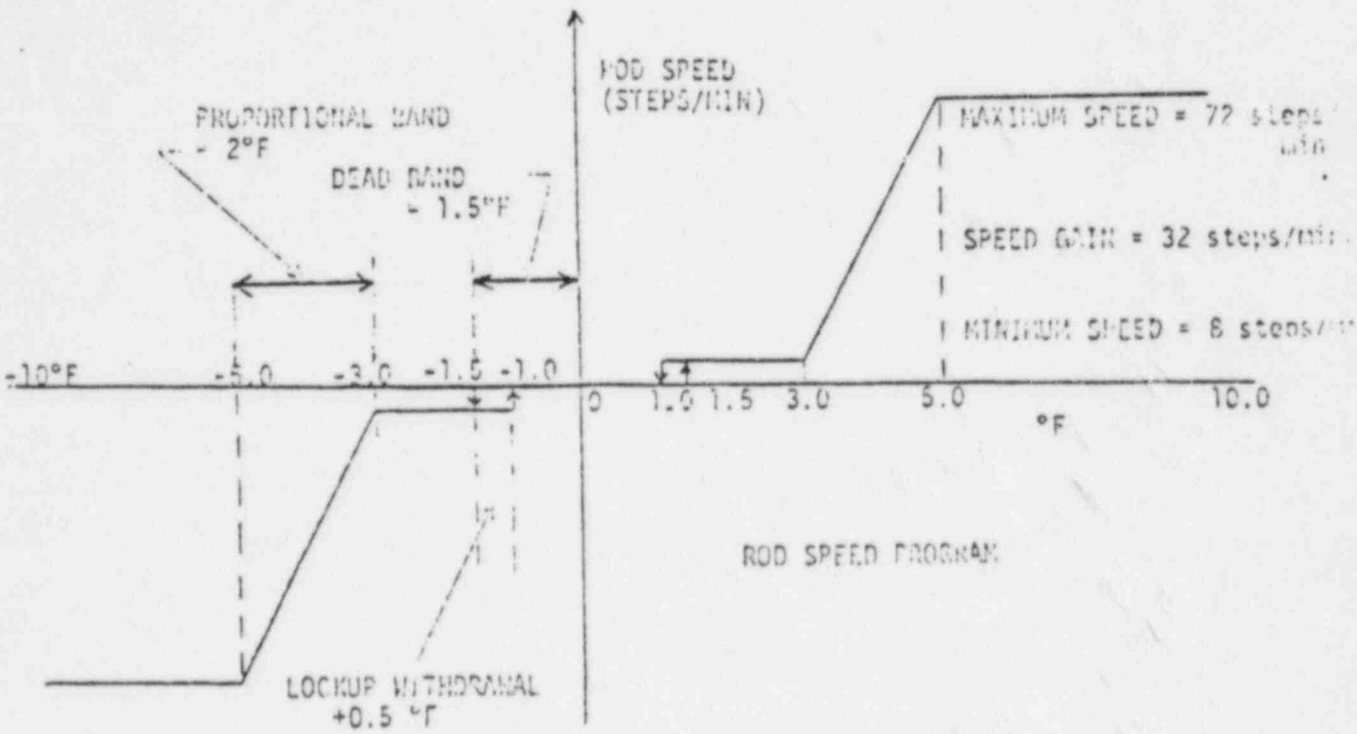
013/000: K4.03 (3.9/4.3)

ANSWER 3.22 (1.50)

See attached sketch

REFERENCE
SQNP PLS pp 22

001/000: K4.03 (3.5/3.8)




ROD SPEED PROGRAM

ANSWER 4.01 (1.00)

b

REFERENCE
Cat, OP/1/A/6100/01, p. 12
SQNP GOI-2, pp 20

015/000; K4.07 (3.7/3.8)

~~ANSWER 4.02 (1.00)~~

~~e~~

~~REFERENCE~~
~~McG, EP/2/A/5000/10, Status Trees~~
~~SQN FR-0, Status Trees~~

~~FWG-10: Recognizing EOP Entry-level conditions (4.1/4.5)~~

deleted

ANSWER 4.03 (1.00)

b

REFERENCE
SQN AOI-34A, pp 1

004/020; FWG-10 (4.3/4.5)

ANSWER 4.04 (1.00)

a

REFERENCE
SQNP GOI-2, pp 11

001/010; A2.07 (3.6/4.2)

ANSWERS -- SEQUOYAH 1&2 -85/11/12-DEAN, W M

ANSWER 4.05 (1.00)

a

REFERENCE
SQNP E-2
035/010: A2.01 (4.5/4.6) & PWG-10 (4.1/4.5)

ANSWER 4.06 (1.00)

c

REFERENCE
10CFR20.5
PWG-15: 10 CFR20 Knowledge (3.4/3.9)

~~ANSWER 4.07 (1.00)~~

~~d~~

~~REFERENCE~~
~~SQNP RCI-1, pp 12~~
~~PWG-15: Knowledge of facility Radcon (3.4/3.9)~~

Deleted

ANSWER 4.08 (2.00)

a) Shutdown (+.5 ea)
b) Startup
c) Shutdown
d) Shutdown

REFERENCE
SQN TS 3.4.6.2
002/020: PWG-8 (3.5/4.4)

ANSWERS -- SEQUOYAH 1&2 -85/11/12-DEAN, W M

ANSWER 4.09 (1.00)

2; 15 minutes; 50; 30 minutes (+.25 ea)

REFERENCE
SQN TS 3/4.2.1

015/020; PWG-8 (3.3/4.3)

ANSWER 4.10 ( .50)

6500 mrem

REFERENCE
10CFR20.101

ANSWER 4.11 (1.00)

a) 5; 10 (+.25 ea response)
b) 5)
c) ~~[illegible]~~ 350

REFERENCE
SQN GOI-2B and GOI-5

PWG-7:Limits and Precautions (3.5 4.0)

ANSWER 4.12 (1.00)

4, 1, 3, 5, 2 (-.2 for each swap required to put in correct order)

REFERENCE
SQNP GOI-85.1A, pp 3

001/010; A4.01 (3.7/3.4)

ANSWER 4.13 (.50)

350 gallons

REFERENCE
SQN ES-0.1, pp 1

EPE-005; EK3.06 (3.9/4.2)

ANSWER 4.14 (1.50)

low pressure letdown; RHR letdown; SI Accumulator Isolation Valves;
SI pumps; one of two centrifugal charging pumps; 160; (+.25 ea)

REFERENCE
SQNP GOI-1, pp 3/4

004/000; K6.02 (3.8/4.1) & 006/000; A1.01 (3.1/3.4)

ANSWER 4.15 (1.00)

a) Watts Bar Nuclear Plant (+.5 ea)
b) Control Building Lunch Room (Elevation 732)

REFERENCE
SQNP IP-7, pp 1 & IP-8, pp 5

PWG-3a: Actions in Facility E-Plan (2.9/4.7)

ANSWER 4.16 (1.50)

1) Decrease turbine load (+.25 ea response)
2) Verify auto rod insertion OR,
3) Manually insert rods to maintain Tavg at Tref
4) Open rx trip breakers at MG Set Room Aux Bldg 759
5) Open breakers to control rod MG sets at 480V Unit Boards A and B
6) Notify Inst to close P-4 contact

REFERENCE
SQNP FR-S.1, pp 2

EPE-029; PWG-11 (4.5/4.7)

ANSWER 4.17 (1.00)

1) Phase B Isolation (+.25)
2) At least 1 of the 4 CCP/SI Pumps Running (+.25) AND RCS Pressure decreasing uncontrolled (+.25) to < 1250 psig (+.25)

REFERENCE
SQNP Foldout Page

003/000; PWG-10 (4.1/4.4)

ANSWER 4.18 (2.00)

a) 1) Centrifugal Charging Pump 2) AHU 3) ERCW Pump 4) CCS and Booster Pump 5) Spare Component Cooling Pump 6) AFW Pump 7) Pressurizer Heaters 8) Fire pump (+.15 ea)

b) To clear the diesel exhausts and superchargers of accumulated combustibles (+.8)

REFERENCE
SQNP AOI-35, pp 3/4

a) 064/000; K4.10 (3.5/4.0)
b) 064/000; A2.06 (2.8/3.1)

ANSWER 4.19 (1.50)

a) Proceed to the auxiliary control room and pick up their respective checklists, go to the appropriate location and transfer controls. (+.7)

b) 1) AOI-35 (Loss of Offsite Power) 2) AOI-27(Control Room Inaccessable) 3) Phone directory 4) Boron-Dilution Table (TI-44) 5) Curve Book(TI-28) 6) SI-127 Heatup and Cooldown) 7) SDM Worksheets Instruction (TI-22) 8) SNP-IPD 9) SOI-3.2 (Cond Feed) 10) SOI-62.1 (CVCS) (+0.1 ea to max of 0.8)

REFERENCE
SQNP AOI-27A, pp 4 & 9

EPE-068; EK3.12 (4.1/4.5)

ANSWER 4.20 (1.50)

1) Reactor Trip-Turbine Trip due to all MFWRV, Regulatory Bypass and MSIVs going shut causing a loss of feedwater & lo S/G level coincident with Stm/Feed Flow mismatch and/or lo-lo S/G level (+.5)
2) MDAFW Pump 1B-B and TDAFW Pump start on lo-lo S/G level (+.25 ea below)
3) Steam dump and S/G blowdown valves fail close
4) Normal LTDN and orifice isolation valves fail close
5) All 4 EDGs start, but do not tie onto shutdown boards

REFERENCE
SQNP AOI-21.1, pp 1/2

EPE-058; EA2.01 (3.7/4.1)

ANSWER 4.21 (1.50)

a) RWST level < 29% and Containment Sump level > 10% (+.5)

b) Stop the corresponding RHR pump and CNTMT Spray Pump (+1.0)

REFERENCE
SQN ES-1.2, pp 3

EPE-011; EK3.15 (4.3/4.4) & PWG-11(4.5/4.5)

ANSWER 4.22 (3.50)

a) -CHG, SI & RHR pumps running (+.25 ea response)
-Flow through the BIT
-If RCS press < 1500 psig, verify SI pump flow
-If RCS press < 180 psig, verify RHR pump flow
b) -Verify Panels 6E & 6F light except in outlined areas
-Verify Panels 6C, 6D and 6H dark & 6G dark except outlined areas
c) -Verify AFW pumps running
-AFW level control valves in AUTO
-If S/G level < 33%, verify AFW flow
-S/G Blowdown valves closed

REFERENCE
SQN ES-0, pp 3-4

013/000; A3.02 (4.1/4.2)

ANSWER 4.23 (1.00)

Core Exit T/C (+.33 ea)
T-Hot
RCS Subcooling

REFERENCE
SQN ES-0.3, pp [illegible]

EPE-074: EA1.02 (3.9 4.2)

ANSWER 4.24 (1.00)

This is to compensate for the inability to borate the pressurizer.

REFERENCE
SQN ES-0.3, pp 3

EPE-074: EK3.11 (4.0/4.3)

ANSWER 4.25 (1.00)

[illegible] +.25 ea in correct order
[illegible] OR 4
[illegible] 3
[illegible] 2
[illegible] 1

REFERENCE
SQNP GOI-[illegible], pp [illegible]

PWG-[illegible]: Performance of Integrated Operations (3.[illegible] [illegible])