U. S. NUCLEAR REGULATORY COMMISSION

REGION V

Report No. 50-275/OL-87-02

Docket Nos. 50-275 and 50-323

Licensee: Pacific Gas and Electric Company
77 Beale Street
San Francisco, California 94106

Facility Name: Diablo Canyon Units 1 and 2

Examinations at: Avila Beach, California

Examination conducted: December 8-17, 1987

Examiners:	P. Morrill	1/22/88 Date Signed
	T. Meadows	1/22/88 Date Signed
	M. Royack	1/22/88 Date Signed
Approved by:	J. Elin, Chief, Operations Section	1/27/88 Date Signed

Summary:

Examinations were conducted December 8 through 17, 1987. The written examination was administered on December 8, 1986 to three senior reactor operator candidates (SRO) and to twelve reactor operator candidates (RO). The oral and simulator examinations were administered to the candidates from December 9 through 17, 1987. All candidates passed the operating and written examinations.

REPORT DETAILS

1. Examiners:

   P. Morrill, Chief Examiner, Region V
   T. Meadows
   M. Royack

2. Persons Attending the Exit Meeting

   December 18, 1986

   NRC

   P. Morrill, Region V
   T. Meadows, Region V
   M. Royack, Region V
   J. Elin, Region V

   Pacific Gas and Electric Company

   J. Townsend, Acting Plant Manager
   T. Martin, Training Manager
   J. Becerra, Senior Training Instructor
   B. Terrell, Senior Training Instructor
   J. Welsch, Senior Training Instructor
   C. Leach, Senior Training Instructor
   J. Molden, Operations Training Supervisor

3. Written Examination Review

   The written examination was administered on December 8, 1987. At the conclusion of the examination a copy of the examination key was provided to Mr. J. Molden, of the licensee's Training Department, for review. The written examination key was reviewed by the licensee's Messrs. Terrell, Welsch, Leach, and Molden.

   The licensee's review of the written examination resulted in comments which are included in Attachment A of this report. Licensee examination comments were given to the NRC examiners on December 11, 1987 in draft form and were subsequently sent to the NRC on January 12, 1988 by PG&E Letter No. DCL-88-002 (Shiffer to Martin). The written examination master key was revised, as described in Attachment A to this report, prior to grading the candidates responses.

4. Operating Examinations

   Simulator and oral examinations were conducted from December 9 through December 17, 1987. During the simulator examination, no generic problems were identified.

5. Exit Meeting

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

ATTACHMENT A

DIABLO CANYON UNITS 1 AND 2

NRC REACTOR OPERATOR EXAMINATION REVIEW

Examination review conducted by, Molden, Welsch, Terrell, and Leach.

QUESTION: 1.02

COMMENT:

We request that the examiners accept answers "c" or "d" as correct.

Using the provided Steam Tables yields an Enthalpy value of 1190 btu/lbm. When this value is cross-referenced on the provided Mollier diagram, the results are approximately 300 °F. The possible choices are 296 and 305 °F. We therefore feel that both choices are correct.

EVALUATION:

The facility comment is correct, the use of the Mollier diagram will result in approximately 300 °F.

RESOLUTION:

Facility comment accepted. The answer key is revised to accept answer "c or d".

QUESTION: 1.18

COMMENT:

We request that the examiners accept answers "c" or "d" as correct.

Depending on the assumed starting point for VARS, either answer would be correct:

If VARS were some level "OUT", then lowering voltage will cause VARS to decrease, answer "c".

If you continue to lower voltage until a Unity Power Factor is reached, or initially assumed that we were operating there, VARS will begin to increase in the "IN", out, direction, answer "d".

EVALUATION:

The facility comment is correct. Depending on the assumed starting point of "VARS" in, out, or unity answer "c or d" would be correct.

RESOLUTION:

Facility comment accepted. The answer key is revised to accept answer "d or c".

QUESTION: 1.19

COMMENT:

We request that the examiners accept answers "a" or "b" as correct.

Our reasons are similar to the above question, the possible choices are too close together. Using the provided tables, all 3 reviewers came up with an answer of approximately 130 gallons, halfway between the two possible choices. Also, at DCPP we teach a thumbrule of 3 gallons of boric acid to increase the ppm by 1. Applying this yields 126 gallons. Therefore we feel both answers are correct.

EVALUATION:

The facility comment is correct. The tolerances in the use of the graphs and nomographs could lead to a response that falls in between answers "a and b".

RESOLUTION:

Facility comment accepted. The answer key is revised to accept answer "a or b".

QUESTION: 2.01

COMMENT:

We request that the examiners delete part "c" from this question. And increase the point value of the parts of this answer.

The problem is in the reference material provided to you. The Unit 1 drawing labels this correctly as the Core Barrel, while the Unit 2 drawing labels the same item as the Core Plate. The true answer was not among the choices. A TIP will be initiated to correct our System Descriptions.

Attached are the highlighted unit drawings from our system descriptions.

EVALUATION:

The reference material provided for the examination preparation was incorrectly labeled.

RESOLUTION:

Facility comment accepted. The answer key is revised to delete item number "c" from the response and the point value of the question has been reduced to 2.5 points.

QUESTION: 2.02

COMMENT:

We request that the following be added to the answer key as possible correct answers to part "b":

Verification of value positions on the Monitor Box. STP done every shift to verify valve positions. Verification that the 8980 valve closed alarm is not in. Use of a locking device on the manual valve SI-1.

The answer given in the key is correct, however, we feel that any of the above answers are also just as correct.

EVALUATION:

Verification of valve position by use of the monitor lights for valve position indication on the Monitor box is required by STP I-1A and is done every shift to verify valve position. This is an action which is taken to insure that the valves from the normal source of water to the RHR pumps are or remain open. (Reference STP I-1a.)

The verification of SI-1 being locked open is part of the valve line up checks and as stated is not an acceptable answer to the question.

The use of alarms requires an action after the valve has left the open position. This does not insure that the valve remains or is open.

RESOLUTION:

Facility comment partially accepted.

The answer key is revised to accept "Verification of valve position on the monitor box or that STP I-1A is done every shift to verify valve position."

QUESTION: 2.03

COMMENT:

We request that the answer key be modified to include brackets in parts "c" and "d" as follows:

c. Reactor coolant system (loop 4) pressure at 700 psig.

d. Reactor coolant system pressure (PT-403 or 405).

The permissive and auto closure signals for 8701 come from PT-405, while the 8702 signals come from PT-403. The required knowledge should not include the loop origin for the signal, and in part d, the loop origin depends upon which valve is being referenced.

EVALUATION:

The noun name or equipment numbers of the components are equivalent.

RESOLUTION:

Facility comment accepted. The answer key is revised as follows:

c. Reactor coolant system loop 4 (PT-403) pressure, at 700 psig.

d. Reactor coolant loop 3 or 4 (PT-405 or PT-403) (Hot leg) pressure.

QUESTION: 2.04

COMMENT:

We request that the examiners accept 12 kv busses D and E as the correct answer to part "a" without reference to which pump is supplied by which bus.

We do not train the operators to memorize which pump is supplied by which bus, instead we train to know which busses supply the pumps and what actions to do on a loss of that bus. We also feel that the KSA catalog does not support this detail.

We also request that the answer to part "b" be modified to include as a possible answer the mechanical operation of the anti-rotation device (by the pawls on the flywheel engaging the frame mounted ratchet as the rotor comes to a stop thereby preventing reverse rotation).

We feel that the question, as written, could be interpreted as solicting this answer also.

EVALUATION:

For part "a" of the question, the knowledge of power supplies for major loads is important to the safe operation of the plant. The question is in accordance with Examiner Standard ES-202, paragraph B.3 and NUREG 1122 KSA catalog knowledge requirements.

For part "b" of the question, it could be interpreted to solicit the actual mechanical operation of the anti-reverse rotation device.

RESOLUTION:

Facility comment partially accepted. For part "b" of the question the answer key is revised to accept "by the pawls on the flywheel engaging the frame mounted ratchet as the rotor comes to a stop thereby preventing reverse rotation." for 0.5 points.

QUESTION: 2.05

COMMENT:

We request that the examiners accept "Reactor Vessel Head Vent" as a possible answer to part "a". This is a more common name for the same device.

We also request that the examiners accept "PT-403 and PT-405" as possible connection names to part "b" of this question. Again the answer key is correct, but these are also methods of referring to the requested loop connections.

EVALUATION:

In part "a", the names appear to be interchangeable and are for the same component.

Inpart "b", the equipment numbers are equivalent to the equipment noun names.

RESOLUTION:

Facility comment accepted. The answer key is revised as follows:

a. "Reactor vessel head vent" is added as an alternative Start-up head vent.

b. "PT-405 and PT-403" are added as alternatives to loop 3 and 4 respectively.

QUESTION: 2.06

COMMENT:

We request that the examiners accept "releasing into the Sparger ring or Sparged" as possible answers to part "c" of this question.

EVALUATION:

The sparger is physically located below the water line in the PRT, therefore, "releasing into the sparger ring or sparged" are correct alternative answers.

RESOLUTION:

Facility comment accepted. The answer key is revised to accept "releasing into the sparger ring or sparged".

QUESTION: 2.07

COMMENT:

We request that the word "instrument" be bracketed in part "c" of the answer. The question asks for the actuating fluid, not system.

EVALUATION:

The "actuating fluid" for the letdown orifice stop valves is "air", therefore, the word "instrument" is not required for a complete answer.

RESOLUTION:

Facility comment accepted. The answer key is revised to put "instrument" in parentheses.

QUESTION: 2.09

COMMENT:

We again request that the word "instrument" be bracketed in part "a" of the answer. The question calls for fluid not system.

EVALUATION:

The "fluid" used to open the MSIVs is "air", therefore, the word "instrument" is not required for a complete answer.

RESOLUTION:

Facility comment accepted. The answer key is revised to put "instrument" in parentheses.

QUESTION: 2.10

COMMENT:

We request that part "c" of the answer also include as possible answers "failed closed by design". As this is also a design feature to prevent inadvertent RCS cooldown.

EVALUATION:

The facility comment is correct. The 10% steam dump valves are designed to fail closed upon a loss of air and/or electrical control power. Reference System Description C-2b.

RESOLUTION:

Facility comment accepted. The answer key is revised to accept "Fail Closed" as an acceptable answer.

QUESTION: 2.11

COMMENT:

We request that the examiners accept "higher rod worth" as a possible answer to the question.

The stated references give both as the reasons. It is attached and highlighted.

EVALUATION:

The rod worth for Unit 2 is 1% less than for Unit 1. (Reference System Description A-3a, Unit Differences).

RESOLUTION:

Facility comment accepted. The answer key is revised to accept "Higher rod worth" as an acceptable answer.

QUESTION: 3.01

COMMENT:

We request that the examiners accept "PT-505" as a possible answer to part "a". It is the P impulse signal that produces T ref.

EVALUATION:

The "P impulse" signal is produced by PT-505, first stage turbine pressure.

RESOLUTION:

Facility comment accepted. The swer key is revised to accept "PT-505" as an alternative answer.

QUESTION: 3.03

COMMENT:

We request that the examiners delete part "a" to this question, and increase the other portions of the question accordingly. As stated above in the comments to question 2.04, we do not feel this kind of memorization is required nor supported by the KSA catalog.

We request that part "b" of the answer key be modified to accept as a possible answer "available for auto", as this is the practical use of the indication.

EVALUATION:

For part "a" of the question, knowledge of safety related power supplies to major loads is an important knowledge. The question is in accordance with Examiner Standard ES-202, paragraph B.3 and NUREG 1122 KSA catalog knowledge requirements.

For part "b" of the question, "available for auto" is synonymous with "auto-after-off".

RESOLUTION:

Facility comment partially accepted.

The answer key is revised to accept "available for auto" as an acceptable answer for part "b" of the question.

QUESTION: 3.07

COMMENT:

We request that the examiners accept the high pressure trip of 2385 psig as a possible answer.

The term "increase button" can be interpreted two ways, one which strictly looks at the increase arrow button, and the other that looks at the application of increasing pressure by using the decrease button. It should be clear in the candidates response how he interpreted your question, and the answer key should reflect the acceptance of either answer as the concept is understood in either case.

EVALUATION:

In order to increase pressurizer pressure the master pressure controller output signal is decreased by pressing the "increase" or "down" pointed arrow on the controller. In order to decrease pressurizer pressure the output from the master pressure controller is increased by pressing the "decrease" or "up" pointed arrow on the controller. Interpretation of the question could mean that increasing the output signal of the controller was taking place or that a decreasing output signal was increasing the actual pressurizer pressure. Reference System Description A-4a.

RESOLUTION:

Facility comment partially accepted. The answer key is revised to accept "2385 psig" as an acceptable response if the response is provided with an explanation.

QUESTION: 3.08

COMMENT:

We request that the examiners accept "P-14" as a possible answer to part "a.1" of the answer key.

EVALUATION:

Steam generator high-high level is the noun name for P-14, which causes a feedwater isolation.

RESOLUTION:

Facility comment accepted. The answer key is revised to accept "P-14" as an acceptable response to part a.1.

QUESTION: 3.10

COMMENT:

We request that the examiners accept "busses F and H" as the correct answer. Reasons stated in response to questions 2.04 and 3.03 above.

EVALUATION:

Knowledge of safety related power supplies to major loads is an important knowledge. The question is in accordance with Examiner Standard ES-202, paragraph B.3 and NUREG 1122 KSA catalog knowledge requirements.

RESOLUTION:

Facility comment not accepted.

QUESTION: 4.03

COMMENT:

We request that the examiners accept "Manually de-energize load centers 13 D & E" as a possible answer to part "a" of this question.

The operators are taught on a Unit 1 simulator, and are, therefore, likely to respond with unit 1 load center numbers. The concept of the desired answer is correct, even with unit 1 load center numbers.

EVALUATION:

The control switches for load centers 13 D and E and 23 D and E are located in identical positions for both Units 1 and 2. The question clearly states that Unit 2 rector has tripped, therefore, the response requires a response for Unit 2.

RESOLUTION:

Facility comment partially accepted. The answer key is revised to accept "Manually de-energize load centers 13 D and E" as acceptable answer for half credit (0.5 points).

QUESTION: 4.07

COMMENT:

We request that the examiners reconsider the point allocating of this question. We feel that the value given to part "b" is too high.

EVALUATION:

The point allocation for part "b" of the question is justified since the information requested falls within the one hour time frame for operator action as required by Technical Specifications and required operator knowledge.

RESOLUTION:

Facility comment not accepted.

QUESTION: 4.09

COMMENT:

We request that the examiners delete part "b" to this question.

The question solicits a response for the actions for Hot Shutdown, the answer given is for Hot Standby.

If the answer were to be modified for Hot Shutdown, it would be a confusing answer involving 3.3.3 implications with assumptions of the actions taken or not taken to get into Hot Standby in the correct amount of time. This is obviously not the examiners intent in this question.

EVALUATION:

The facility comment is correct. The term "Hot Standby" should have been used in part "b" of the question.

RESOLUTION:

Facility comment accepted. The answer key is revised to delete part "b" of the question.

QUESTION: 4.11

COMMENT:

We request that the examiners accept parts "a.1, a.3 and a.4" as the correct answer, without given "a.2".

The question solicits the answer of the SI termination criteria. The actual criteria is:

Subcooling 20
RCS pressure stable or increasing
Pzr level 4%
Heat sink available:

SG NR level 4% in 1 SG
or
AFW flow 460 gpm

Therefore, if the operator listed the first 3 above, and assumed the heat sink criteria satisfied from the question (due to SG level), we feel that this should be considered for full credit.

EVALUATION:

The facility comment is correct. For part "a" of the question the stem could imply that the "heat sink availability" criteria is met.

RESOLUTION:

Facility comment accepted. The answer key is revised to accept a.1, a.3, and a.4 as an accept ble response for full credit at 0.667 points each.

ATTACHMENT A

DIABLO CANYON UNITS 1 AND 2
NRC SRO EXAMINATION REVIEW

Examination review conducted by: Molden, Welsch, Terrell, Leach.

QUESTION: 5-4

COMMENT:

Answer "a" is also correct.

EVALUATION:

The question did not state whether the tank or the reference leg varied from calibration temperature. Therefore, the level instrument could indicate correctly.

RESOLUTION:

Comment accepted, either answer (a) or (c) is correct.

QUESTION: 5-7

COMMENT:

The figure given, 5-4, is very simplistic and does not give adequate selection points to pick off the various processes.

We request that the examiners accept either answer for part (c) and part (f).

(c) 1-2 or 1-3-3

(f) 2-3-4 or 3-4

EVALUATION:

The figure does not clearly show the endpoint of feedwater heating. Therefore the facility comment is correct. However, if an individual chose 1-2-3 for feedwater heating then 3-4 would be the only correct answer for heat added by steam generators.

RESOLUTION:

Comment partially accepted. Add 1-2-3 to answer (c) and 3-4 to answer (f) with the provision described above.

QUESTION: 5-10

COMMENT:

In part (b) it is asked if blowdown flow was "actually" 400 gpm. There are 2 ways to interpret this.

1. If you recalculate power while blowing down 400 gpm, you must remove that mass from the total mass flow rate. This will result in a lower "calculated" power.

This is the interpretation used in the Key.

2. If, however, you assume in the question that it was 400 gpm and you didn't know it (i.e., used 0) then your "calculated" power would be the same.

Either answer should be acceptable.

EVALUATION:

The facility expressed the concern that part (b) of the question was ambiguous. The candidates' assumption may change the answer to that indicated by the facility.

RESOLUTION:

The grader will consider the candidates' responses in light of any assumptions stated. If no assumptions are stated, the question will be graded to the existing key. The examiner will also revise the point distribution of part (a) to 0.4, 0.4, 0.4, and 0.3 as discussed with the facility reviewers.

QUESTION: 5-13

COMMENT:

The "best" answer is, of course, answer (b) high gamma flux. We request that the examiners also accept answer (d) high radiation flux.

EVALUATION:

The "best" answer is clearly (b), therefore the answer should be "(b)".

RESOLUTION:

Comment not accepted, no change will be made to the key.

QUESTION: 5-24

COMMENT:

Equilibrium Samarium does not vary with Power level, answer (d) is correct, not answer (c).

Reference enclosed.

EVALUATION:

The facility is correct. During editing the order or responses was changed without changing the answer. Page 4-31 of the cited reference applies to this situation.

RESOLUTION:

Comment accepted, the key will be changed to indicate that (d) is the correct answer.

QUESTION: 5-26

COMMENT:

The Test did not give the Student the Curve for Boron Worth that they use in calculating an ECC. The Power Change Worksheet (attached) simply uses 10 pcm/ppm. They were given the Inverse Boron Worth Curve which they do not use.

They should be expected to calculate the change in Power Defect of -235 pcm. Their answer for the corresponding Boron Change required will vary depending on their assumed Boron Worth.

We request that the answer key reflect this latitude.

EVALUATION:

The inverse boron worth curve supplied by the facility was used due to the fact that the boron worth curve described above was not supplied. It is acceptable to use 10 pcm/ppm with an answer of - 22.5 +/- 3 ppm.

RESOLUTION:

Comment accepted, the key will be changed as described above. In the future the facility personnel were requested to send the curves the operators actually used to the NRC examiners.

($t_{1/2}$ = 53.1 hrs). Therefore, Pm-149 is assumed to be a direct result of 1.07 percent of all fissions.

$$\frac{\Delta N_{Pm}}{\Delta t} = \gamma_{Pm} \Sigma_f \phi - \lambda_{Pm} N_m$$

At equilibrium, Pm-149 production = Pm-149 removal:

$$\frac{\Delta N_{Pm}}{\Delta t} = 0 = \gamma_{Pm} \Sigma_f \phi - \lambda_{Pm} N_{Pm}$$

$$\lambda_{Pm} N_{Pm} = \gamma \Sigma_f \phi$$

and Sm-149 production = Sm-149 removal:

$$\frac{\Delta N_{Sm}}{\Delta t} = 0 = \lambda_{Pm} N_{Pm} - \sigma_a N_{Sm} \phi$$

$$\lambda_{Pm} N_{Pm} = \sigma_a N_{Sm} \phi$$

Substituting and solving for N_{Sm}:

$$\gamma_{Pm} \Sigma_f \phi = \sigma_a N_{Sm} \phi$$

$$N_{Sm} = \frac{\gamma_{Pm} \Sigma_f d}{s_a d}$$

$$N_{Sm} = \frac{\gamma_{Pm} \Sigma_f}{\sigma_a}$$

Samarium-149 has an equilibrium concentration independent of the flux level.

Figure FND-RF-251 is a graph of the reactivity due to Sm-149 versus time after startup for a clean reactor core. The Sm-149 concentration reaches its equilibrium value in about 400 hours.

TITLE: POWER CHANGE WORKSHEET

3. Rod Worth

   a. Refer to Volume 9, Figure R4-1F-4 (R4-2F-4)

   b. Initial Rod Position ___________steps, Initial Worth_______pcm

   c. Final Rod Position___________steps, Final Worth___________pcm

   d. Net Rod Worth Change (C.3.b - C.3.a)_____________pcm

4. Net Reactivity Change (C.2.d + C.3.d) _____________pcm

5. Net Boron Change (C.4 ÷ 10 pcm/ppm) __________ppm

6. Final Boron Concentration (C.1 + C.5) ____________________ppm

7. Boration

   a. Refer to nomagraph, Vol. 9, Sect. IA Figure IA-2, Pg. I-2

   b. Gallons 12% Boric Acid to Add ____________________gallons

8. Dilution

   a. Refer to nomograph, Vol. 9, Sect. IA, Fig. IA-4, Pg IA-4

   b. Gallons Primary Water to Add_______________ gallons.

D. Fxy:

1. Power level at which Fxy was last measured: __________%
   Consult with plant technical department for above value.

2. Refer to Precaution and Limitations, item D.

Work sheet data and calculations performed by ______________________________

Reviewed by ______________________________

Comments ______________________________

____

____

____

____

QUESTION: 6-3

COMMENT:

Request that brackets be placed in part "a" of the answer key as follows:

"Upper - during natural circulation (or when the RCP in the loop with the hot leg connection is not operating)"

EVALUATION:

The subject phrase was intended for clarification. The examiner agrees.

RESOLUTION:

Comment accepted, the subject phrase will be placed in brackets for clarification.

QUESTION: 6-4

COMMENT:

In part (c) they should also accept 328-330°F as in part (b)

EVALUATION:

The facility is correct. The same tolerance as used in part (b) was intended to be used in part (c).

RESOLUTION:

Comment accepted, 328F will be changed to 328 - 330 F.

QUESTION: 6-5

COMMENT:

Request that the answer key for part "c" have the "Pzr level falls...." deleted, the question doesn't solicit this.

EVALUATION:

The referenced phrase was intended to be supporting material. It was not solicited by the question.

RESOLUTION:

Comment accepted, the subject phrase will be placed in brackets.

QUESTION: 6-6

COMMENT:

Answer for part (a) lists OTΔT twice, should be OPΔP on one of them.

Answer for part (c) lists "above 15% power" which has nothing to do with the Steam Dumps. Please delete this from the key.

EVALUATION:

The fifth line of the answer should be "Overpressure delta T channel activated". The comment in brackets in answer (c) is left over from editing and is not applicable.

RESOLUTION:

Comment accepted, the answer to parts (a) and (c) will be changed as described above.

QUESTION: 6-7

COMMENT:

In part (a) it is not clear which switch at the Hot Shutdown Panel is referred to. If one assumes the actual Control Switch, rather than the Control Transfer Switch, then it will not matter which position it is in.

Accept "Remote" as synonymous with "Control Room".

Answer for part (b) should be: (any 2)

1. Less than 40 psig discharge pressure

2. Low voltage on opposite bus

3. Bus Transfer to Startup

4. Bus Transfer to Diesel

Ref: Page 13 of System Description E-5

EVALUATION:

In answer (a) "Control Room" or "Remote" express the same switch position from the remote shutdown panel, consequently either answer is acceptable. In answer (b) based on PG&E drawing 437594, Change 14, the facility is correct. Any two of the four start signals would be correct.

RESOLUTION:

Comment accepted. The answers to part (a) and (b) will be modified as described above.

QUESTION: 6-8

COMMENT:

Request that the examiners accept the simplified answers given in the Operator Information Manual.

Reference is attached.

EVALUATION:

The question states that the bases for the trips are described in the Technical Specifications. The descriptions in the Operator Information Manual are not the same as the Technical Specification Bases and contains less detail. See Operator Information Manual, pages B-6-4a and B-6-4b.

RESOLUTION:

Comment not accepted, the examiner will grade based on the existing key. Partial credit may be given for partial answers, i.e. some of the Operator Information Manual data as long as it is consistent with the Technical Specification Bases.

QUESTION: 6-9

COMMENT:

Answer for part (e) should say "Alarm Only"

Answer for part (f) should also say "Transfer Blowdown Tank Outlet from Outfall to EDR" (FCV-498/499 swap to EDR)

EVALUATION:

In part (e) Unit 1 discharge isolation valve is jumpered and does not isolate, while in Unit 2 the discharge isolation valve is not jumpered. With proper detector operation Unit 2 would isolate, however, the detector cannot be calibrated at this time. Facility personnel stated that the entire matter is under review with the hope of purchasing a sufficiently sensitive instrument which can be calibrated to the proper setpoint. In part (f) based on PG&E drawing 102931 the tank outlet is switched from the outfall to the EDR and valves FCV-498 and 499 are shut. This is a more precise answer than the one originally solicited.

RESOLUTION:

Comments accepted. In part (e) due to the on going facility work on this device, the only correct answer would be a lengthy explanation well beyond the purpose of the question. Part (e) is therefore deleted. In part (f) the answer will be modified to include that the tank outlet is switched to the EDR.

- NUCLEAR INSTRUMENTATION SIGNALS -

TRIP	SETPOINT**	COINCIDENCE	INTERLOCKS	PROTECTION AFFORDED
Source Range Hi Flux	10^5 cps	1/2	P-6, P-10	Start-up Accident
Intermediate Range Hi Flux	25% power (current equivalent)	1/2	P-10	Start-up accident
Power Range Hi Flux (low)	25% power	2/4	P-10	* Start-up accident
Power Range Hi Flux (high)	109% power	2/4		* Over power (kw/ft)
Power Range Rate Trip	+5% power/2sec	2/4		Ejected rod
	-5% power/2sec			DNBR >1.30 during single/multiple rod drops

- REACTOR COOLANT SYSTEM SIGNALS -

OTΔT 117.4% ITavg ± Press-ΔI	117.4% ± penalties	2/4		*DNBR >1.30
OPΔT	107.9% - penalties -Tavg -Tavg Rate	2/4		*KW/ft
Loop low flow	90%	2/3 sensors on: 2/4 LOOPS (<P-8) 1/4 loops (>P-8)	P-7, P-8	*DNBR >1.30
RCP breaker open	Open	2/4 loops	P-7	DNBR >1.30
RCP bus under voltage	8050 volts	1/2 sensors 2/2 busses	P-7	*DNBR >1.30
RCP bus under frequency	54 Hz	2/3 sensors 1/2 busses	P-7	DNBR >1.30

* Protection assumed in FSAR analyzed accidents

** Reset values approx. 1% different than setpoint value (see appropriate setpoint documentation for exact values).

- PRESSURIZER SYSTEM SIGNALS -

TRIP	SETPOINT**	COINCIDENCE	INTERLOCKS	PROTECTION AFFORDED
Low Pressure	1950 psig	2/4	P-7	* DNB
High Pressure	2385 psig	2/4		* RCS integrity
High Level	92%	2/3	P-7	Prevent water relief, RCS integrity

- SECONDARY SYSTEMS SIGNALS -

Steam Generator low level and flow mismatch	25% NR Lvl-and-SF>FF by $1.45X10^6$#/hr U1 $1.49X10^6$#/hr U2	1/2 sensors on any S/G - and - 1/2 sensors on same S/G		Loss of heat sink
Steam Generator low low level	15%	2/3 sensors on 1/4 loops		* Loss of heat sink
Turbine trip	Auto Stop Oil<50 psig -or- stop valves closed	2/3 4/4	P-7	* Limit temperature/ pressure transients on the RCS

- MISCELLANEOUS SIGNALS -

Manual		1/2		Operator judgement
Safety Injection		Any "S" signal		* Limit consequences of accidents
Seismic	.35g	2/3 sensors (in the same direction)		Trip reactor in the event of a double design earthquake

* Protection assumed in FSAR analyzed accidents

** Reset values approx. 1% different than setpoint value (see appropriate setpoint documentation for exact values).

QUESTION: 6-10

COMMENT:

Request that the examiner accept "temperature" as well as "power" in the answers for parts "b and c". This is the actual function of the rods.

EVALUATION:

Considering that power defect and NTC will stabilize power at a higher or lower temperature (assuming no rod motion) either power or temperature could be viewed as controlling the rods and evaluation of the effects of the transient.

RESOLUTION:

Comment accepted. Appropriate changes to the key will be made.

QUESTION: 6-15

COMMENT:

Request that the examiners accept a description of the Mechanical interlock for the correct answer.

EVALUATION:

A description of the mechanical interlock demonstrates that the candidates know what prevents paralleling power supplies, consequently this would also be a correct answer.

RESOLUTION:

Comment accepted. However, no change to the key needs to be made.

QUESTION: 7-5

COMMENT:

Answer in part (b) should also list as an action for Criticality below the RIL:

- Emergency Borate 100 ppm

EVALUATION:

Unit 2 has a higher rod insertion limit than Unit 1 (for which the question was originally written), consequently the facillity is correct.

RESOLUTION:

Comment accepted. The key will be changed appropriately.

QUESTION 7-12

COMMENT:

The answer to part d. should accept partial credit for indicating that there is required access control per 10 CFR 20 for the pump room, tank room, and valve room. Only the tank room is required to be locked or access control per 10 CFR 20.

After reading the answer it would be obvious that the "or access controlled per 10 CFR 20" is meaning other options if the tank room can not be locked.

The examinee could interprete the question ad identify that all the rooms require access control per 10 CFR 20.

EVALUATION:

The question asks which area(s) must be locked or access controlled per 10 CFR 20. The facility uses Access Control to mean the "Restricted Areas" which are the radiation areas of 10 CFR 20. The facility comment has some merit. In the future it would be beneficial to avoid the phrase "or access controlled". The ambiguity introduced by this phrase defeats the purpose of the question.

RESOLUTION:

Question 7-12(d) will be deleted.

QUESTION: 8-01

COMMENT:

The Abnormal Procedures for Steam Generator Tube Leaks are as follows:

OP AP-3A "Steam Generator Tube Leak"
OP AP-3B "Steam Generator Tube Failure"

In these procedures the actions are to find the leak and reduce power as necessary for OP AP-3A "SG Tube Leak", and to find the leak and commence shutdown for OP AP-3B "SG Tube Failure".

The question denotes AP-3 as the Minor SG Tube Failure, and AP-3A as the SG Tube Leak. But in either instance, the answer key is incorrect. We request that the examiner accept answers "a" or "d" as correct. Dependent upon which the candidate assumed to be 3A or 3B, one of the two would be the correct answer.

Excerpts of OP AP-3A and 3B are enclosed.

EVALUATION:

The reference material sent to the NRC by the facility included AP-3 "Minor Steam Generator Tube Failure" dated 7/20/84, and AP-3A "Steam Generator Tube Leak" dated 6/22/87. The existence of AP-3B "Steam Generator Tube Failure" dated 6/22/87 was identified to the NRC personnel during the examination review. Neither AP-3 or AP-3B were listed in the list of material forwarded to the NRC. Aside from the administrative problems described above, the purpose of the question was to determine if the candidates knew the different major actions required by procedure for a "tube leak" vs. a "minor tube failure". Considering that procedure AP-3B appears to replace AP-3 and the question reference a procedure no longer in use, the question appears to be no longer valid.

RESOLUTION:

Comment accepted, however question 8-1 will be deleted.

PACIFIC GAS AND ELECTRIC COMPANY

DEPARTMENT OF NUCLEAR POWER GENERATION
DIABLO CANYON POWER PLANT

NUMBER OP AP-3A
REVISION 1

UNITS **1** AND **2**

TITLE: ABNORMAL OPERATING PROCEDURE
STEAM GENERATOR TUBE LEAK

APPROVED: [redacted] 6-22-87 6-22-87
PLANT MANAGER DATE EFFECTIVE DATE

SCOPE

This procedure provides instructions in the event steam generator tube leakage is indicated by secondary radiation alarms or increased secondary activity. This procedure is applicable for leak rates that might exceed Technical Specification limits but are too small to observe increased charging flow or pressurizer level fluctuations.

This procedure and changes thereto require PSRC review.

SYMPTOMS

1. Secondary radiation alarms or up-scale readings
   a. Air ejector off-gas high radiation (RE-15)
   b. S/G blowdown high radiation (RE-19, 23, 27)
   c. Main steam line high radiation (RE-71, 72, 73, 74)
2. Increase in sampled secondary coolant activity
3. VCT level trending down or increased automatic makeup
4. Possible Main Annunciator Alarms:
   a. S/G BLOWDOWN HI RAD (PK11-17)
   b. HIGH RADIATION (PK11-21)
   c. MAIN STEAM LINE HI RAD (PK11-18)
   d. PLANT VENT RADIATION (PK11-25)
   e. STM JET AIR EJECT HI RAD (PK11-06) UNIT 2 ONLY

ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED
4. CHECK SG Specific Activity:	
a. Notify Chem and Rad to perform specific activity analysis on leaking steam generator.	
b. Refer to Tech Spec 3.7.1.4 for compliance to SG specific activity limits.	IF secondary activity limit is exceeded THEN GO to Cold Shutdown per Tech Spec action statement.
5. CHECK SG Leak Rate:	
a. Perform STP R-10 Part C.	
b. Notify CARP to perform CAP D-15 to determine specific SG leak rate.	
c. Refer to Tech Spec 3.4.6.2 for compliance to SG leakage limits.	
6. DETERMINE Response To SG Tube Leak:	
o If continued operation is desired go to OP L-4 NORMAL OPERATION AT POWER.	
o If leak rate reduction is desired continue with this procedure.	
7. REDUCE Power Level as needed to attempt to reduce leakrate.	
8. REVERIFY Leak Rate LESS Than Technical Specification Limit:	Return to Step 7 if leakrate reduction is desired.
o Perform STP R-10 Part C o Notify CARP to perform CAP D-15 o Verify compliance with Tech Spec 3.4.6.2	

PACIFIC GAS AND ELECTRIC COMPANY		NUMBER	OP AP-3B
		REVISION	2
DEPARTMENT OF NUCLEAR POWER GENERATION		PAGE	1 OF 13
DIABLO CANYON POWER PLANT		UNITS	1 AND 2

ABNORMAL OPERATING PROCEDURE
TITLE: STEAM GENERATOR TUBE FAILURE

APPROVED: [redacted] 6-22-81 6-22-81
PLANT MANAGER DATE EFFECTIVE DATE

SCOPE

This procedure provides instructions and general guidelines for operator actions in the event of a steam generator tube failure. The conditions assumed for entry into this procedure are primary to secondary leak rate clearly in excess of Technical Specification limits and secondary radiation monitors in alarm condition.

This procedure and changes thereto require PSRC review.

OBJECTIVE

The objective of this procedure is to rapidly shutdown the reactor, isolate the affected steam generator, cooldown and depressurize RCS to the point where primary to secondary break flow is stopped, without actuation of reactor protection or safeguards systems.

SYMPTOMS

1. Indication of RCS leakage:
   a. Increase in charging flow
   b. Increased VCT makeup frequency
2. Secondary system radiation monitor alarms:
   a. Air ejector off-gas (RE-15)
   b. Steam generator blowdown (RE-19, 23, 27)
   c. Main steam line (RE-71, 72, 73, 74)
3. Increase in sampled secondary coolant activity.

ACTION/EXPECTED RESPONSE | RESPONSE NOT OBTAINED

4. DETERMINE Affected Steam Generator:

   a. Contact Chemistry and Radiation Protection - COMMENCE SAMPLING SGs.

   b. Check main steam line radiation monitors.

   c. Use portable radiation detectors to survey main steam leads or SG blowdown lines.

   d. Continue with Step 5 concurrent with Step 4.

5. COMMENCE Unit Shutdown:

   a. Notify system dispatcher that unit is coming off the grid.

   b. Begin load reduction in accordance with OP L-4 up to 50 MW/min ramp down rate.

6. PLACE Reactor in HOT STANDBY in accordance with OP L-5

QUESTION: 8-3

COMMENTS:

See attached drawings.

No key was provided.

Copy of NPAP enclosed to check against examiners' key.

EVALUATION:

The NPAP was not previously requested to avoid possible question compromise. The Chief Examiner requested this document from the licensee after the examination was completed.

RESOLUTION:

Supplement 1 to NPAP C-101, Figure 1 and 2 will be used for the examination key.

QUESTION: 8-4

COMMENT:

Administrative Procedure C-150 was rescinded in May of 1987, its' scope is now covered by the switching procedures. Refer to the attached AP C-7S1 for description of caution tag usage. Therefore, request that the examiners accept the following variation to the answer key:

Part C: Caution tag. This is actually a more correct answer to the type of tag used. The switching tag is the document used as a procedure, unlike the name implies.

EVALUATION:

Based on the elimination of AP C-150 the switching procedures now cover the same scope. The caution tag would be appropriate for the grounding switch based on C-7S1, Revision 2, page 3.

RESOLUTION:

The comment is accepted, the correct answer is the caution tag.

PACIFIC GAS AND ELECTRIC COMPANY
DEPARTMENT OF NUCLEAR PLANT OPERATIONS
DIABLO CANYON POWER PLANT UNIT NOS. 1 AND 2
SUPPLEMENT 1 TO NUCLEAR PLANT ADMINISTRATIVE PROCEDURE C-101

TITLE: CONFINES OF CONTROL ROOM AT DIABLO CANYON

SCOPE

This procedure identifies the boundaries of the Control Room at Diablo Canyon.

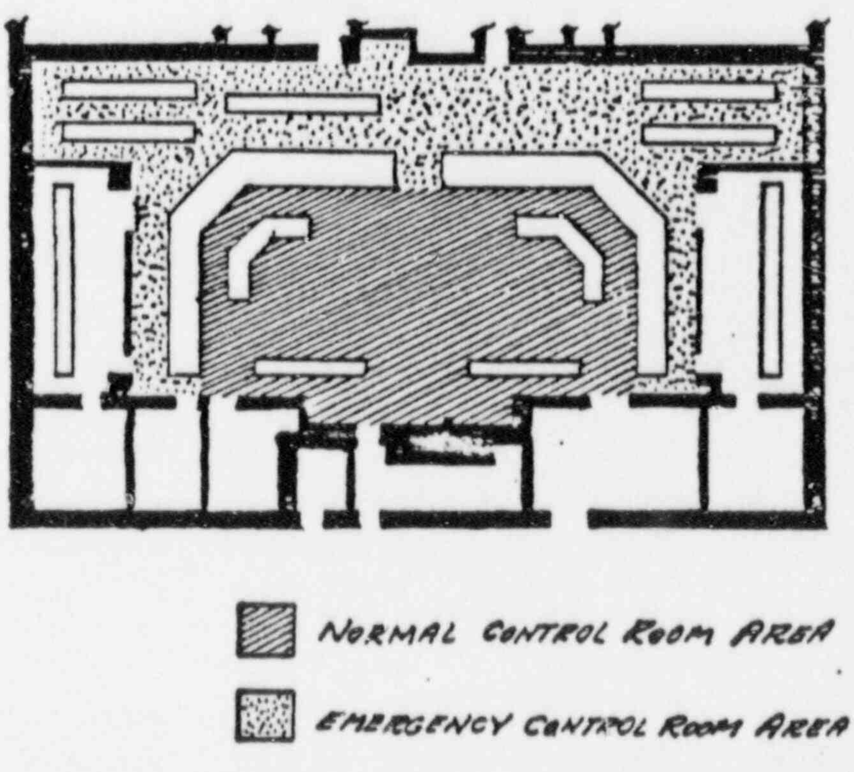
PROCEDURE

1. The normal boundaries of the control room for the Control Operator (operator at the controls) shall be as shown on Figure 1.

2. The emergency boundaries of the control room for the Control Operator shall be as shown on Figure 1.

3. The boundaries of the control room for the senior licensed operator shall include areas 1 and 2 above, the Shift Foreman's office and other appropriate adjacent areas. This area is shown on Figure 2.

FIGURE 1



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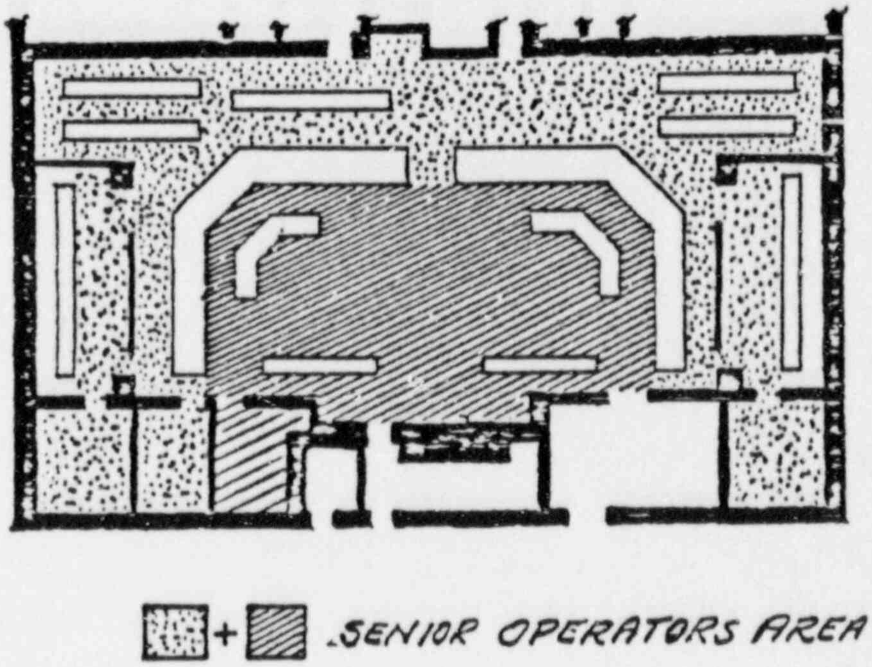
APPROVAL R.D. Ramsayke 5/6/80
PLANT SUPERINTENDENT DATE

FIGURE 2



3.3.3 Equipment that is tagged with Man-On-Line Tags shall not be operated for any reason.

3.3.4 A Man-On-Line Tag shall be filled out with the following information, as a minimum.

a. The description or number of the device to which the tag is to be attached.

b. The name of the person who is taking the Clearance.

c. The Clearance Request number.

3.3.5 Man-On-Line Tags shall be removed and destroyed when no longer needed.

3.4 Caution Tags

3.4.1 Caution Tags shall be used to identify any plant equipment that should not be operated for reasons other than those requiring use of a Man-On-Line Tag. Examples of these applications are: Tagging open vents and drains in conjunction with a clearance, tagging closed an electrical ground switch, and for Administrative Tag Outs.

3.4.2 Caution Tags shall not be hung in the plant unless their installation and removal is documented by an approved procedure, Clearance Request, Work Order Activity or Administrative Tag Out.

3.4.3 Caution Tags shall be completely filled out with the following information.

a. The description or number of the device to which the Tag is to be attached.

b. The persons name who initiated the Tag.

c. The Clearance, Procedure number, or Administrative Tag Out number.

3.4.4 Caution Tags should be hung by personnel who are responsible for carrying out the procedure requiring the tag. (Operations personnel hang tags involved with clearances and Administrative Tag Outs, I&C personnel hang tags involved with instrumentation work, etc.)

QUESTION: 8-7

COMMENT:

Request the following modifications be accepted as part of the key for part b of this question:

AP C-104S1 page 2 also states that if a component has been cleared on a previous clearance which was independently verified, verification of the subsequent clearances is not necessary. Therefore, this answer should be accepted for full credit also.

Admin procedure excerpts included.

EVALUATION:

The facility comment and reference to C-104S1, page 2, are correct. The alternate answer would demonstrate a high level of knowledge in the subject area of the question.

RESOLUTION:

The comment is accpeted.

QUESTION: 8-11

COMMENT:

Request that the examiner change the key to part "d" of this question to "ALERT".

The question is an ATWS Without apparent core damage. No mention of an SI or other transient in the question.

Our procedures on this are G-1, and the Appendix Z of FR-S1. Both are enclosed and highlighted.

Appendix Z designates this as an ALERT, only upgraded to a SITE AREA EMERGENCY if an SI was initiated before the rods were inserted into the core.

In EP G-1 the ATWS concern is called out in the ALERT and the SITE AREA EMERGENCY areas. Under the NUREG Column the difference is in the Transient condition needed for a SAE category, the DCPP column is not as clear. It in fact uses the same criteria for both. This problem is being forwarded to the Emergency Planning group for correction in future revisions to EP G-1.

EVALUATION:

Based on a review of EP G-1, pages 25 and 33 and FR S-1, Appendix Z, the facility comment is correct. The facility identified the ambiguity in procedure EP G-1 and appears to be taking appropriate corrective action to clarify that the correct classification is "ALERT".

RESOLUTION:

The comment is accepted and the key will be changed.

PACIFIC GAS AND ELECTRIC COMPANY

DEPARTMENT OF NUCLEAR POWER GENERATION
DIABLO CANYON POWER PLANT

ADMINISTRATIVE PROCEDURE
TITLE: INDEPENDENT VERIFICATION OF OPERATING ACTIVITIES
SUPPLEMENT 1

APPROVED R. C. Thornberry 3-24-87
PLANT MANAGER DATE EFFECTIVE DATE

SCOPE

This procedure describes the method of implementing the requirements of independent verification of operating activities at Diablo Canyon as defined in NPAP C-104 Independent Verification of Operating Activities. This procedure and changes thereto require PSRC review.

DISCUSSION

Independent verification of configuration changes to plant systems important to safety shall be performed during routine system alignment changes, removal from and return to service for plant maintenance or testing, installation and removal of jumpers, lifted circuits, or mechanical bypasses, and alignment to initiate liquid or gaseous radwaste or chemical discharges. This provides additional assurance that these tasks are properly performed to comply with the plant procedures and technical specifications and that the health and safety of the public and environmental quality is protected.

INSTRUCTIONS

A. Removal from Service/Clearances

When equipment which is important to safety is removed from service for maintenance or testing, independent verification will be performed to assure that other plant systems are not affected unknowingly by the clearance. This verification shall proceed as follows.

1. A second licensed operator, other than the Shift Foreman shall review the clearance prior to the clearance being initiated to verify that the proper clearance points are addressed and all items documented on the clearance (Tech Spec Applicability, Post Maintenance Test, etc.) have been properly addressed. This verification will be documented by that person's signature in the spot designated as "Reviewed By" under the preparer's signature in Section III of the Clearance Request and Job Assignment Sheet.

2. Following the clearance being approved and after all tags are hung, a second person shall independently verify the clearance by:

   a) Verifying that all clearance points are in their proper position (valves closed, breakers open, etc.).

   b) Verifying that all tags are on their respective clearance points.

   c) Verifying that any necessary additional measures called out on the clearance have been satisfied. (Tanks drained, piping vented, etc.) This verification shall be documented in the independent verification signoff on the clearance form.

   d) In the case where multiple clearances are issued on the same piece of equipment, independent verification is not necessary after the first clearance is issued providing the additional clearances do not increase the scope of the original clearance. If independent verification of a clearance is waived due to a previous clearance on the equipment, it should be documented in the Remarks section of that clearance, including the clearance number that was independently verified.

   e) This independent verification may be performed by either an operator or the journeyman taking the clearance.

B. Return to Service/Clearances

When equipment which is important to safety is returned to service following maintenance or testing, independent verification will be performed to assure the equipment is properly returned to service. This verification will proceed as follows:

1. If an approved surveillance test is performed as a post-maintenance test which demonstrates that all alignments are correct on that piece of equipment, then the test will satisfy the independent verification requirements. If this is the case, the performance of the test shall be entered in the independent verification signoff on the clearance request form.

TITLE EMERGENCY PROCEDURE
RESPONSE TO NUCLEAR POWER GENERATION/ATWS

APPROVED R. C. Thornberry 3-25-85
PLANT MANAGER DATE

IMPORTANT TO SAFETY

SCOPE

This procedure provides actions to add negative reactivity to the core if it is observed to be critical when expected to be shut down. This procedure and changes thereto requires PSRC review.

SYMPTOMS OR ENTRY CONDITIONS

1. E-0, REACTOR TRIP OR SAFETY INJECTION, Step 1, when reactor trip is not verified and manual trip is not effective.

2. F-0.1, SUBCRITICALITY Critical Safety Function Status Tree on either a RED or ORANGE condition.

APPENDIX Z

EMERGENCY PROCEDURE NOTIFICATION INSTRUCTIONS

1. When the emergency procedure has been activated and upon direction from the Shift Foreman proceed as follows:

   a. Designate this event an Alert. Notify plant staff and response organizations required for this classification by Emergency Procedure G-2 "Establishment of On-Site Organization" and Emergency Procedure G-3 "Notification of Off-Site Organization" in accordance with Emergency Procedure G-1 "Accident Classification and Emergency Plan Activation."

   b. Designate this event a Site Area Emergency if safety injection was initiated before rods were inserted into the core but no core damage is evident (no abnormal increase in RCS coolant activity and no abnormal increase in gross failed fuel indication). Notify plant staff and response organizations required by EP G-2 and EP G-3 in accordance with EP G-1.

   c. Designate this event a General Emergency if one of the following conditions exist:

      1) Core damage is evident by:

         a) Reactor coolant activity greater than 300 μCi/cc equivalent I-131, or

         b) Radiation levels indicate greater than 100% gap release (Refer to Appendix H of EP OP-1).

      2) Complete loss of safe shutdown system simultaneous with rods not inserted in the core.

      3) Loss of CVCS capability to increase boric acid concentration in the RCS simultaneous with rods not inserted into the core.

2. Notify plant staff and response organizations required by EP G-2 and EP G-3 in accordance with EP G-1.

PACIFIC GAS AND ELECTRIC COMPANY

DEPARTMENT OF NUCLEAR POWER GENERATION

DIABLO CANYON POWER PLANT

NUMBER EP G-1

REVISION 8

UNITS **1 AND 2**

EMERGENCY PROCEDURE

TITLE: ACCIDENT CLASSIFICATION AND EMERGENCY PLAN ACTIVATION

APPROVED: John D Townsend 8-27-87 8-27-87
PLANT MANAGER DATE EFFECTIVE DATE

SCOPE

This procedure describes the guidelines for Accident Classification and responsibilities for Activation of the Emergency Plan. Implementation of this procedure constitutes declaration of an emergency condition. This procedure and revisions thereto require PSRC review.

GENERAL

This procedure provides guidance on activating the emergency plan and classifying an accident. The steps required by this procedure are in addition to the steps required to maintain or restore the plant to a safe condition.

Prompt notification of off-site authorities should be given within about 15 minutes for the Unusual Event class and sooner (consistent with the need for other emergency actions) for other classes. The time is measured from the time which the Shift Foreman recognizes that events have occurred which make declaration of an emergency class appropriate.

This procedure is organized as follows:

ACTIVATION OF EMERGENCY PLAN

The initial steps to be taken for each of the established accident classifications are listed below under:

1. Notification of an Unusual Event
2. Alert
3. Site Area Emergency
4. General Emergency

ALERT - (cont.)

NUREG-0654, APPENDIX 1 CONDITIONS	DIABLO CANYON POTENTIAL INDICATED CONDITIONS
	3.4-1) or 100 µCi/gm specific activity (Technical Specification 3.4.8) (Unusual Event Condition No. 3).
10. Complete loss of any function needed for plant cold shutdown.	10. Loss of both residual heat removal trains.
11. Failure of the reactor protection system to initiate and complete a scram which brings the reactor subcritical.	11. Plant conditions indicate the required conditions for Reactor Trip has occurred or the required coincidence of bistables have tripped, or trip is manually activated, and Nuclear Instrumentation indicates reactor not subcritical (non-negative start-up rate).
12. Fuel damage accident with release of radioactivity to containment or fuel handling building.	12. a. High Containment Radiogas and/or particulate alarms or Containment Ventilation Isolation caused by high containment activity while in the refueling mode or b. High Fuel Handling Building Area Radiation Alarm or Fuel Handling Building Ventilation automatic change to the Iodine Removal Mode, while irradiated fuel is in the building.

SITE AREA EMERGENCY (cont.)

NUREG-0654, APPENDIX 1 CONDITIONS	DIABLO CANYON POTENTIAL INDICATED CONDITIONS
	g. Complete loss of Instrumentation or Controls required for any of the systems capabilities in items 7.a-f. above.
8. Transient requiring operation of shutdown systems with failure to scram (continued power generation but no core damage immediately evident).	8. Plant Conditions indicate the required conditions for Reactor Trip has occurred or the required coincidence of bistables have tripped, or trip is manually activated (ALERT Condition number 11), and power generation indicated on power range channels, and no gross fuel failure evident (absence of ALERT Condition No. 1).
9. Major damage to spent fuel in containment or fuel handling building (e.g., large object damages fuel or water loss below fuel level).	9. a. High Containment Radiogas and/or particulate alarms or Containment Ventilation Isolation caused by high containment activity while in the refueling mode or b. High Fuel Handling Building Area Radiation Alarm or Fuel Handling Building Ventilation automatic change to the Iodine Removal Mode, while irradiated fuel is in the building. (Alert Condition number 12) and Confirmed gross fuel damage or loss of water level to below fuel level.

QUESTION: 8-13

COMMENT:

Request the examiner change the key for part "b" of this question to include all 4 of the conditions.

Centrifugal Charging Pump 21 is activated by Train A of SSPS, while RHR pump 21 is activated by Train B of SSPS, therefore, it would be a 3.0.3 condition. At DCPP it is not a safe assumption to make that all pumps "1" are Train A, we have many variations to this rule.

Charging pump 21 inoperable and Charging pump 22 inoperable would constitute the same conditions as listed above. As well as the inability to satisfy TS 3.5.2 on ECCS Subsystems, or TS 3.1.2.4 on Charging pumps. The examiner might have assumed CCP 21 to be the Reciprocating pump, this is pump 23.

EVALUATION:

Based on facility drawing 445651, sheet 2, change 3, which tabulates the ESF equipment with power supplies and logic trains, the facility comments are correct. The intent of the question was to evaluate the candidates' knowledge of 3.0.3 not of this particular drawing or of the unique ordering of components, power supplies, and logic channels. It appears that the original purpose of the question is no longer satisfied and therefore the question is no longer valid.

RESOLUTION:

Comment accepted, however, the question will be dropped.

CORRECTED EXAM KEY

U.S. Nuclear Regulatory Commission
Reactor Operator License Examination

Facility: DIABLO CANYON UNITS 1& 2

Reactor Type: WESTINGHOUSE PWR 4 LOOP

Date Administered: DECEMBER 8, 1987

Examiner: MICHAEL J. ROYACK

Candidate: ******KEY*******

INSTRUCTIONS TO CANDIDATE:

Use separate paper for the answers. Write answers on one side only. Staple question sheet on top of the answer sheets. Points for each question are indicated in parentheses after the question. The passing grade requires at least 70% in each category 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	Candidate's Score	% of Category Value		Category
25	~~25%~~ 25.38			1.	Principles of Nuclear Power Plant Operation, Thermodynamics, Heat Transfer and Fluid Flow
~~25~~ 24.5	~~25%~~ 24.87			2.	Plant Design Including Safety and Emergency Systems
25	~~25%~~ 25.38			3.	Instruments and Controls
~~25~~ 24	~~25%~~ 24.37			4.	Procedures - Normal, Abnormal, Emergency, and Radiological Control
~~100~~ ~~99~~ 98.5					TOTALS

Final Grade KEY %

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

******KEY******
Candidate's Signature

NRC RULES AND GUIDELINES FOR LICENSE EXAMINATIONS

During the administration of this examination the following rules apply:

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

2. Restroom trips are to be limited and only one candidate at a time may leave. You must avoid all contacts with anyone outside the examination room to avoid even the appearance or possibility of cheating.

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

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

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

6. Use only the paper provided for answers.

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

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

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

10. Skip at least three lines between each answer.

11. Separate answer sheets from pad and place finished answer sheets face down on your desk or table.

12. Use abbreviations only if they are commonly used in facility literature.

13. The point value for each question is indicated in parentheses after the question and can be used as a guide for the depth of answer required.

14. Show all calculations, methods, or assumptions used to obtain an answer to mathematical problems whether indicated in the question or not.

15. Partial credit may be given. Therefore, ANSWER ALL PARTS OF THE QUESTION AND DO NOT LEAVE ANY ANSWER BLANK.

16. If parts of the examination are not clear as to intent, ask questions of the examiner only.

17. You must sign the statement on the cover sheet that indicates that the work is your own and you have not received or been given assistance in completing the examination. This must be done after the examination has been completed.

18. When you complete your examination, you shall:

a. Assemble your examination as follows:

(1) Exam questions on top.

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

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

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

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

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

EQUATION SHEET

$f = ma$

$w = mg$

$E = mC^2$

$KE = \frac{1}{2}mv^2$

$PE = mgh$

$W = v\Delta P$

$\Delta E = 931\Delta m$

$\dot{Q} = \dot{m}\,\Delta h$

$\dot{Q} = \dot{m}C_p\Delta T$

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

$Pwr = W_f\,\dot{m}$

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

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

$SUR = 26.06/T$

$T = 1.44\ DT$

$SUR = 26\left(\frac{\lambda_{eff}\rho}{\bar{\beta} - \rho}\right)$

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

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

$T = (\bar{\beta} - \rho)/\lambda_{eff}\rho$

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

$\rho = [\ell^*/TK_{eff}] + [\bar{\beta}/(1 + \lambda_{eff}T)]$

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

$\Sigma = N\sigma$

$v = s/t$

$s = v_o t + \frac{1}{2}at^2$

$a = (v_f - v_o)/t$

$v_f = v_o + at$

$\omega = \theta/t$

$\text{Cycle efficiency} = \frac{\text{Net Work (out)}}{\text{Energy (in)}}$

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

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

$t_{1/2}(eff) = \frac{(t_{1/2})(t_b)}{(t_{1/2} + t_b)}$

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

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

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

$TVL = 1.3/\mu$

$HVL = 0.693/\mu$

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

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

$CR_1(1 - K_{eff})_1 = CR_2(1 - K_{eff})_2$

$M = 1/(1 - K_{eff}) = CR_1/CR_0$

$M = (1 - K_{eff})_0/(1 - K_{eff})_1$

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

$\ell^* = 1 \times 10^{-5}$ seconds

$\lambda_{eff} = 0.1\ \text{seconds}^{-1}$

$I_1 d_1 = I_2 d_2$

$I_1 d_1^2 = I_2 d_2^2$

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

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

WATER PARAMETERS

1 gal. = 8.345 lbm

1 gal. = 3.78 liters

1 ft^3 = 7.48 gal.

Density = 62.4 lbm/ft^3

Density = 1 gm/cm^3

Heat of vaporization = 970 Btu/lbm

Heat of fusion = 144 Btu/lbm

1 Atm = 14.7 psi = 29.9 in. Hg

1 ft. H_2O = 0.4335 lbf/in^2

MISCELLANEOUS CONVERSIONS

1 Curie = 3.7×10^{10} dps

1 kg = 2.21 lbm

1 hp = 2.54×10^3 BTU/hr

1 Mw = 3.41×10^6 Btu/hr

1 Btu = 778 ft-lbf

1 inch = 2.54 cm

$^oF = 9/5\,^oC + 32$

$^oC = 5/9\,(^oF - 32)$

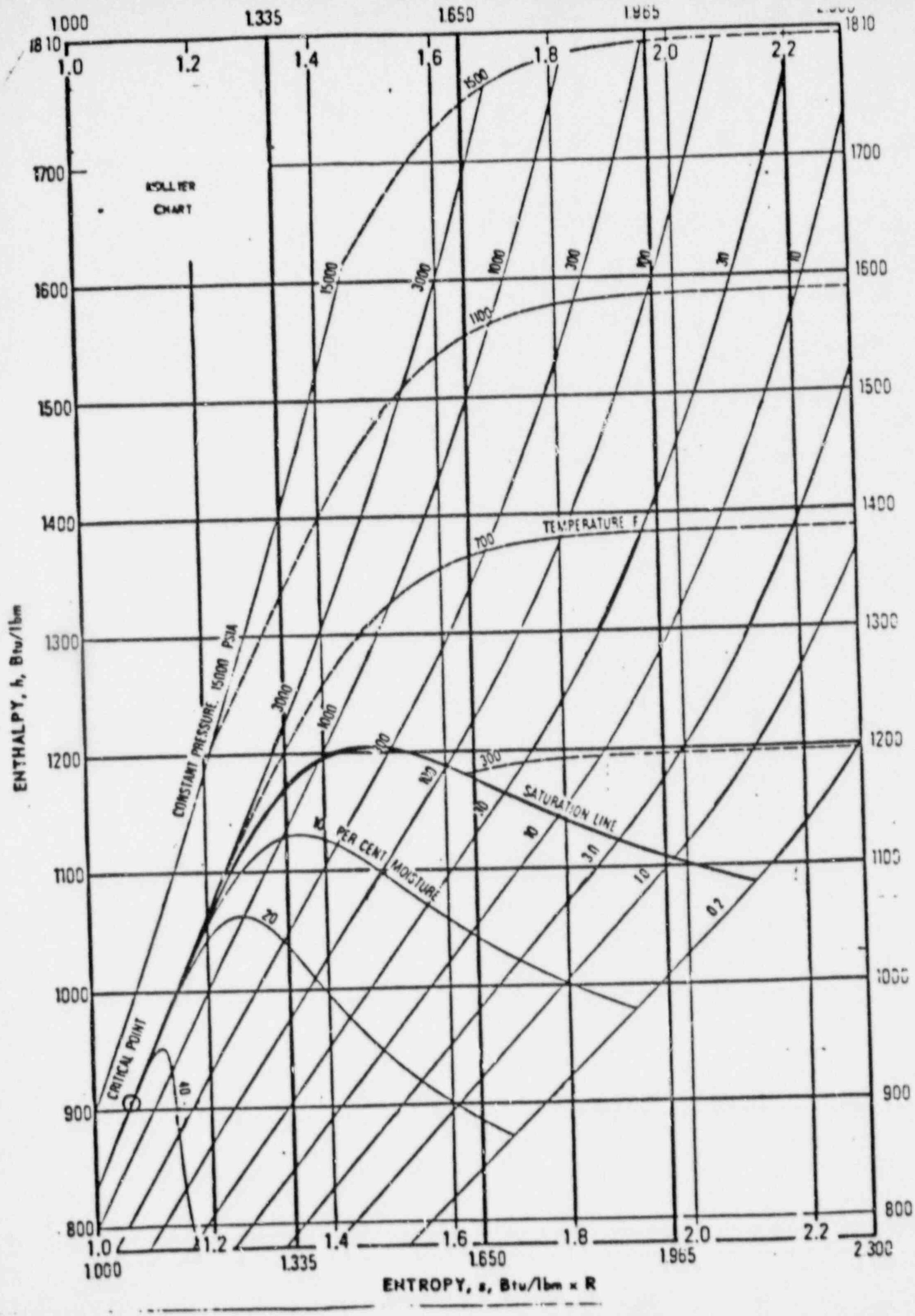

MOLLIER CHART
ENTHALPY, h, Btu/lbm
ENTROPY, s, Btu/lbm x R
CONSTANT PRESSURE, 15000 PSIA
TEMPERATURE F
SATURATION LINE
PER CENT MOISTURE
CRITICAL POINT

Table 1. Saturated Steam: Temperature Table

Temp Fahr t	Abs Press. Lb per Sq In. p	Specific Volume Sat. Liquid v_f	Specific Volume Evap v_{fg}	Specific Volume Sat. Vapor v_g	Enthalpy Sat. Liquid h_f	Enthalpy Evap h_{fg}	Enthalpy Sat. Vapor h_g	Entropy Sat. Liquid s_f	Entropy Evap s_{fg}	Entropy Sat. Vapor s_g	Temp Fahr t
32.0	0.08859	0.016022	3304.7	3304.7	0.0179	1075.5	1075.5	0.0000	2.1873	2.1873	32.0
34.0	0.09600	0.016021	3061.9	3061.9	1.996	1074.4	1076.4	0.0041	2.1762	2.1802	34.0
36.0	0.10395	0.016020	2839.0	2839.0	4.008	1073.2	1077.2	0.0081	2.1651	2.1732	36.0
38.0	0.11249	0.016019	2634.1	2634.2	6.018	1072.1	1078.1	0.0122	2.1541	2.1663	38.0
40.0	1.12163	0.016019	2445.8	2445.8	8.027	1071.0	1079.0	0.0162	2.1432	2.1594	40.0
42.0	0.13143	0.016019	2272.4	2272.4	10.035	1069.8	1079.9	0.0202	2.1325	2.1527	42.0
44.0	0.14192	0.016019	2112.8	2112.8	12.041	1068.7	1080.7	0.0242	2.1217	2.1459	44.0
46.0	0.15314	0.016020	1965.7	1965.7	14.047	1067.6	1081.6	0.0282	2.1111	2.1393	46.0
48.0	0.16514	0.016021	1830.0	1830.0	16.051	1066.4	1082.5	0.0321	2.1006	2.1327	48.0
50.0	0.17796	0.016023	1704.8	1704.8	18.054	[illegible]	1083.4	0.0361	2.0901	2.1262	50.0
52.0	0.19165	0.016024	1589.2	1589.2	20.057	1064.2	1084.2	0.0400	2.0798	2.1197	52.0
54.0	0.20625	0.016026	1482.4	1482.4	22.058	1063.1	1085.1	0.0439	2.0695	2.1134	54.0
56.0	0.22183	0.016028	1383.6	1383.6	24.059	1061.9	1086.0	0.0478	2.0593	2.1070	56.0
58.0	0.23843	0.016031	1292.2	1292.2	26.060	1060.8	1086.9	0.0516	2.0491	2.1008	58.0
60.0	0.25611	0.016033	1207.6	1207.6	28.060	1059.7	1087.7	0.0555	2.0391	2.0946	60.0
62.0	0.27494	0.016036	1129.2	1129.2	30.059	1058.5	1088.6	0.0593	2.0291	2.0885	62.0
64.0	0.29497	0.016039	1056.5	1056.5	32.058	1057.4	1089.5	0.0632	2.0192	2.0824	64.0
66.0	0.31626	0.016043	989.0	989.1	34.056	1056.3	1090.4	0.0670	2.0094	2.0764	66.0
68.0	0.33889	0.016046	926.5	926.5	36.054	1055.2	1091.2	0.0708	1.9996	2.0704	68.0
70.0	0.36292	0.016050	868.3	868.4	38.052	1054.0	1092.1	0.0745	1.9900	2.0645	70.0
72.0	0.38844	0.016054	814.3	814.3	40.049	1052.9	1093.0	0.0783	1.9804	2.0587	72.0
74.0	0.41550	0.016058	764.1	764.1	42.046	1051.8	1093.8	0.0821	1.9708	2.0529	74.0
76.0	0.44420	0.016063	717.4	717.4	44.043	1050.7	1094.7	0.0858	1.9614	2.0472	76.0
78.0	0.47461	0.016067	673.8	673.9	46.040	1049.5	1095.6	0.0895	1.9520	2.0415	78.0
80.0	0.50683	0.016072	633.3	633.3	48.037	1048.4	1096.4	0.0932	1.9426	2.0359	80.0
82.0	0.54093	0.016077	595.5	595.5	50.033	1047.3	1097.3	0.0969	1.9334	2.0303	82.0
84.0	0.57702	0.016082	560.3	560.3	52.029	1046.1	1098.2	0.1006	1.9242	2.0248	84.0
86.0	0.61518	0.016087	227.5	527.5	54.026	1045.0	1099.0	0.1043	1.9151	2.0193	86.0
88.0	0.65551	0.016093	496.8	496.8	56.022	1043.9	1099.9	0.1079	1.9060	2.0139	88.0
90.0	0.69813	0.016099	468.1	468.1	58.018	1042.7	1100.8	0.1115	1.8970	2.0086	90.0
92.0	0.74313	0.016105	441.3	441.3	60.014	1041.6	1101.6	0.1152	1.8881	2.0033	92.0
94.0	0.79062	0.016111	416.3	416.3	62.010	1040.5	1102.5	0.1188	1.8792	1.9980	94.0
96.0	0.84072	0.016117	392.8	392.9	64.006	1039.3	1103.3	0.1224	1.8704	1.9928	96.0
98.0	0.89356	0.016123	370.9	370.9	66.003	1038.2	1104.2	0.1260	1.8617	1.9876	98.0

Temp Fahr t	Abs Press. Lb per Sq In. p	Specific Volume Sat. Liquid v_f	Evap v_{fg}	Sat. Vapor v_g	Enthalpy Sat. Liquid h_f	Evap h_{fg}	Sat. Vapor h_g	Entropy Sat. Liquid s_f	Evap s_{fg}	Sat. Vapor s_g	Temp Fahr t
100.0	0.94924	0.016130	350.4	350.4	67.999	1037.1	1105.1	0.1295	1.8530	1.9825	100.0
102.0	1.00789	0.016137	331.1	331.1	69.995	1035.9	1105.9	0.1331	1.8444	1.9775	102.0
104.0	1.06965	0.016144	313.1	313.1	71.992	1034.8	1106.8	0.1366	1.8358	1.9725	104.0
106.0	1.1347	0.016151	296.16	296.18	73.99	1033.6	1107.6	0.1402	1.8273	1.9675	106.0
108.0	1.2030	0.016158	280.28	280.30	75.98	1032.5	1108.5	0.1437	1.8188	1.9626	108.0
110.0	1.2750	0.016165	265.37	265.39	77.98	1031.4	1109.3	0.1472	1.8105	1.9577	110.0
112.0	1.3505	0.016173	251.37	251.38	79.98	1030.2	1110.2	0.1507	1.8021	1.9528	112.0
114.0	1.4299	0.016180	238.21	238.22	81.97	1029.1	1111.0	0.1542	1.7938	1.9480	114.0
116.0	1.5133	0.016188	225.84	225.85	83.97	1027.9	1111.9	0.1577	1.7856	1.9433	116.0
118.0	1.6009	0.016196	214.20	214.21	85.97	1026.8	1112.7	0.1611	1.7774	1.9386	118.0
120.0	1.6927	0.016204	203.25	203.26	87.97	1025.6	1113.6	0.1646	1.7693	1.9339	120.0
122.0	1.7891	0.016213	192.94	192.95	89.96	1024.5	1114.4	0.1680	1.7613	1.9293	122.0
124.0	1.8901	0.016221	183.23	183.24	91.96	1023.3	1115.3	0.1715	1.7533	1.9247	124.0
126.0	1.9959	0.016229	174.08	174.09	93.96	1022.2	1116.1	0.1749	1.7453	1.9202	126.0
128.0	2.1068	0.016238	165.45	165.47	95.96	1021.0	1117.0	0.1783	1.7374	1.9157	128.0
130.0	2.2230	0.016247	157.32	157.33	97.96	1019.8	1117.8	0.1817	1.7295	1.9112	130.0
132.0	2.3445	0.016256	149.64	149.66	99.95	1018.7	1118.6	0.1851	1.7217	1.9068	132.0
134.0	2.4717	0.016265	142.40	142.41	101.95	1017.5	1119.5	0.1884	1.7140	1.9024	134.0
136.0	2.6047	0.016274	135.55	135.57	103.95	1016.4	1120.3	0.1918	1.7063	1.8980	136.0
138.0	2.7438	0.016284	129.09	129.11	105.95	1015.2	1121.1	0.1951	1.6986	1.8937	138.0
140.0	2.8892	0.016293	122.98	123.00	107.95	1014.0	1122.0	0.1985	1.6910	1.8895	140.0
142.0	3.0411	0.016303	117.21	117.22	109.95	1012.9	1122.8	0.2018	1.6534	1.8852	142.0
144.0	3.1997	0.016312	111.74	111.76	111.95	1011.7	1123.6	0.2051	1.6759	1.8810	144.0
146.0	3.3653	0.016322	106.58	106.59	113.95	1010.5	1124.5	0.2084	1.6684	1.8769	146.0
148.0	3.5381	0.016332	101.68	101.70	115.95	1009.3	1125.3	0.2117	1.6610	1.8727	148.0
150.0	3.7184	0.016343	97.05	97.07	117.95	1008.2	1126.1	0.2150	1.6536	1.8686	150.0
152.0	3.9065	0.016353	92.66	92.68	119.95	1007.0	1126.9	0.2183	1.6463	1.8646	152.0
154.0	4.1025	0.016363	88.50	88.52	121.95	1005.8	1127.7	0.2216	1.6390	1.8606	154.0
156.0	4.3068	0.016374	84.56	84.57	123.95	1004.6	1128.6	0.2248	1.6318	1.8566	156.0
158.0	4.5197	0.016384	80.82	80.83	125.96	1003.4	1129.4	0.2281	1.6245	1.8526	158.0
160.0	4.7414	0.016395	77.27	77.29	127.96	1002.2	1130.2	0.2313	1.6174	1.8487	160.0
162.0	4.9722	0.016406	73.90	73.92	129.96	1001.0	1131.0	0.2345	1.6103	1.8448	162.0
164.0	5.2124	0.016417	70.70	70.72	131.96	999.8	1131.8	0.2377	1.6032	1.8409	164.0
166.0	5.4623	0.016428	67.67	67.68	133.97	998.6	1132.6	0.2409	1.5961	1.8371	166.0
168.0	5.7223	0.016440	64.78	64.80	135.97	997.4	1133.4	0.2441	1.5892	1.8333	168.0
170.0	5.9926	0.016451	62.04	62.06	137.97	996.2	1134.2	0.2473	1.5822	1.8295	170.0
172.0	6.2736	0.016463	59.43	59.45	139.98	995.0	1135.0	0.2505	1.5753	1.8258	172.0
174.0	6.5656	0.016474	56.95	56.97	141.98	993.8	1135.8	0.2537	1.5684	1.8221	174.0
176.0	6.8690	0.016486	54.59	54.61	143.99	992.6	1136.6	0.2568	1.5616	1.8184	176.0
178.0	7.1840	0.016498	52.35	52.36	145.99	991.4	1137.4	0.2600	1.5548	1.8147	178.0

Temp Fahr t	Abs Press. Lb per Sq In. p	Specific Volume Sat. Liquid v_f	Evap v_{fg}	Sat. Vapor v_g	Enthalpy Sat. Liquid h_f	Evap h_{fg}	Sat. Vapor h_g	Entropy Sat. Liquid s_f	Evap s_{fg}	Sat. Vapor s_g	Temp Fahr t
180.0	7.5110	0.016510	50.21	50.22	148.00	990.2	1138.2	0.2631	1.5480	1.8111	180.0
182.0	7.850	0.016522	48.172	18.189	150.01	989.0	1139.0	0.2662	1.5413	1.8075	182.0
184.0	8.203	0.016534	46.232	46.249	152.01	987.8	1139.8	0.2694	1.5346	1.8040	184.0
186.0	8.568	0.016547	44.383	44.400	154.02	986.5	1140.5	0.2725	1.5279	1.8004	186.0
188.0	8.947	0.016559	42.621	42.638	156.03	985.3	1141.3	0.2756	1.5213	1.7969	188.0
190.0	9.340	0.016572	40.941	40.957	158.04	984.1	1142.1	0.2787	1.5148	1.7934	190.0
192.0	9.747	0.016585	39.337	39.354	160.05	982.8	1142.9	0.2818	1.5082	1.7900	192.0
194.0	10.168	0.016598	37.808	37.824	162.05	981.6	1143.7	0.2848	1.5017	1.7865	194.0
195.0	10.605	0.016611	36.348	36.364	164.06	980.4	1144.4	0.2879	1.4952	1.7831	196.0
198.0	11.058	0.016624	34.954	34.970	166.08	979.1	1145.2	0.2910	1.4888	1.7798	198.0
200.0	11.526	0.016637	33.622	33.639	168.09	977.9	1146.0	0.2940	1.4824	1.7764	200.0
204.0	12.512	0.016664	31.135	31.151	172.11	975.4	1147.5	0.3001	1.4697	1.7698	204.0
208.0	13.568	0.016691	28.862	28.878	176.14	972.8	1149.0	0.3061	1.4571	1.7632	208.0
212.0	14.696	0.016719	26.782	26.799	180.17	970.3	1150.5	0.3121	1.4447	1.7568	212.0
216.0	15.901	0.016747	24.878	24.894	184.20	967.8	1152.0	0.3181	1.4323	1.7505	216.0
220.0	17.186	0.016775	23.131	23.148	188.23	965.2	1153.4	0.3241	1.4201	1.7442	220.0
224.0	18.556	0.016805	21.529	21.545	192.27	962.6	1154.9	0.3300	1.4081	1.7380	224.0
228.0	20.015	0.016834	20.056	20.073	196.31	960.0	1156.3	0.3359	1.3961	1.7320	228.0
232.0	21.567	0.016864	18.701	18.718	200.35	957.4	1157.8	0.3417	1.3842	1.7260	232.0
236.0	23.216	0.016895	17.454	17.471	204.40	954.8	1159.2	0.3476	1.3725	1.7201	236.0
240.0	24.968	0.016926	16.304	16.321	208.45	952.1	1160.6	0.3533	1.3609	1.7142	240.0
244.0	26.826	0.016958	15.243	15.260	212.50	949.5	1162.0	0.3591	1.3494	1.7085	244.0
248.0	28.796	0.016990	14.264	14.281	216.56	946.8	1163.4	0.3649	1.3379	1.7028	248.0
252.0	30.883	0.017022	13.358	13.375	220.62	944.1	1164.7	0.3706	1.3266	1.6972	252.0
256.0	33.091	0.017055	12.520	12.538	224.69	941.4	1166.1	0.3763	1.3154	1.6917	256.0
260.0	35.427	0.017089	11.745	11.762	228.76	938.6	1167.4	0.3819	1.3043	1.6862	260.0
264.0	37.894	0.017123	11.025	11.042	232.83	935.9	1168.7	0.3876	1.2933	1.6808	264.0
268.0	40.500	0.017157	10.358	10.375	236.91	933.1	1170.0	0.3932	1.2823	1.6755	268.0
272.0	43.249	0.017193	9.738	9.755	240.99	930.3	1171.3	0.3987	1.2715	1.6702	272.0
276.0	46.147	0.017228	9.162	9.180	245.08	927.5	1172.5	0.4043	1.2607	1.6650	276.0
280.0	49.200	0.017264	8.627	8.644	249.17	924.6	1173.8	0.4098	1.2501	1.6599	280.0
284.0	52.414	0.01730	8.1280	8.1453	253.3	921.7	1175.0	0.4154	1.2395	1.6548	284.0
288.0	55.795	0.01734	7.6634	7.6807	257.4	918.8	1176.2	0.4208	1.2290	1.6498	288.0
292.0	59.350	0.01738	7.2301	7.2475	261.5	915.9	1177.4	0.4263	1.2186	1.6449	292.0
296.0	63.084	0.01741	6.8259	6.8433	265.6	913.0	1178.6	0.4317	1.2082	1.6400	296.0

Temp Fahr t	Abs Press. Lb per Sq In. p	Specific Volume Sat. Liquid v_f	Evap v_{fg}	Sat. Vapor v_g	Enthalpy Sat. Liquid h_f	Evap h_{fg}	Sat. Vapor h_g	Entropy Sat. Liquid s_f	Evap s_{fg}	Sat. Vapor s_g	Temp Fahr t
300.0	67.005	0.01745	6.4483	6.4658	269.7	910.0	1179.7	0.4372	1.1979	1.6351	300.0
304.0	71.119	0.01749	6.0955	6.1130	273.8	907.0	1180.9	0.4426	1.1877	1.6303	304.0
308.0	75.433	0.01753	5.7655	5.7830	278.0	904.0	1182.0	0.4479	1.1776	1.6256	308.0
312.0	79.953	0.01757	5.4566	5.4742	282.1	901.0	1183.1	0.4533	1.1676	1.6209	312.0
316.0	84.688	0.01761	5.1673	5.1849	286.3	897.9	1184.1	0.4586	1.1576	1.6162	316.0
320.0	89.643	0.01766	4.8961	4.9138	290.4	894.8	1185.2	0.4640	1.1477	1.6116	320.0
324.0	94.826	0.01770	4.6418	4.6595	294.6	891.6	1186.2	0.4692	1.1378	1.6071	324.0
328.0	100.245	0.01774	4.4030	4.4208	298.7	888.5	1187.2	0.4745	1.1280	1.6025	328.0
332.0	109.907	0.01779	4.1788	4.1966	302.9	885.3	1188.2	0.4798	1.1183	1.5981	332.0
336.0	111.820	0.01783	3.9681	3.9859	307.1	882.1	1189.1	0.4850	1.1086	1.5936	336.0
340.0	117.992	0.01787	3.7699	3.7878	311.3	878.8	1190.1	0.4902	1.0990	1.5892	340.0
344.0	124.430	0.01792	3.5834	3.6013	315.5	875.5	1191.0	0.4954	1.0894	1.5849	344.0
348.0	131.142	0.01797	3.4078	3.4258	319.7	872.2	1191.1	0.5006	1.0799	1.5806	348.0
352.0	138.138	0.01801	3.2423	3.2603	323.9	868.9	1192.7	0.5058	1.0705	1.5763	352.0
356.0	145.424	0.01806	3.0863	3.1044	328.1	865.5	1193.6	0.5110	1.0611	1.5721	356.0
360.0	153.010	0.01811	2.9392	2.9573	332.3	862.1	1194.4	0.5161	1.0517	1.5678	360.0
364.0	160.903	0.01816	2.8002	2.8184	336.5	858.6	1195.2	0.5212	1.0424	1.5637	364.0
368.0	169.113	0.01821	2.6691	2.6873	340.8	855.1	1195.9	0.5263	1.0332	1.5595	368.0
372.0	177.648	0.01826	2.5451	2.5633	345.0	851.6	1196.7	0.5314	1.0240	1.5554	372.0
376.0	186.517	0.01831	2.4279	2.4462	349.3	848.1	1197.4	0.5365	1.0148	1.5513	376.0
380.0	195.729	0.01836	2.3170	2.3353	353.6	844.5	1198.0	0.5416	1.0057	1.5473	380.0
384.0	205.294	0.01842	2.2120	2.2304	357.9	840.8	1198.7	0.5466	0.9966	1.5432	384.0
388.0	215.220	0.01847	2.1126	2.1311	362.2	837.2	1199.3	0.5516	0.9876	1.5392	388.0
392.0	225.516	0.01853	2.0184	2.0369	366.5	833.4	1199.9	0.5567	0.9786	1.5352	392.0
396.0	236.193	0.01858	1.9291	1.9477	370.8	829.7	1200.4	0.5617	0.9696	1.5313	396.0
400.0	247.259	0.01864	1.8444	1.8630	375.1	825.9	1201.0	0.5667	0.9607	1.5274	400.0
404.0	258.725	0.01870	1.7640	1.7827	379.4	822.0	1201.5	0.5717	0.9518	1.5234	404.0
408.0	270.600	0.01875	1.6877	1.7064	383.8	818.2	1201.9	0.5766	0.9429	1.5195	408.0
412.0	282.894	0.01881	1.6152	1.6340	388.1	814.2	1202.4	0.5816	0.9341	1.5157	412.0
416.0	295.617	0.01887	1.5463	1.5651	392.5	810.2	1202.8	0.5866	0.9253	1.5118	416.0
420.0	308.780	0.01894	1.4808	1.4997	396.9	806.2	1203.1	0.5915	0.9165	1.5080	420.0
424.0	322.391	0.01900	1.4184	1.4374	401.3	802.2	1203.5	0.5964	0.9077	1.5042	424.0
428.0	336.463	0.01906	1.3591	1.3782	405.7	798.0	1203.7	0.6014	0.8990	1.5004	428.0
432.0	351.00	0.01913	1.30266	1.32179	410.1	793.9	1204.0	0.6063	0.8903	1.4966	432.0
436.0	366.03	0.01919	1.24887	1.26806	414.6	789.7	1204.2	0.6112	0.8816	1.4928	436.0
440.0	381.54	0.01926	1.19761	1.21687	419.0	785.4	1204.4	0.6161	0.8729	1.4890	440.0
444.0	397.56	0.01933	1.14874	1.16806	423.5	781.1	1204.6	0.6210	0.8643	1.4853	444.0
448.0	414.09	0.01940	1.10212	1.12152	428.0	776.7	1204.7	0.6259	0.8557	1.4815	448.0
[illegible]	431.14	0.01947	1.05764	1.07711	[illegible]	772.3	1204.8	0.6308	0.8471	1.4778	[illegible]
[illegible]	448.73	0.01954	1.01518	1.03472	[illegible]	767.8	1204.8	0.6356	0.8385	1.4741	[illegible]

Temp Fahr t	Abs Press. Lb per Sq In. p	Specific Volume Sat. Liquid v_f	Evap v_{fg}	Sat. Vapor v_g	Enthalpy Sat. Liquid h_f	Evap h_{fg}	Sat. Vapor h_g	Entropy Sat. Liquid s_f	Evap s_{fg}	Sat. Vapor s_g	Temp Fahr t
460.0	466.87	0.01961	0.97463	0.99424	441.5	763.2	1204.8	0.6405	0.8299	1.4704	**460.0**
464.0	485.56	0.01969	0.93588	0.95557	446.1	758.6	1204.7	0.6454	0.8213	1.4667	**464.0**
468.0	504.83	0.01976	0.89885	0.91862	450.7	754.0	1204.6	0.6502	0.8127	1.4629	**468.0**
472.0	524.67	0.01984	0.86345	0.88329	455.2	749.3	1204.5	0.6551	0.8042	1.4592	**472.0**
476.0	545.11	0.01992	0.82958	0.84950	459.9	744.5	1204.3	0.6599	0.7956	1.4555	**476.0**
480.0	566.15	0.02000	0.79716	0.81717	464.5	739.6	1204.1	0.6648	0.7871	1.4518	**480.0**
484.0	587.81	0.02009	0.76613	0.78622	469.1	734.7	1203.8	0.6696	0.7785	1.4481	**484.0**
488.0	610.10	0.02017	0.73641	0.75658	473.8	729.7	1203.5	0.6745	0.7700	1.4444	**488.0**
492.0	633.03	0.02026	0.70794	0.72820	478.5	724.6	1203.1	0.6793	0.7614	1.4407	**492.0**
496.0	656.61	0.02034	0.68065	0.70100	483.2	719.5	1202.7	0.6842	0.7528	1.4370	**496.0**
500.0	680.86	0.02043	0.65448	0.67492	487.9	714.3	1202.2	0.6890	0.7443	1.4333	**500.0**
504.0	705.78	0.02053	0.62938	0.64991	492.7	709.0	1201.7	0.6939	0.7357	1.4296	**504.0**
508.0	731.40	0.02062	0.60530	0.62592	497.5	703.7	1201.1	0.6987	0.7271	1.4258	**508.0**
512.0	757.72	0.02072	0.58218	0.60289	502.3	698.2	1200.5	0.7036	0.7185	1.4221	**512.0**
516.0	784.76	0.02081	0.55997	0.58079	507.1	692.7	1199.8	0.7085	0.7099	1.4183	**516.0**
520.0	812.53	0.02091	0.53864	0.55956	512.0	687.0	1199.0	0.7133	0.7013	1.4146	**520.0**
524.0	841.04	0.02102	0.51814	0.53916	516.9	681.3	1198.2	0.7182	0.6926	1.4108	**524.0**
528.0	870.31	0.02112	0.49843	0.51955	521.8	675.5	1197.3	0.7231	0.6839	1.4070	**528.0**
532.0	900.34	0.02123	0.47947	0.50070	526.8	669.6	1196.4	0.7280	0.6752	1.4032	**532.0**
536.0	931.17	0.02134	0.46123	0.48257	531.7	663.6	1195.4	0.7329	0.6665	1.3993	**536.0**
540.0	962.79	0.02146	0.44367	0.46513	536.8	657.5	1194.3	0.7378	0.6577	1.3954	**540.0**
544.0	995.22	0.02157	0.42677	0.44834	541.8	651.3	1193.1	0.7427	0.6489	1.3915	**544.0**
548.0	1028.49	0.02169	0.41048	0.43217	546.9	645.0	1191.9	0.7476	0.6400	1.3876	**548.0**
552.0	1062.59	0.02182	0.39479	0.41660	552.0	638.5	1190.6	0.7525	0.6311	1.3837	**552.0**
556.0	1097.55	0.02194	0.37966	0.40160	557.2	632.0	1189.2	0.7575	0.6222	1.3797	**556.0**
560.0	1133.38	0.02207	0.36507	0.38714	562.4	625.3	1187.7	0.7625	0.6132	1.3757	**560.0**
564.0	1170.10	0.02221	0.35099	0.37320	567.6	618.5	1186.1	0.7674	0.6041	1.3716	**564.0**
568.0	1207.72	0.02235	0.33741	0.35975	572.9	611.5	1184.5	0.7725	0.5950	1.3675	**568.0**
572.0	1246.26	0.02249	0.32429	0.34678	578.3	604.5	1182.7	0.7775	0.5859	1.3634	**572.0**
576.0	1285.74	0.02264	0.31162	0.33426	583.7	597.2	1180.9	0.7825	0.5766	1.3592	**576.0**
580.0	1326.17	0.02279	0.29937	0.32216	589.1	589.9	1179.0	0.7876	0.5673	1.3550	**580.0**
584.0	1367.7	0.02295	0.28753	0.31048	594.6	582.4	1176.9	0.7927	0.5580	1.3507	**584.0**
588.0	1410.0	0.02311	0.27608	0.29919	600.1	574.7	1174.8	0.7978	0.5485	1.3464	**588.0**
592.0	1453.3	0.02328	0.26499	0.28827	605.7	566.8	1172.6	0.8030	0.5390	1.3420	**592.0**
596.0	1497.8	0.02345	0.25425	0.27770	611.4	558.8	1170.2	0.8082	0.5293	1.3375	**596.0**

Temp Fahr t	Abs Press. Lb per Sq In. p	Specific Volume Sat. Liquid v_f	Evap v_{fg}	Sat. Vapor v_g	Enthalpy Sat. Liquid h_f	Evap h_{fg}	Sat. Vapor h_g	Entropy Sat. Liquid s_f	Evap s_{fg}	Sat. Vapor s_g	Temp Fahr t
600.0	1543.2	0.02364	0.24384	0.26747	617.1	550.6	1167.7	0.8134	0.5196	1.3330	600.0
604.0	1589.7	0.02382	0.23374	0.25757	622.9	542.2	1165.1	0.8187	0.5097	1.3284	604.0
608.0	1637.3	0.02402	0.22394	0.24796	628.8	533.6	1162.4	0.8240	0.4997	1.3238	608.0
612.0	1686.1	0.02422	0.21442	0.23865	634.8	524.7	1159.5	0.8294	0.4896	1.3190	612.0
616.6	1735.9	0.02444	0.20516	0.22960	640.8	515.6	1156.4	0.8348	0.4794	1.3141	616.0
626.0	1786.9	0.02466	0.19615	0.22081	646.9	506.3	1153.2	0.8403	0.4689	1.3092	620.0
624.0	1839.0	0.02489	0.18737	0.21226	653.1	496.6	1149.8	0.8458	0.4583	1.3041	624.0
628.0	1892.4	0.02514	0.17880	0.20394	659.5	486.7	1146.1	0.8514	0.4474	1.2988	628.0
632.0	1947.0	0.02539	0.17044	0.19583	665.9	476.4	1142.2	0.8571	0.4364	1.2934	632.0
636.0	2002.8	0.02566	0.16226	0.18792	672.4	465.7	1138.1	0.8628	0.4251	1.2879	636.0
640.0	2059.9	0.02595	0.15427	0.18021	679.1	454.6	1133.7	0.8686	0.4134	1.2821	640.0
644.0	2118.3	0.02625	0.14644	0.17269	685.9	443.1	1129.0	0.8746	0.4015	1.2761	644.0
648.0	2178.1	0.02657	0.13876	0.16534	692.9	431.1	1124.0	0.8806	0.3893	1.2699	648.0
652.0	2239.2	0.02691	0.13124	0.15816	700.0	418.7	1118.7	0.8868	0.3767	1.2634	652.0
656.0	2301.7	0.02728	0.12387	0.15115	707.4	405.7	1113.1	0.8931	0.3637	1.2567	656.0
660.0	2365.7	0.02768	0.11663	0.14431	714.9	392.1	1107.0	0.8995	0.3502	1.2498	660.0
664.0	2431.1	0.02811	0.10947	0.13757	722.9	377.7	1100.6	0.9064	0.3361	1.2425	664.0
668.0	2498.1	0.02858	0.10229	0.13087	731.5	362.1	1093.5	0.9137	0.3210	1.2347	668.0
672.0	2566.6	0.02911	0.09514	0.12424	740.2	345.7	1085.9	0.9212	0.3054	1.2266	672.0
676.0	2636.8	0.02970	0.08799	0.11769	749.2	328.5	1077.6	0.9287	0.2892	1.2179	676.0
680.0	2708.6	0.03037	0.08080	0.11117	758.5	310.1	1068.5	0.9365	0.2720	1.2086	680.0
684.0	2782.1	0.03114	0.07349	0.10463	768.2	290.2	1058.4	0.9447	0.2537	1.1984	684.0
688.0	2857.4	0.03204	0.06595	0.09799	778.8	268.2	1047.0	0.9535	0.2337	1.1872	688.0
692.0	2934.5	0.03313	0.05797	0.09110	790.5	243.1	1033.6	0.9634	0.2110	1.1744	692.0
696.0	3013.4	0.03455	0.04916	0.08371	804.4	212.8	1017.2	0.9749	0.1841	1.1591	696.0
700.0	3094.3	0.03662	0.03857	0.07519	822.4	172.7	995.2	0.9901	0.1490	1.1390	700.0
702.0	3135.5	0.03824	0.03173	0.06997	835.0	144.7	979.7	1.0006	0.1246	1.1252	702.0
704.0	3177.2	0.04108	0.02192	0.06300	854.2	102.0	956.2	1.0169	0.0876	1.1046	704.0
705.0	3198.3	0.04427	0.01304	0.05730	873.0	61.4	934.4	1.0329	0.0527	1.0856	705.0
705.47*	3208.2	0.05078	0.00000	0.05078	906.0	0.0	906.0	1.0612	0.0000	1.0612	705.47*

*Critical temperature

Table 2: Saturated Steam: Pressure Table

Abs Press. Lb/Sq In. p	Temp Fahr t	Specific Volume Sat. Liquid v_f	Evap v_{fg}	Sat. Vapor v_g	Enthalpy Sat. Liquid h_f	Evap h_{fg}	Sat. Vapor h_g	Entropy Sat. Liquid s_f	Evap s_{fg}	Sat. Vapor s_g	Abs Press. Lb/Sq In. p
0.08865	32.018	0.016022	3302.4	3302.4	0.0003	1075.5	1075.5	0.0000	2.1872	2.1872	0.08865
0.25	59.323	0.016032	1235.5	1235.5	27.382	1060.1	1087.4	0.0542	2.0425	2.0967	0.25
0.50	79.586	0.016071	641.5	641.5	47.623	1048.6	1096.3	0.0925	1.9446	2.0370	0.50
1.0	101.74	0.016136	333.59	333.60	69.73	1036.1	1105.8	0.1326	1.8455	1.9781	1.0
5.0	162.24	0.016407	73.515	73.532	130.20	1000.9	1131.1	0.2349	1.6094	1.8443	5.0
10.0	193.21	0.016592	38.404	38.420	161.26	982.1	1143.3	0.2836	1.5043	1.7879	10.0
14.696	212.00	0.016719	26.782	26.799	180.17	970.3	1150.5	0.3121	1.4447	1.7568	14.696
15.0	213.03	0.016726	26.274	26.290	181.21	969.7	1150.9	0.3137	1.4415	1.7552	15.0
20.0	227.96	0.016834	20.070	20.087	196.27	960.1	1156.3	0.3358	1.3962	1.7320	20.0
30.0	250.34	0.017009	13.7266	13.7436	218.9	945.2	1164.1	0.3682	1.3313	1.6995	30.0
40.0	267.25	0.017151	10.4794	10.4965	236.1	933.6	1169.8	0.3921	1.2844	1.6765	40.0
50.0	281.02	0.017274	8.4967	8.5140	250.2	923.9	1174.1	0.4112	1.2474	1.6586	50.0
60.0	292.71	0.017383	7.1562	7.1736	262.2	915.4	1177.6	0.4273	1.2167	1.6440	60.0
70.0	302.93	0.017482	6.1875	6.2050	272.7	907.8	1180.6	0.4411	1.1905	1.6316	70.0
80.0	312.04	0.017573	5.4536	5.4711	282.1	900.9	1183.1	0.4534	1.1675	1.6208	80.0
90.0	320.28	0.017659	4.8779	4.8953	290.7	894.6	1185.3	0.4643	1.1470	1.6113	90.0
100.0	327.82	0.017740	4.4133	4.4310	298.5	888.6	1187.2	0.4743	1.1284	1.6027	100.0
110.0	334.79	0.01782	4.0306	4.0484	305.8	883.1	1188.9	0.4834	1.1115	1.5950	110.0
120.0	341.27	0.01789	3.7097	3.7275	312.6	877.8	1190.4	0.4919	1.0960	1.5879	120.0
130.0	347.33	0.01796	3.4364	3.4544	319.0	872.8	1191.7	0.4998	1.0815	1.5813	130.0
140.0	353.04	0.01803	3.2010	3.2190	325.0	868.0	1193.0	0.5071	1.0681	1.5752	140.0
150.0	358.43	0.01809	2.9958	3.0139	330.6	863.4	1194.1	0.5141	1.0554	1.5695	150.0
160.0	363.55	0.01815	2.8155	2.8336	336.1	859.0	1195.1	0.5206	1.0435	1.5641	160.0
170.0	368.42	0.01821	2.6556	2.6738	341.2	854.8	1196.0	0.5269	1.0322	1.5591	170.0
180.0	373.08	0.01827	2.5129	2.5312	346.2	850.7	1196.9	0.5328	1.0215	1.5543	180.0
190.0	377.53	0.01833	2.3847	2.4030	350.9	846.7	1197.6	0.5384	1.0113	1.5498	190.0
200.0	381.80	0.01839	2.2689	2.2873	355.5	842.8	1198.3	0.5438	1.0016	1.5454	200.0
210.0	385.91	0.01844	2.16373	2.18217	359.9	839.1	1199.0	0.5490	0.9923	1.5413	210.0
220.0	389.88	0.01850	2.06779	2.08629	364.2	835.4	1199.6	0.5540	0.9834	1.5374	220.0
230.0	393.70	0.01855	1.97991	1.99846	368.3	831.8	1200.1	0.5588	0.9748	1.5336	230.0
240.0	397.39	0.01860	1.89909	1.91769	372.3	828.4	1200.6	0.5634	0.9665	1.5299	240.0
250.0	400.97	0.01865	1.82452	1.84317	376.1	825.0	1201.1	0.5679	0.9585	1.5264	250.0
260.0	404.44	0.01870	1.75548	1.77418	379.9	821.6	1201.5	0.5722	0.9508	1.5230	260.0
270.0	407.80	0.01875	1.69137	1.71013	383.6	818.3	1201.9	0.5764	0.9433	1.5197	270.0
280.0	411.07	0.01880	1.63169	1.65049	387.1	815.1	1202.3	0.5805	0.9361	1.5166	280.0
290.0	414.25	0.01885	1.57597	1.59482	390.6	812.0	1202.6	0.5844	0.9291	1.5135	290.0
300.0	417.35	0.01889	1.52384	1.54274	394.0	808.9	1202.9	0.5882	0.9223	1.5105	300.0
350.0	431.73	0.01912	1.30642	1.32554	409.8	794.2	1204.0	0.6059	0.8909	1.4968	350.0
400.0	444.60	0.01934	1.14162	1.16095	424.2	780.4	1204.6	0.6217	0.8630	1.4847	400.0

Abs Press. Lb/Sq In. p	Temp Fahr t	Specific Volume Sat. Liquid v_f	Specific Volume Evap v_{fg}	Specific Volume Sat. Vapor v_g	Enthalpy Sat. Liquid h_f	Enthalpy Evap h_{fg}	Enthalpy Sat. Vapor h_g	Entropy Sat. Liquid s_f	Entropy Evap s_{fg}	Entropy Sat. Vapor s_g	Abs Press. Lb/Sq In. p
450.0	456.28	0.01954	1.01224	1.03179	437.3	767.5	1204.8	0.6360	0.8378	1.4738	450.0
500.0	467.01	0.01975	0.90787	0.92762	449.5	755.1	1204.7	0.6490	0.8148	1.4639	500.0
550.0	476.94	0.01994	0.82183	0.84177	460.9	743.3	1204.3	0.6611	0.7936	1.4547	550.0
600.0	486.20	0.02013	0.74962	0.76975	471.7	732.0	1203.7	0.6723	0.7738	1.4461	600.0
650.0	494.89	0.02032	0.68811	0.70843	481.9	720.9	1202.8	0.6828	0.7552	1.4381	650.0
700.0	503.08	0.02050	0.63505	0.65556	491.6	710.2	1201.8	0.6928	0.7377	1.4304	700.0
750.0	510.84	0.02069	0.58880	0.60949	500.9	699.8	1200.7	0.7022	0.7210	1.4232	750.0
800.0	518.21	0.02087	0.54809	0.56896	509.8	689.6	1199.4	0.7111	0.7051	1.4163	800.0
850.0	525.24	0.02105	0.51197	0.53302	518.4	679.5	1198.0	0.7197	0.6899	1.4096	850.0
900.0	531.95	0.02123	0.47968	0.50091	526.7	669.7	1196.4	0.7279	0.6753	1.4032	900.0
950.0	538.39	0.02141	0.45064	0.47205	534.7	660.0	1194.7	0.7358	0.6612	1.3970	950.0
1000.0	544.58	0.02159	0.42436	0.44596	542.6	650.4	1192.9	0.7434	0.6476	1.3910	1000.0
1050.0	550.53	0.02177	0.40047	0.42224	550.1	640.9	1191.0	0.7507	0.6344	1.3851	1050.0
1100.0	556.28	0.02195	0.37863	0.40058	557.5	631.5	1189.1	0.7578	0.6216	1.3794	1100.0
1150.0	561.82	0.02214	0.35859	0.38073	564.8	622.2	1187.0	0.7647	0.6091	1.3738	1150.0
1200.0	567.19	0.02232	0.34013	0.36245	571.9	613.0	1184.8	0.7714	0.5969	1.3683	1200.0
1250.0	572.38	0.02250	0.32306	0.34556	578.8	603.8	1182.6	0.7780	0.5850	1.3630	1250.0
1300.0	577.42	0.02269	0.30722	0.32991	585.6	594.6	1180.2	0.7843	0.5733	1.3577	1300.0
1350.0	582.32	0.02288	0.29250	0.31537	592.3	585.4	1177.8	0.7906	0.5620	1.3525	1350.0
1400.0	587.07	0.02307	0.27871	0.30178	598.8	576.5	1175.3	0.7966	0.5507	1.3474	1400.0
1450.0	591.70	0.02327	0.26584	0.28911	605.3	567.4	1172.8	0.8026	0.5397	1.3423	1450.0
1500.0	596.20	0.02346	0.25372	0.27719	611.7	558.4	1170.1	0.8085	0.5288	1.3373	1500.0
1550.0	600.59	0.02366	0.24235	0.26601	618.0	549.4	1167.4	0.8142	0.5182	1.3324	1550.0
1600.0	604.87	0.02387	0.23159	0.25545	624.2	540.3	1164.5	0.8199	0.5076	1.3274	1600.0
1650.0	609.05	0.02407	0.22143	0.24551	630.4	531.3	1161.6	0.8254	0.4971	1.3225	1650.0
1700.0	613.13	0.02428	0.21178	0.23607	636.5	522.2	1158.6	0.8309	0.4867	1.3176	1700.0
1750.0	617.12	0.02450	0.20263	0.22713	642.5	513.1	1155.6	0.8363	0.4765	1.3128	1750.0
1800.0	621.02	0.02472	0.19390	0.21861	648.5	503.8	1152.3	0.8417	0.4662	1.3079	1800.0
1850.0	624.83	0.02495	0.18558	0.21052	654.5	494.6	1149.0	0.8470	0.4561	1.3030	1850.0
1900.0	628.56	0.02517	0.17761	0.20278	660.4	485.2	1145.6	0.8522	0.4459	1.2981	1900.0
1950.0	632.22	0.02541	0.16999	0.19540	666.3	475.8	1142.0	0.8574	0.4358	1.2931	1950.0
2000.0	635.80	0.02565	0.16266	0.18831	672.1	466.2	1138.3	0.8625	0.4256	1.2881	2000.0
2100.0	642.76	0.02615	0.14885	0.17501	683.8	446.7	1130.5	0.8727	0.4053	1.2780	2100.0
2200.0	649.45	0.02669	0.13603	0.16272	695.5	426.7	1122.2	0.8828	0.3848	1.2676	2200.0
2300.0	655.89	0.02727	0.12406	0.15133	707.2	406.0	1113.2	0.8929	0.3640	1.2569	2300.0
2400.0	662.11	0.02790	0.11287	0.14076	719.0	384.8	1103.7	0.9031	0.3430	1.2460	2400.0
2500.0	668.11	0.02859	0.10209	0.13068	731.7	361.6	1093.3	0.9139	0.3206	1.2345	2500.0
2600.0	673.91	0.02938	0.09172	0.12110	744.5	337.6	1082.0	0.9247	0.2977	1.2225	2600.0
2700.0	679.53	0.03029	0.08165	0.11194	757.3	312.3	1069.7	0.9356	0.2741	1.2097	2700.0
2800.0	684.96	0.03134	0.07171	0.10305	770.7	285.1	1055.8	0.9468	0.2491	1.1958	2800.0
2900.0	690.22	0.03262	0.06158	0.09420	785.1	254.7	1039.8	0.9588	0.2215	1.1803	2900.0
3000.0	695.33	0.03428	0.05073	0.08500	801.8	218.4	1020.3	0.9728	0.1891	1.1619	3000.0
3100.0	700.28	0.03681	0.03771	0.07452	824.0	169.3	993.3	0.9914	0.1460	1.1373	3100.0
3200.0	705.08	0.04472	0.01191	0.05663	875.5	56.1	931.6	1.0351	0.0482	1.0832	3200.0
3208.2*	705.47	0.05078	0.00000	0.05078	906.0	0.0	906.0	1.0612	0.0000	1.0612	3208.2*

*Critical pressure

APPENDIX B

SUPERHEATED STEAM TABLES

(Intentionally Blank)

Table 3. Superheated Steam

Abs Press Lb/Sq In (Sat Temp)		Sat Water	Sat Steam	200	250	300	350	400	450	500	600	700	800	900	1000	1100	1200
1 (101.74)	Sh			98.26	148.26	198.26	248.26	298.26	348.26	398.26	498.26	598.26	698.26	798.26	898.26	998.26	1098.26
	v	0.01614	333.6	392.5	422.4	452.3	482.1	511.9	541.7	571.5	631.1	690.7	750.3	809.9	869.5	929.1	988.6
	h	69.73	1105.8	1150.2	1172.9	1195.7	1218.7	1241.8	1265.1	1288.6	1336.1	1384.5	1433.7	1483.8	1534.9	1586.8	1639.7
	s	0.1326	1.9781	2.0509	2.0841	2.1152	2.1445	2.1722	2.1985	2.2237	2.2708	2.3144	2.3551	2.3934	2.4296	2.4640	2.4969
5 (162.24)	Sh			37.76	87.76	137.76	187.76	237.76	287.76	337.76	437.76	537.76	637.76	737.76	837.76	937.76	1037.76
	v	0.01641	73.53	78.14	84.21	90.24	96.25	102.24	108.23	114.21	126.15	138.08	150.01	161.94	173.86	185.78	197.70
	h	130.20	1131.1	1148.6	1171.7	1194.8	1218.0	1241.3	1264.7	1288.2	1335.9	1384.3	1433.6	1483.7	1534.7	1586.7	1639.6
	s	0.2349	1.8443	1.8716	1.9054	1.9369	1.9664	1.9943	2.0208	2.0460	2.0932	2.1369	2.1776	2.2159	2.2521	2.2866	2.3194
10 (193.21)	Sh			6.79	56.79	106.79	156.79	206.79	256.79	306.79	406.79	506.79	606.79	706.79	806.79	906.79	1006.79
	v	0.01659	38.42	38.84	41.93	44.98	48.02	51.03	54.04	57.04	63.03	69.00	74.98	80.94	86.91	92.87	98.84
	h	161.26	1143.3	1146.6	1170.2	1193.7	1217.1	1240.6	1264.1	1287.8	1335.5	1384.0	1433.4	1483.5	1534.6	1586.6	1639.5
	s	0.2836	1.7879	1.7928	1.8273	1.8593	1.8892	1.9173	1.9439	1.9692	2.0166	2.0603	2.1011	2.1394	2.1757	2.2101	2.2430
14.696 (212.00)	Sh				38.00	88.00	138.00	188.00	238.00	288.00	388.00	488.00	588.00	688.00	788.00	888.00	988.00
	v	.0167	26.799		28.42	30.52	32.60	34.67	36.72	38.77	42.86	46.93	51.00	55.06	59.13	63.19	67.25
	h	180.17	1150.5		1168.8	1192.6	1216.3	1239.9	1263.6	1287.4	1335.2	1383.8	1433.2	1483.4	1534.5	1586.5	1639.4
	s	.3121	1.7568		1.7833	1.8158	1.8459	1.8743	1.9010	1.9265	1.9739	2.0177	2.0585	2.0969	2.1332	2.1676	2.2005
15 (213.03)	Sh				36.97	86.97	136.97	186.97	236.97	286.97	386.97	486.97	586.97	686.97	786.97	886.97	986.97
	v	0.01673	26.290		27.837	29.899	31.939	33.963	35.977	37.985	41.986	45.978	49.964	53.946	57.926	61.905	65.882
	h	181.21	1150.9		1168.7	1192.5	1216.2	1239.9	1263.6	1287.3	1335.2	1383.8	1433.2	1483.4	1534.5	1586.5	1639.4
	s	0.3137	1.7552		1.7809	1.8134	1.8437	1.8720	1.8988	1.9242	1.9717	2.0155	2.0563	2.0946	2.1309	2.1653	2.1982
20 (227.96)	Sh				22.04	72.04	122.04	172.04	222.04	272.04	372.04	472.04	572.04	672.04	772.04	872.04	972.04
	v	0.01683	20.087		20.788	22.356	23.900	25.428	26.946	28.457	31.466	34.465	37.458	40.447	43.435	46.420	49.405
	h	196.27	1156.3		1167.1	1191.4	1215.4	1239.2	1263.0	1286.9	1334.9	1383.5	1432.9	1483.2	1534.3	1586.3	1639.3
	s	0.3358	1.7320		1.7475	1.7805	1.8111	1.8397	1.8666	1.8921	1.9397	1.9836	2.0244	2.0628	2.0991	2.1336	2.1665
25 (240.07)	Sh				9.93	59.93	109.93	159.93	209.93	259.93	359.93	459.93	559.93	659.93	759.93	859.93	959.93
	v	0.01693	16.301		16.558	17.829	19.076	20.307	21.527	22.740	25.153	27.557	29.954	32.348	34.740	37.130	39.518
	h	208.57	1160.6		1165.6	1190.2	1214.5	1238.5	1262.5	1286.4	1334.6	1383.3	1432.7	1483.0	1534.2	1586.2	1639.2
	s	0.3535	1.7141		1.7212	1.7547	1.7856	1.8145	1.8415	1.8672	1.9149	1.9588	1.9997	2.0381	2.0744	2.1089	2.1418
30 (250.34)	Sh					49.66	99.66	149.66	199.66	249.66	349.66	449.66	549.66	649.66	749.66	849.66	949.66
	v	0.01701	13.744			14.810	15.859	16.892	17.914	18.929	20.945	22.951	24.952	26.949	28.943	30.936	32.927
	h	218.93	1164.1			1189.0	1213.6	1237.8	1261.9	1286.0	1334.2	1383.0	1432.5	1482.8	1534.0	1586.1	1639.0
	s	0.3682	1.6995			1.7334	1.7647	1.7937	1.8210	1.8467	1.8946	1.9386	1.9795	2.0179	2.0543	2.0888	2.1217
35 (259.29)	Sh					40.71	90.71	140.71	190.71	240.71	340.71	440.71	540.71	640.71	740.71	840.71	940.71
	v	0.01708	11.896			12.654	13.562	14.453	15.334	16.207	17.939	19.662	21.379	23.092	24.803	26.512	28.220
	h	228.03	1167.1			1187.8	1212.7	1237.1	1261.3	1285.5	1333.9	1382.8	1432.3	1482.7	1533.9	1586.0	1638.9
	s	0.3809	1.6872			1.7152	1.7468	1.7761	1.8035	1.8294	1.8774	1.9214	1.9624	2.0009	2.0372	2.0717	2.1046
40 (267.25)	Sh					32.75	82.75	132.75	182.75	232.75	332.75	432.75	532.75	632.75	732.75	832.75	932.75
	v	0.01715	10.497			11.036	11.838	12.624	13.398	14.165	15.685	17.195	18.699	20.199	21.697	23.194	24.689
	h	236.14	1169.8			1186.6	1211.7	1236.4	1260.8	1285.0	1333.6	1382.5	1432.1	1482.5	1533.7	1585.8	1638.8
	s	0.3921	1.6765			1.6992	1.7312	1.7608	1.7883	1.8143	1.8624	1.9065	1.9476	1.9860	2.0224	2.0569	2.0899
45 (274.44)	Sh					25.56	75.56	125.56	175.56	225.56	325.56	425.56	525.56	625.56	725.56	825.56	925.56
	v	0.01721	9.399			9.777	10.497	11.201	11.892	12.577	13.932	15.276	16.614	17.950	19.282	20.613	21.943
	h	243.49	1172.1			1185.4	1210.4	1235.7	1260.2	1284.6	1333.3	1382.3	1431.9	1482.3	1533.6	1585.7	1638.7
	s	0.4021	1.6671			1.6849	1.7173	1.7471	1.7748	1.8010	1.8492	1.8934	1.9345	1.9730	2.0093	2.0439	2.0768
50 (281.02)	Sh					18.98	68.98	118.98	168.98	218.98	318.98	410.98	518.98	618.98	718.98	818.98	918.98
	v	0.01727	8.514			8.769	9.424	10.062	10.688	11.306	12.529	13.741	14.947	16.150	17.350	18.549	19.746
	h	250.21	1174.1			1184.1	1209.9	1234.9	1259.6	1284.1	1332.9	1382.0	1431.7	1482.2	1533.4	1585.6	1638.6
	s	0.4112	1.6586			1.6720	1.7048	1.7349	1.7628	1.7890	1.8374	1.8816	1.9227	1.9613	1.9977	2.0322	2.0652
55 (287.07)	Sh					12.93	62.93	112.93	162.93	212.93	312.93	412.93	512.93	612.93	712.93	812.93	912.93
	v	0.01733				7.945	8.546	9.130	9.702	10.267	11.381	12.485	13.583	14.677	15.769	16.859	17.948
	h	256.43				1182.9	1208.9	1234.2	1259.1	1283.6	1332.6	1381.8	1431.5	1482.0	1533.3	1585.5	1638.5
	s	0.4196				1.6601	1.6933	1.7237	1.7518	1.7781	1.8266	1.8710	1.9121	1.9507	1.98	2.027	2.055
60 (292.71)	Sh					7.29	57.29	107.29	157.29	207.29	307.29	407.29	507.29	607.29	707.29	807.29	907.29
	v	0.01738	7.174			7.257	7.815	8.354	8.881	9.400	10.425	11.438	12.446	13.450	14.452	15.452	16.450
	h	262.21	1177.6			1181.6	1208.0	1233.5	1258.5	1283.2	1332.3	1381.5	1431.3	1481.8	1533.2	1585.3	1638.4
	s	0.4273	1.6440			1.6492	1.6829	1.7134	1.7417	1.7681	1.8168	1.8612	1.9024	1.9410	1.9774	2.0120	2.0450
65 (297.98)	Sh					2.02	52.02	102.02	152.02	202.02	302.02	402.02	502.02	602.02	702.02	802.02	902.02
	v	0.01743	6.653			6.675	7.195	7.697	8.186	8.667	9.615	10.552	11.484	12.412	13.337	14.261	15.183
	h	267.63	1179.1			1180.3	1207.0	1232.7	1257.9	1282.7	1331.9	1381.3	1431.1	1481.6	1533.0	1585.2	1638.3
	s	0.4344	1.6375			1.6390	1.6731	1.7040	1.7324	1.7590	1.8077	1.8522	1.8935	1.9321	1.9685	2.0031	2.0361
70 (302.93)	Sh						47.07	97.07	147.07	197.07	297.07	397.07	497.07	597.07	697.07	797.07	897.07
	v	0.01748	6.205				6.664	7.133	7.590	8.039	8.922	9.793	10.659	11.522	12.382	13.240	14.09
	h	272.74	1180.6				1206.0	1232.0	1257.3	1282.2	1331.6	1381.0	1430.9	1481.5	1532.9	1585.1	1638.2
	s	0.4411	1.6316				1.6640	1.6951	1.7237	1.7504	1.7993	1.8439	1.8852	1.9238	1.9603	1.9949	2.0279
75 (307.61)	Sh						42.39	92.39	142.39	192.39	292.39	392.39	492.39	592.39	692.39	792.39	892.39
	v	0.01753	5.814				6.204	6.645	7.074	7.494	8.320	9.135	9.945	10.750	11.553	12.355	13.155
	h	277.56	1181.9				1205.0	1231.2	1256.7	1281.7	1331.3	1380.7	1430.7	1481.3	1532.7	1585.0	1638.1
	s	0.4474	1.6260				1.6554	1.6868	1.7156	1.7424	1.7915	1.8361	1.8774	1.9161	1.9526	1.9872	2.0202

Temperature – Degrees Fahrenheit

Sh = superheat, F
v = specific volume, cu ft per lb
h = enthalpy, Btu per lb
s = entropy, Btu per R per lb

Table 3. Superheated Steam – *Continued*

Abs Press Lb/Sq In (Sat Temp)		Sat Water	Sat Steam	350	400	450	500	550	600	700	800	900	1000	1100	1200	1300	1400
80 (312.04)	Sh			37.96	87.96	137.96	187.96	237.96	287.96	387.96	487.96	587.96	687.96	787.96	887.96	987.96	1087.96
	v	0.01757	5.471	5.801	6.218	6.622	7.018	7.408	7.794	8.560	9.319	10.075	10.829	11.581	12.331	13.081	13.829
	h	282.15	1183.1	1204.0	1230.5	1256.1	1281.3	1306.2	1330.9	1380.5	1430.5	1481.1	1532.6	1584.9	1638.0	1692.0	1746.8
	s	0.4534	1.6208	1.6473	1.6790	1.7080	1.7349	1.7602	1.7842	1.8289	1.8702	1.9089	1.9454	1.9800	2.0131	2.0446	2.0750
85 (316.26)	Sh			33.74	83.74	133.74	183.74	233.74	283.74	383.74	483.74	583.74	683.74	783.74	883.74	983.74	1083.74
	v	0.01762	5.167	5.445	5.840	6.223	6.597	6.966	7.330	8.052	8.768	9.480	10.190	10.898	11.604	12.310	13.014
	h	286.52	1184.2	1203.0	1229.7	1255.5	1280.8	1305.8	1330.6	1380.2	1430.3	1481.0	1532.4	1584.7	1637.9	1691.9	1746.8
	s	0.4590	1.6159	1.6396	1.6716	1.7008	1.7279	1.7532	1.7772	1.8220	1.8634	1.9021	1.9386	1.9733	2.0063	2.0379	2.0682
90 (320.28)	Sh			29.72	79.72	129.72	179.72	229.72	279.72	379.72	479.72	579.72	679.72	779.72	879.72	979.72	1079.72
	v	0.01766	4.895	5.128	5.505	5.869	6.223	6.572	6.917	7.600	8.277	8.950	9.621	10.290	10.958	11.625	12.290
	h	290.69	1185.3	1202.0	1228.9	1254.9	1280.3	1305.4	1330.2	1380.0	1430.1	1480.8	1532.3	1584.6	1637.8	1691.8	1746.7
	s	0.4643	1.6113	1.6323	1.6646	1.6940	1.7212	1.7467	1.7707	1.8156	1.8570	1.8957	1.9323	1.9669	2.0000	2.0316	2.0619
95 (324.13)	Sh			25.87	75.87	125.87	175.87	225.87	275.87	375.87	475.87	575.87	675.87	775.87	875.87	975.87	1075.87
	v	0.01770	4.651	4.845	5.205	5.551	5.889	6.221	6.548	7.196	7.838	8.477	9.113	9.747	10.380	11.012	11.643
	h	294.70	1186.2	1200.9	1228.1	1254.3	1279.8	1305.0	1329.9	1379.7	1429.9	1480.6	1532.1	1584.5	1637.7	1691.7	1746.6
	s	0.4694	1.6069	1.6253	1.6580	1.6876	1.7149	1.7404	1.7645	1.8094	1.8509	1.8897	1.9262	1.9609	1.9940	2.0256	2.0559
100 (327.82)	Sh			22.18	72.18	122.18	172.18	222.18	272.18	372.18	472.18	572.18	672.18	772.18	872.18	972.18	1072.18
	v	0.01774	4.431	4.590	4.935	5.266	5.588	5.904	6.216	6.833	7.443	8.050	8.655	9.258	9.860	10.460	11.060
	h	298.54	1187.2	1199.9	1227.4	1253.7	1279.3	1304.6	1329.6	1379.5	1429.7	1480.4	1532.0	1584.4	1637.6	1691.6	1746.5
	s	0.4743	1.6027	1.6187	1.6516	1.6814	1.7088	1.7344	1.7586	1.8036	1.8451	1.8839	1.9205	1.9552	1.9883	2.0199	2.0502
105 (331.37)	Sh			18.63	68.63	118.63	168.63	218.63	268.63	368.63	468.63	568.63	668.63	768.63	868.63	968.63	1068.63
	v	0.01778	4.231	4.359	4.690	5.007	5.315	5.617	5.915	6.504	7.086	7.665	8.241	8.816	9.389	9.961	10.532
	h	302.24	1188.0	1198.8	1226.6	1253.1	1278.8	1304.2	1329.2	1379.2	1429.4	1480.3	1531.8	1584.2	1637.5	1691.5	1746.4
	s	0.4790	1.5988	1.6122	1.6455	1.6755	1.7031	1.7288	1.7530	1.7981	1.8396	1.8785	1.9151	1.9498	1.9828	2.0145	2.0448
110 (334.79)	Sh			15.21	65.21	115.21	165.21	215.21	265.21	365.21	465.21	565.21	665.21	765.21	865.21	965.21	1065.21
	v	0.01782	4.048	4.149	4.468	4.772	5.068	5.357	5.642	6.205	6.761	7.314	7.865	8.413	8.961	9.507	10.053
	h	305.80	1188.9	1197.7	1225.8	1252.5	1278.3	1303.8	1328.9	1379.0	1429.2	1480.1	1531.7	1584.1	1637.4	1691.4	1746.4
	s	0.4834	1.5950	1.6061	1.6396	1.6698	1.6975	1.7233	1.7476	1.7928	1.8344	1.8732	1.9099	1.9446	1.9777	2.0093	2.0397
115 (338.08)	Sh			11.92	61.92	111.92	161.92	211.92	261.92	361.92	461.92	561.92	661.92	761.92	861.92	961.92	1061.92
	v	0.01785	3.881	3.957	4.265	4.558	4.841	5.119	5.392	5.932	6.465	6.994	7.521	8.046	8.570	9.093	9.615
	h	309.25	1189.6	1196.7	1225.0	1251.8	1277.9	1303.3	1328.6	1378.7	1429.0	1479.9	1531.6	1584.0	1637.2	1691.4	1746.3
	s	0.4877	1.5913	1.6001	1.6340	1.6644	1.6922	1.7181	1.7425	1.7877	1.8294	1.8682	1.9049	1.9396	1.9727	2.0044	2.0347
120 (341.27)	Sh			8.73	58.73	108.73	158.73	208.73	258.73	358.73	458.73	558.73	658.73	758.73	858.73	958.73	1058.73
	v	0.01789	3.7275	3.7815	4.0786	4.3610	4.6341	4.9009	5.1637	5.6813	6.1928	6.7006	7.2060	7.7096	8.2119	8.7130	9.2134
	h	312.58	1190.4	1195.6	1224.1	1251.2	1277.4	1302.9	1328.2	1378.4	1428.8	1479.8	1531.4	1583.9	1637.1	1691.3	1746.2
	s	0.4919	1.5879	1.5943	1.6286	1.6592	1.6872	1.7132	1.7376	1.7829	1.8246	1.8635	1.9001	1.9349	1.9680	1.9996	2.0300
130 (347.33)	Sh			2.67	52.67	102.67	152.67	202.67	252.67	352.67	452.67	552.67	652.67	752.67	852.67	952.67	1052.67
	v	0.01796	3.4544	3.4699	3.7489	4.0129	4.2672	4.5151	4.7589	5.2384	5.7118	6.1814	6.6486	7.1140	7.5781	8.0411	8.5033
	h	318.95	1191.7	1193.4	1222.5	1249.9	1276.4	1302.1	1327.5	1377.9	1428.4	1479.4	1531.1	1583.6	1636.9	1691.1	1746.1
	s	0.4998	1.5813	1.5833	1.6182	1.6493	1.6775	1.7037	1.7283	1.7737	1.8155	1.8545	1.8911	1.9259	1.9591	1.9907	2.0211
140 (353.04)	Sh				46.96	96.96	146.96	196.96	246.96	346.96	446.96	546.96	646.96	746.96	846.96	946.96	1046.96
	v	0.01803	3.2190		3.4661	3.7143	3.9526	4.1844	4.4119	4.8581	5.2995	5.7364	6.1709	6.6036	7.0349	7.4652	7.8946
	h	324.96	1193.0		1220.8	1248.7	1275.3	1301.3	1326.8	1377.4	1428.0	1479.1	1530.8	1583.4	1636.7	1690.9	1745.9
	s	0.5071	1.5752		1.6085	1.6400	1.6686	1.6949	1.7196	1.7652	1.8071	1.8461	1.8828	1.9176	1.9508	1.9825	2.0129
150 (358.43)	Sh				41.57	91.57	141.57	191.57	241.57	341.57	441.57	541.57	641.57	741.57	841.57	941.57	1041.57
	v	0.01809	3.0139		3.2208	3.4555	3.6799	3.8978	4.1112	4.5298	4.9421	5.3507	5.7568	6.1612	6.5642	6.9661	7.3671
	h	330.65	1194.1		1219.1	1247.4	1274.3	1300.5	1326.1	1376.9	1427.6	1478.7	1530.5	1583.1	1636.5	1690.7	1745.7
	s	0.5141	1.5695		1.5993	1.6313	1.6602	1.6867	1.7115	1.7573	1.7992	1.8383	1.8751	1.9099	1.9431	1.9748	2.0052
160 (363.55)	Sh				36.45	86.45	136.45	186.45	236.45	336.45	436.45	536.45	636.45	736.45	836.45	936.45	1036.45
	v	0.01815	2.8336		3.0060	3.2288	3.4413	3.6469	3.8480	4.2420	4.6295	5.0132	5.3945	5.7741	6.1522	6.5293	6.9055
	h	336.07	1195.1		1217.4	1246.0	1273.3	1299.6	1325.4	1376.4	1427.2	1478.4	1530.3	1582.9	1636.3	1690.5	1745.6
	s	0.5206	1.5641		1.5906	1.6231	1.6522	1.6790	1.7039	1.7499	1.7919	1.8310	1.8678	1.9027	1.9359	1.9676	1.9980
170 (368.42)	Sh				31.58	81.58	131.58	181.58	231.58	331.58	431.58	531.58	631.58	731.58	831.58	931.58	1031.58
	v	0.01821	2.6738		2.8162	3.0288	3.2306	3.4255	3.6158	3.9879	4.3536	4.7155	5.0749	5.4325	5.7888	6.1440	6.4983
	h	341.24	1196.0		1215.6	1244.7	1272.2	1298.8	1324.7	1375.8	1426.8	1478.0	1530.0	1582.6	1636.1	1690.4	1745.4
	s	0.5269	1.5591		1.5823	1.6152	1.6447	1.6717	1.6968	1.7428	1.7850	1.8241	1.8610	1.8959	1.9291	1.9608	1.9913
180 (373.08)	Sh				26.92	76.92	126.92	176.92	226.92	326.92	426.92	526.92	626.92	726.92	826.92	926.92	1026.92
	v	0.01827	2.5312		2.6474	2.8508	3.0433	3.2286	3.4093	3.7621	4.1084	4.4508	4.7907	5.1289	5.4657	5.8014	6.1363
	h	346.19	1196.9		1213.8	1243.4	1271.2	1297.9	1324.0	1375.3	1426.3	1477.7	1529.7	1582.4	1635.9	1690.2	1745.3
	s	0.5328	1.5543		1.5743	1.6078	1.6376	1.6647	1.6900	1.7362	1.7784	1.8176	1.8545	1.8894	1.9227	1.9545	1.9849
190 (377.53)	Sh				22.47	72.47	122.47	172.47	222.47	322.47	422.47	522.47	622.47	722.47	822.47	922.47	1022.47
	v	0.01833	2.4030		2.4961	2.6915	2.8756	3.0525	3.2246	3.5601	3.8889	4.2140	4.5365	4.8572	5.1766	5.4949	5.8124
	h	350.94	1197.6		1212.0	1242.0	1270.1	1297.1	1323.3	1374.8	1425.9	1477.4	1529.4	1582.1	1635.7	1690.0	1745.1
	s	0.5384	1.5498		1.5667	1.6006	1.6307	1.6581	1.6835	1.7299	1.7722	1.8115	1.8484	1.8834	1.9166	1.9484	1.9789
200 (381.80)	Sh				18.20	68.20	118.20	168.20	218.20	318.20	418.20	518.20	618.20	718.20	818.20	918.20	1018.20
	v	0.01839	2.2873		2.3598	2.5480	2.7247	2.8935	3.0583	3.3783	3.6915	4.0008	4.3077	4.6128	4.9165	5.2191	5.5209
	h	355.51	1198.3		1210.1	1240.6	1269.0	1296.2	1322.6	1374.3	1425.5	1477.0	1529.1	1581.9	1635.4	1689.8	1745.0
	s	0.5438	1.5454		1.5593	1.5938	1.6242	1.6518	1.6773	1.7239	1.7663	1.8057	1.8426	1.8776	1.9109	1.9427	1.9732

Sh = superheat, F
v = specific volume, cu ft per lb
h = enthalpy, Btu per lb
s = entropy, Btu per F per lb

Table 3. Superheated Steam – *Continued*

Abs Press Lb/Sq In (Sat Temp)		Sat Water	Sat Steam	400	450	500	550	600	700	800	900	1000	1100	1200	1300	1400	1500
	Sh			14.09	64.09	114.09	164.09	214.09	314.09	414.09	514.09	614.09	714.09	814.09	914.09	1014.09	1114.09
210	v	0.01844	2.1822	2.2364	2.4181	2.5880	2.7504	2.9078	3.2137	3.5128	3.8080	4.1007	4.3915	4.6811	4.9695	5.2571	5.5440
(385.91)	h	359.91	1199.0	1208.02	1239.2	1268.0	1295.3	1321.9	1373.7	1425.1	1476.7	1528.8	1581.6	1635.2	1689.6	1744.8	1800.8
	s	0.5490	1.5413	1.5522	1.5872	1.6180	1.6458	1.6715	1.7182	1.7607	1.8001	1.8371	1.8721	1.9054	1.9372	1.9677	1.9970
	Sh			10.12	60.12	110.12	160.12	210.12	310.12	410.12	510.12	610.12	710.12	810.12	910.12	1010.12	1110.12
220	v	0.01850	2.0863	2.1240	2.2999	2.4638	2.6199	2.7710	3.0642	3.3504	3.6327	3.9125	4.1905	4.4671	4.7426	5.0173	5.2913
(389.88)	h	364.17	1199.6	1206.3	1237.8	1266.9	1294.5	1321.2	1373.2	1424.7	1476.3	1528.5	1581.4	1635.0	1689.4	1744.7	1800.6
	s	0.5540	1.5374	1.5453	1.5808	1.6120	1.6400	1.6658	1.7128	1.7553	1.7948	1.8318	1.8668	1.9002	1.9320	1.9625	1.9919
	Sh			6.30	56.30	106.30	156.30	206.30	306.30	406.30	506.30	606.30	706.30	806.30	906.30	1006.30	1106.30
230	v	0.01855	1.9985	2.0212	2.1919	2.3503	2.5008	2.6461	2.9276	3.2020	3.4726	3.7406	4.0068	4.2717	4.5355	4.7984	5.0606
(393.70)	h	368.28	1200.1	1204.4	1236.3	1265.7	1293.6	1320.4	1372.7	1424.2	1476.0	1528.2	1581.1	1634.8	1689.3	1744.5	1800.5
	s	0.5588	1.5336	1.5385	1.5747	1.6062	1.6344	1.6604	1.7075	1.7502	1.7897	1.8268	1.8618	1.8952	1.9270	1.9576	1.9869
	Sh			2.61	52.61	102.61	152.61	202.61	302.61	402.61	502.61	602.61	702.61	802.61	902.61	1002.61	1102.61
240	v	0.01860	1.9177	1.9268	2.0928	2.2467	2.3915	2.5316	2.8024	3.0661	3.3259	3.5831	3.8385	4.0926	4.3456	4.5977	4.8492
(397.39)	h	372.27	1200.6	1202.4	1234.9	1264.6	1292.7	1319.7	1372.1	1423.8	1475.6	1527.9	1580.9	1634.6	1689.1	1744.3	1800.4
	s	0.5634	1.5299	1.5320	1.5687	1.6006	1.6291	1.6552	1.7025	1.7452	1.7848	1.8219	1.8570	1.8904	1.9223	1.9528	1.9822
	Sh				49.03	99.03	149.03	199.03	299.03	399.03	499.03	599.03	699.03	799.03	899.03	999.03	1099.03
250	v	0.01865	1.8432		2.0016	2.1504	2.2909	2.4262	2.6872	2.9410	3.1909	3.4382	3.6837	3.9278	4.1709	4.4131	4.6546
(400.97)	h	376.14	1201.1		1233.4	1263.5	1291.8	1319.0	1371.6	1423.4	1475.3	1527.6	1580.6	1634.4	1688.9	1744.2	1800.2
	s	0.5679	1.5264		1.5629	1.5951	1.6239	1.6502	1.6976	1.7405	1.7801	1.8173	1.8524	1.8858	1.9177	1.9482	1.9776
	Sh				45.56	95.56	145.56	195.56	295.56	395.56	495.56	595.56	695.56	795.56	895.56	995.56	1095.56
260	v	0.01870	1.7742		1.9173	2.0619	2.1981	2.3289	2.5808	2.8256	3.0663	3.3044	3.5408	3.7758	4.0097	4.2427	4.4750
(404.44)	h	379.90	1201.5		1231.9	1262.4	1290.9	1318.2	1371.1	1423.0	1474.9	1527.3	1580.4	1634.2	1688.7	1744.0	1800.1
	s	0.5722	1.5230		1.5573	1.5899	1.6189	1.6453	1.6930	1.7359	1.7756	1.8128	1.8480	1.8814	1.9133	1.9439	1.9732
	Sh				42.20	92.20	142.20	192.20	292.20	392.20	492.20	592.20	692.20	792.20	892.20	992.20	1092.20
270	v	0.01875	1.7101		1.8391	1.9799	2.1121	2.2388	2.4824	2.7186	2.9509	3.1806	3.4084	3.6349	3.8603	4.0849	4.3087
(407.80)	h	383.56	1201.9		1230.4	1261.2	1290.0	1317.5	1370.5	1422.6	1474.6	1527.1	1580.1	1634.0	1688.5	1743.9	1800.0
	s	0.5764	1.5197		1.5518	1.5848	1.6140	1.6406	1.6885	1.7315	1.7713	1.8085	1.8437	1.8771	1.9090	1.9396	1.9690
	Sh				38.93	88.93	138.93	188.93	288.93	388.93	488.93	588.93	688.93	788.93	888.93	988.93	1088.93
280	v	0.01880	1.6505		1.7665	1.9037	2.0322	2.1551	2.3909	2.6194	2.8437	3.0655	3.2855	3.5042	3.7217	3.9384	4.1543
(411.07)	h	387.12	1202.3		1228.8	1260.0	1289.1	1316.8	1370.0	1422.1	1474.2	1526.8	1579.9	1633.8	1688.4	1743.7	1799.8
	s	0.5805	1.5166		1.5464	1.5798	1.6093	1.6361	1.6841	1.7273	1.7671	1.8043	1.8395	1.8730	1.9050	1.9356	1.9649
	Sh				35.75	85.75	135.75	185.75	285.75	385.75	485.75	585.75	685.75	785.75	885.75	985.75	1085.75
290	v	0.01885	1.5948		1.6988	1.8327	1.9578	2.0772	2.3058	2.5269	2.7440	2.9585	3.1711	3.3824	3.5926	3.8019	4.0106
(414.25)	h	390.60	1202.6		1227.3	1258.9	1288.1	1316.0	1369.5	1421.7	1473.9	1526.5	1579.6	1633.5	1688.2	1743.6	1799.7
	s	0.5844	1.5135		1.5412	1.5750	1.6048	1.6311	1.6799	1.7232	1.7630	1.8003	1.8356	1.8690	1.9010	1.9316	1.9610
	Sh				32.65	82.65	132.65	182.65	282.65	382.65	482.65	582.65	682.65	782.65	882.65	982.65	1082.65
300	v	0.01889	1.5427		1.6356	1.7665	1.8883	2.0044	2.2263	2.4407	2.6509	2.8585	3.0643	3.2688	3.4721	3.6746	3.8764
(417.35)	h	393.99	1202.9		1225.7	1257.7	1287.2	1315.2	1368.9	1421.3	1473.6	1526.2	1579.4	1633.3	1688.0	1743.4	1799.6
	s	0.5882	1.5105		1.5361	1.5703	1.6003	1.6274	1.6758	1.7192	1.7591	1.7964	1.8317	1.8652	1.8972	1.9278	1.9572
	Sh				29.64	79.64	129.64	179.64	279.64	379.64	479.64	579.64	679.64	779.64	879.64	979.64	1079.64
310	v	0.01894	1.4939		1.5763	1.7044	1.8233	1.9363	2.1520	2.3600	2.5638	2.7650	2.9644	3.1625	3.3594	3.5555	3.7509
(420.36)	h	397.30	1203.2		1224.1	1256.5	1286.3	1314.5	1368.4	1420.9	1473.2	1525.8	1579.2	1633.1	1687.8	1743.3	1799.4
	s	0.5920	1.5076		1.5311	1.5657	1.5960	1.6233	1.6719	1.7153	1.7553	1.7927	1.8280	1.8615	1.8935	1.9241	1.9536
	Sh				26.69	76.69	126.69	176.69	276.69	376.69	476.69	576.69	676.69	776.69	876.69	976.69	1076.69
320	v	0.01899	1.4480		1.5207	1.6462	1.7623	1.8725	2.0823	2.2843	2.4821	2.6774	2.8708	3.0628	3.2538	3.4438	3.6332
(423.31)	h	400.53	1203.4		1222.5	1255.2	1285.3	1313.7	1367.8	1420.5	1472.9	1525.6	1578.9	1632.9	1687.6	1743.1	1799.3
	s	0.5956	1.5048		1.5261	1.5612	1.5918	1.6192	1.6680	1.7116	1.7516	1.7890	1.8243	1.8579	1.8899	1.9206	1.9500
	Sh				23.82	73.82	123.82	173.82	273.82	373.82	473.82	573.82	673.82	773.82	873.82	973.82	1073.82
330	v	0.01903	1.4048		1.4684	1.5915	1.7050	1.8125	2.0168	2.2132	2.4054	2.5950	2.7828	2.9692	3.1545	3.3389	3.5227
(426.18)	h	403.70	1203.6		1220.9	1254.0	1284.4	1313.0	1367.3	1420.0	1472.5	1525.3	1578.7	1632.7	1687.5	1742.9	1799.2
	s	0.5991	1.5021		1.5213	1.5568	1.5876	1.6153	1.6643	1.7079	1.7480	1.7855	1.8208	1.8544	1.8864	1.9171	1.9466
	Sh				21.01	71.01	121.01	171.01	271.01	371.01	471.01	571.01	671.01	771.01	871.01	971.01	1071.01
340	v	0.01908	1.3640		1.4191	1.5399	1.6511	1.7561	1.9552	2.1463	2.3333	2.5175	2.7000	2.8811	3.0611	3.2402	3.4186
(428.99)	h	406.80	1203.8		1219.2	1252.8	1283.4	1312.2	1366.7	1419.6	1472.2	1525.0	1578.4	1632.5	1687.3	1742.8	1799.0
	s	0.6026	1.4994		1.5165	1.5525	1.5836	1.6114	1.6606	1.7044	1.7445	1.7820	1.8174	1.8510	1.8831	1.9138	1.9432
	Sh				18.27	68.27	118.27	168.27	268.27	368.27	468.27	568.27	668.27	768.27	868.27	968.27	1068.27
350	v	0.01912	1.3255		1.3725	1.4913	1.6002	1.7028	1.8970	2.0832	2.2652	2.4445	2.6219	2.7980	2.9730	3.1471	3.3205
(431.73)	h	409.83	1204.0		1217.5	1251.5	1282.4	1311.4	1366.2	1419.2	1471.8	1524.7	1578.2	1632.3	1687.1	1742.6	1798.9
	s	0.6059	1.4968		1.5119	1.5483	1.5797	1.6077	1.6571	1.7009	1.7411	1.7787	1.8141	1.8477	1.8798	1.9105	1.9400
	Sh				15.59	65.59	115.59	165.59	265.59	365.59	465.59	565.59	665.59	765.59	865.59	965.59	1065.59
360	v	0.01917	1.2891		1.3285	1.4454	1.5521	1.6525	1.8421	2.0237	2.2009	2.3755	2.5482	2.7196	2.8898	3.0592	3.2279
(434.41)	h	412.81	1204.1		1215.8	1250.3	1281.5	1310.6	1365.6	1418.7	1471.5	1524.4	1577.9	1632.1	1686.9	1742.5	1798.8
	s	0.6092	1.4943		1.5073	1.5441	1.5758	1.6040	1.6536	1.6976	1.7379	1.7754	1.8109	1.8445	1.8766	1.9073	1.9368
	Sh				10.39	60.39	110.39	160.39	260.39	360.39	460.39	560.39	660.39	760.39	860.39	960.39	1060.39
380	v	0.01925	1.2218		1.2472	1.3606	1.4635	1.5598	1.7410	1.9139	2.0825	2.2484	2.4124	2.5750	2.7366	2.8973	3.0572
(439.61)	h	418.59	1204.4		1212.4	1247.7	1279.5	1309.0	1364.5	1417.9	1470.8	1523.8	1577.4	1631.6	1686.5	1742.2	1798.5
	s	0.6156	1.4894		1.4982	1.5360	1.5683	1.5969	1.6470	1.6911	1.7315	1.7692	1.8047	1.8384	1.8705	1.9012	1.9307

Sh = superheat, F
v = specific volume, cu ft per lb
h = enthalpy, Btu per lb
s = entropy, Btu per R per lb

Table 3. Superheated Steam – *Continued*

Abs Press Lb/Sq In (Sat Temp)		Sat Water	Sat Steam	Temperature – Degrees Fahrenheit 450	500	550	600	650	700	800	900	1000	1100	1200	1300	1400	1500
400 (444.60)	Sh			5.40	55.40	105.40	155.40	205.40	255.40	355.40	455.40	555.40	655.40	755.40	855.40	955.40	1055.40
	v	0.01934	1.1610	1.1738	1.2841	1.3836	1.4763	1.5646	1.6499	1.8151	1.9759	2.1339	2.2901	2.4450	2.5987	2.7515	2.9037
	h	424.17	1204.6	1208.8	1245.1	1277.5	1307.4	1335.9	1363.4	1417.0	1470.1	1523.3	1576.9	1631.2	1686.2	1741.9	1798.2
	s	0.6217	1.4847	1.4894	1.5282	1.5611	1.5901	1.6163	1.6406	1.6850	1.7255	1.7632	1.7988	1.8325	1.8647	1.8955	1.9250
420 (449.40)	Sh			.60	50.60	100.60	150.60	200.60	250.60	350.60	450.60	550.60	650.60	750.60	850.60	950.60	1050.60
	v	0.01942	1.1057	1.1071	1.2148	1.3113	1.4007	1.4856	1.5676	1.7258	1.8795	2.0304	2.1795	2.3273	2.4739	2.6196	2.7647
	h	429.56	1204.7	1205.2	1242.4	1275.4	1305.8	1334.5	1362.3	1416.2	1469.4	1522.7	1576.4	1630.8	1685.8	1741.6	1798.0
	s	0.6276	1.4802	1.4808	1.5206	1.5542	1.5835	1.6100	1.6345	1.6791	1.7197	1.7575	1.7932	1.8269	1.8591	1.8899	1.9195
440 (454.03)	Sh				45.97	95.97	145.97	195.97	245.97	345.97	445.97	545.97	645.97	745.97	845.97	945.97	1045.97
	v	0.01950	1.0554		1.1517	1.2454	1.3319	1.4138	1.4926	1.6445	1.7918	1.9363	2.0790	2.2203	2.3605	2.4998	2.6384
	h	434.77	1204.8		1239.7	1273.4	1304.2	1333.2	1361.1	1415.3	1468.7	1522.1	1575.9	1630.4	1685.5	1741.2	1797.7
	s	0.6332	1.4759		1.5132	1.5474	1.5772	1.6040	1.6286	1.6734	1.7142	1.7521	1.7878	1.8216	1.8538	1.8847	1.9143
460 (458.50)	Sh				41.50	91.50	141.50	191.50	241.50	341.50	441.50	541.50	641.50	741.50	841.50	941.50	1041.50
	v	0.01959	1.0092		1.0939	1.1852	1.2691	1.3482	1.4242	1.5703	1.7117	1.8504	1.9872	2.1226	2.2569	2.3903	2.5230
	h	439.83	1204.8		1236.9	1271.3	1302.5	1331.8	1360.0	1414.4	1468.0	1521.5	1575.4	1629.9	1685.1	1740.9	1797.4
	s	0.6387	1.4718		1.5060	1.5409	1.5711	1.5982	1.6230	1.6680	1.7089	1.7469	1.7826	1.8165	1.8488	1.8797	1.9093
480 (462.82)	Sh				37.18	87.18	137.18	187.18	237.18	337.18	437.18	537.18	637.18	737.18	837.18	937.18	1037.18
	v	0.01967	0.9668		1.0409	1.1300	1.2115	1.2881	1.3615	1.5023	1.6384	1.7716	1.9030	2.0330	2.1619	2.2900	2.4173
	h	444.75	1204.8		1234.1	1269.1	1300.8	1330.5	1358.8	1413.6	1467.2	1520.9	1574.9	1629.5	1684.7	1740.6	1797.2
	s	0.6439	1.4677		1.4990	1.5346	1.5652	1.5925	1.6176	1.6628	1.7038	1.7419	1.7777	1.8116	1.8439	1.8748	1.9045
500 (467.01)	Sh				32.99	82.99	132.99	182.99	232.99	332.99	432.99	532.99	632.99	732.99	832.99	932.99	1032.99
	v	0.01975	0.9276		0.9919	1.0791	1.1584	1.2327	1.3037	1.4397	1.5708	1.6992	1.8256	1.9507	2.0746	2.1977	2.3200
	h	449.52	1204.7		1231.2	1267.0	1299.1	1329.1	1357.7	1412.7	1466.6	1520.3	1574.4	1629.1	1684.4	1740.3	1796.9
	s	0.6490	1.4639		1.4921	1.5284	1.5595	1.5871	1.6123	1.6578	1.6990	1.7371	1.7730	1.8069	1.8393	1.8702	1.8998
520 (471.07)	Sh				28.93	78.93	128.93	178.93	228.93	328.93	428.93	528.93	628.93	728.93	828.93	928.93	1028.93
	v	0.01982	0.8914		0.9466	1.0321	1.1094	1.1816	1.2504	1.3819	1.5085	1.6323	1.7542	1.8746	1.9940	2.1125	2.2302
	h	454.18	1204.5		1228.3	1264.8	1297.4	1327.7	1356.5	1411.8	1465.9	1519.7	1573.9	1628.7	1684.0	1740.0	1796.7
	s	0.6540	1.4601		1.4853	1.5223	1.5539	1.5818	1.6072	1.6530	1.6943	1.7325	1.7684	1.8024	1.8348	1.8657	1.8954
540 (475.01)	Sh				24.99	74.99	124.99	174.99	224.99	324.99	424.99	524.99	624.99	724.99	824.99	924.99	1024.99
	v	0.01990	0.8577		0.9045	0.9884	1.0640	1.1342	1.2010	1.3284	1.4508	1.5704	1.6880	1.8042	1.9193	2.0336	2.1471
	h	458.71	1204.4		1225.3	1262.5	1295.7	1326.3	1355.3	1410.9	1465.1	1519.1	1573.3	1628.2	1683.6	1739.7	1796.4
	s	0.6587	1.4565		1.4786	1.5164	1.5485	1.5767	1.6023	1.6483	1.6897	1.7280	1.7640	1.7981	1.8305	1.8615	1.8911
560 (478.84)	Sh				21.16	71.16	121.16	171.16	221.16	321.16	421.16	521.16	621.16	721.16	821.16	921.16	1021.16
	v	0.01998	0.8264		0.8653	0.9479	1.0217	1.0902	1.1552	1.2787	1.3972	1.5129	1.6266	1.7388	1.8500	1.9603	2.0699
	h	463.14	1204.2		1222.2	1260.3	1293.9	1324.9	1354.2	1410.0	1464.4	1518.6	1572.9	1627.8	1683.3	1739.4	1796.1
	s	0.6634	1.4529		1.4720	1.5106	1.5431	1.5717	1.5975	1.6438	1.6853	1.7237	1.7598	1.7939	1.8263	1.8573	1.8870
580 (482.57)	Sh				17.43	67.43	117.43	167.43	217.43	317.43	417.43	517.43	617.43	717.43	817.43	917.43	1017.43
	v	0.02006	0.7971		0.8287	0.9100	0.9824	1.0492	1.1125	1.2324	1.3473	1.4593	1.5693	1.6780	1.7855	1.8921	1.9980
	h	467.47	1203.9		1219.1	1258.0	1292.1	1323.4	1353.0	1409.2	1463.7	1518.0	1572.4	1627.4	1682.9	1739.1	1795.9
	s	0.6679	1.4495		1.4654	1.5049	1.5380	1.5668	1.5929	1.6394	1.6811	1.7196	1.7556	1.7898	1.8223	1.8533	1.8831
600 (486.20)	Sh				13.80	63.80	113.80	163.80	213.80	313.80	413.80	513.80	613.80	713.80	813.80	913.80	1013.80
	v	0.02013	0.7697		0.7944	0.8746	0.9456	1.0109	1.0726	1.1892	1.3008	1.4093	1.5160	1.6211	1.7252	1.8284	1.9309
	h	471.70	1203.7		1215.9	1255.6	1290.3	1322.0	1351.8	1408.3	1463.0	1517.4	1571.9	1627.0	1682.6	1738.8	1795.6
	s	0.6723	1.4461		1.4590	1.4993	1.5329	1.5621	1.5884	1.6351	1.6769	1.7155	1.7517	1.7859	1.8184	1.8494	1.8792
650 (494.89)	Sh				5.11	55.11	105.11	155.11	205.11	305.11	405.11	505.11	605.11	705.11	805.11	905.11	1005.11
	v	0.02032	0.7084		0.7173	0.7954	0.8634	0.9254	0.9835	1.0929	1.1969	1.2979	1.3969	1.4944	1.5909	1.6864	1.7813
	h	481.89	1202.8		1207.6	1249.6	1285.7	1318.3	1348.7	1406.0	1461.2	1515.9	1570.7	1625.9	1681.6	1738.0	1794.9
	s	1.6828	1.4381		1.4430	1.4858	1.5207	1.5507	1.5775	1.6249	1.6671	1.7059	1.7422	1.7765	1.8092	1.8403	1.8701
700 (503.08)	Sh					46.92	96.92	146.92	196.92	296.92	396.92	496.92	596.92	696.92	796.92	896.92	996.92
	v	0.02050	0.6556			0.7271	0.7928	0.8520	0.9072	1.0102	1.1078	1.2023	1.2948	1.3858	1.4757	1.5647	1.6530
	h	491.60	1201.8			1243.4	1281.0	1314.6	1345.6	1403.7	1459.4	1514.4	1569.4	1624.8	1680.7	1737.2	1794.3
	s	0.6928	1.4304			1.4726	1.5090	1.5399	1.5673	1.6154	1.6580	1.6970	1.7335	1.7679	1.8006	1.8318	1.8617
750 (510.84)	Sh					39.16	89.16	139.16	189.16	289.16	389.16	489.16	589.16	689.16	789.16	889.16	989.16
	v	0.02069	0.6095			0.6676	0.7313	0.7882	0.8409	0.9386	1.0306	1.1195	1.2063	1.2916	1.3759	1.4592	1.5419
	h	500.89	1200.7			1236.9	1276.1	1310.7	1342.5	1401.5	1457.6	1512.9	1568.2	1623.8	1679.8	1736.4	1793.6
	s	0.7022	1.4232			1.4598	1.4977	1.5296	1.5577	1.6065	1.6494	1.6886	1.7252	1.7598	1.7926	1.8239	1.8538
800 (518.21)	Sh					31.79	81.79	131.79	181.79	281.79	381.79	481.79	581.79	681.79	781.79	881.79	981.79
	v	0.02087	0.5690			0.6151	0.6774	0.7323	0.7828	0.8759	0.9631	1.0470	1.1289	1.2093	1.2885	1.3669	1.4446
	h	509.81	1199.4			1230.1	1271.1	1306.8	1339.3	1399.1	1455.8	1511.4	1566.9	1622.7	1678.9	1735.7	1792.9
	s	0.7111	1.4163			1.4472	1.4869	1.5198	1.5484	1.5980	1.6413	1.6807	1.7175	1.7522	1.7851	1.8164	1.8464
850 (525.24)	Sh					24.76	74.76	124.76	174.76	274.76	374.76	474.76	574.76	674.76	774.76	874.76	974.76
	v	0.02105	0.5330			0.5683	0.6296	0.6829	0.7315	0.8205	0.9034	0.9830	1.0606	1.1366	1.2115	1.2855	1.3588
	h	518.40	1198.0			1223.0	1265.9	1302.8	1336.0	1396.8	1454.0	1510.0	1565.7	1621.6	1678.0	1734.9	1792.3
	s	0.7197	1.4096			1.4347	1.4763	1.5102	1.5396	1.5899	1.6336	1.6733	1.7102	1.7450	1.7788	1.8094	1.8395
900 (531.95)	Sh					18.05	68.05	118.05	168.05	268.05	368.05	468.05	568.05	668.05	768.05	868.05	968.05
	v	0.02123	0.5009			0.5263	0.5869	0.6388	0.6858	0.7713	0.8504	0.9262	0.9998	1.0720	1.1430	1.2131	1.2825
	h	526.70	1196.4			1215.5	1260.6	1298.6	1332.7	1394.4	1452.2	1508.5	1564.4	1620.6	1677.1	1734.1	1791.6
	s	0.7279	1.4032			1.4223	1.4659	1.5010	1.5311	1.5827	1.6263	1.6662	1.7033	1.7382	1.7713	1.8028	1.8329

Sh = superheat, F
v = specific volume, cu ft per lb
h = enthalpy, Btu per lb
s = entropy, Btu per F per lb

Table 3. Superheated Steam – *Continued*

Abs Press Lb/Sq In (Sat. Temp)		Sat Water	Sat Steam	Temperature – Degrees Fahrenheit 550	600	650	700	750	800	850	900	1000	1100	1200	1300	1400	1500
950 (538.39)	Sh			11.61	61.61	111.61	161.61	211.61	261.61	311.61	361.61	461.61	561.61	661.61	761.61	861.61	961.61
	v	0.02141	0.4721	0.4883	0.5485	0.5993	0.6449	0.6871	0.7272	0.7656	0.8030	0.8753	0.9455	1.0142	1.0817	1.1484	1.2143
	h	534.74	1194.7	1207.6	1255.1	1294.4	1329.3	1361.5	1392.0	1421.5	1450.3	1507.0	1563.2	1619.5	1676.2	1733.3	1791.0
	s	0.7358	1.3970	1.4098	1.4557	1.4921	1.5228	1.5500	1.5748	1.5977	1.6193	1.6595	1.6967	1.7317	1.7649	1.7965	1.8267
1000 (544.58)	Sh			5.42	55.42	105.42	155.42	205.42	255.42	305.42	355.42	455.42	555.42	655.42	755.42	855.42	955.42
	v	0.02159	0.4460	0.4535	0.5137	0.5636	0.6080	0.6489	0.6875	0.7245	0.7603	0.8295	0.8966	0.9622	1.0266	1.0901	1.1529
	h	542.55	1192.9	1199.3	1249.3	1290.1	1325.9	1358.7	1389.6	1419.4	1448.5	1505.4	1561.9	1618.4	1675.3	1732.5	1790.3
	s	0.7434	1.3910	1.3973	1.4457	1.4833	1.5149	1.5426	1.5677	1.5908	1.6126	1.6530	1.6905	1.7256	1.7589	1.7905	1.8207
1050 (550.53)	Sh				49.47	99.47	149.47	199.47	249.47	299.47	349.47	449.47	549.47	649.47	749.47	849.47	949.47
	v	0.02177	0.4222		0.4821	0.5312	0.5745	0.6142	0.6515	0.6872	0.7216	0.7881	0.8524	0.9151	0.9767	1.0373	1.0973
	h	550.15	1191.0		1243.4	1285.7	1322.4	1355.8	1387.2	1417.3	1446.6	1503.9	1560.7	1617.4	1674.4	1731.8	1789.6
	s	0.7507	1.3851		1.4358	1.4748	1.5072	1.5354	1.5608	1.5842	1.6062	1.6469	1.6845	1.7197	1.7531	1.7848	1.8151
1100 (556.28)	Sh				43.72	93.72	143.72	193.72	243.72	293.72	343.72	443.72	543.72	643.72	743.72	843.72	943.72
	v	0.02195	0.4006		0.4531	0.5017	0.5440	0.5826	0.6188	0.6533	0.6865	0.7505	0.8121	0.8723	0.9313	0.9894	1.0468
	h	557.55	1189.1		1237.3	1281.2	1318.8	1352.9	1384.7	1415.2	1444.7	1502.4	1559.4	1616.3	1673.5	1731.0	1789.0
	s	0.7578	1.3794		1.4259	1.4664	1.4996	1.5284	1.5542	1.5779	1.6000	1.6410	1.6787	1.7141	1.7475	1.7793	1.8097
1150 (561.82)	Sh				39.18	89.18	139.18	189.18	239.18	289.18	339.18	439.18	539.18	639.18	739.18	839.18	939.18
	v	0.02214	0.3807		0.4263	0.4746	0.5162	0.5538	0.5889	0.6223	0.6544	0.7161	0.7754	0.8332	0.8899	0.9456	1.0007
	h	564.78	1187.0		1230.9	1276.6	1315.2	1349.9	1382.2	1413.0	1442.8	1500.9	1558.1	1615.2	1672.6	1730.2	1788.3
	s	0.7647	1.3738		1.4160	1.4582	1.4923	1.5216	1.5478	1.5717	1.5941	1.6353	1.6732	1.7087	1.7422	1.7741	1.8045
1200 (567.19)	Sh				32.81	82.81	132.81	182.81	232.81	282.81	332.81	432.81	532.81	632.81	732.81	832.81	932.81
	v	0.02232	0.3624		0.4016	0.4497	0.4905	0.5273	0.5615	0.5939	0.6250	0.6845	0.7418	0.7974	0.8519	0.9055	0.9584
	h	571.85	1184.8		1224.2	1271.8	1311.5	1346.9	1379.7	1410.8	1440.9	1499.4	1556.9	1614.2	1671.6	1729.4	1787.6
	s	0.7714	1.3683		1.4061	1.4501	1.4851	1.5150	1.5415	1.5658	1.5883	1.6298	1.6679	1.7035	1.7371	1.7691	1.7996
1300 (577.42)	Sh				22.58	72.58	122.58	172.58	222.58	272.58	322.58	422.58	522.58	622.58	722.58	822.58	922.58
	v	0.02269	0.3299		0.3570	0.4052	0.4451	0.4804	0.5129	0.5436	0.5729	0.6287	0.6822	0.7341	0.7847	0.8345	0.8836
	h	585.58	1180.2		1209.9	1261.9	1303.9	1340.8	1374.6	1406.4	1437.1	1496.3	1554.3	1612.0	1669.8	1727.9	1786.3
	s	0.7843	1.3577		1.3860	1.4340	1.4711	1.5022	1.5296	1.5544	1.5773	1.6194	1.6578	1.6937	1.7275	1.7596	1.7902
1400 (587.07)	Sh				12.93	62.93	112.93	162.93	212.93	262.93	312.93	412.93	512.93	612.93	712.93	812.93	912.93
	v	0.02307	0.3018		0.3176	0.3667	0.4059	0.4400	0.4712	0.5004	0.5282	0.5809	0.6311	0.6798	0.7272	0.7737	0.8195
	h	598.83	1175.3		1194.1	1251.4	1296.1	1334.5	1369.3	1402.0	1433.2	1493.2	1551.8	1609.9	1668.0	1726.3	1785.0
	s	0.7966	1.3474		1.3652	1.4181	1.4575	1.4900	1.5182	1.5436	1.5670	1.6096	1.6484	1.6845	1.7185	1.7508	1.7815
1500 (596.20)	Sh				3.80	53.80	103.80	153.80	203.80	253.80	303.80	403.80	503.80	603.80	703.80	803.80	903.80
	v	0.02346	0.2772		0.2820	0.3328	0.3717	0.4049	0.4350	0.4629	0.4894	0.5394	0.5869	0.6327	0.6773	0.7210	0.7639
	h	611.68	1170.1		1176.3	1240.2	1287.9	1328.0	1364.0	1397.4	1429.2	1490.1	1549.2	1607.7	1666.2	1724.8	1783.7
	s	0.8085	1.3373		1.3431	1.4022	1.4443	1.4782	1.5073	1.5333	1.5572	1.6004	1.6395	1.6759	1.7101	1.7425	1.7734
1600 (604.87)	Sh					45.13	95.13	145.13	195.13	245.13	295.13	395.13	495.13	595.13	695.13	795.13	895.13
	v	0.02387	0.2555			0.3026	0.3415	0.3741	0.4032	0.4301	0.4555	0.5031	0.5482	0.5915	0.6336	0.6748	0.7153
	h	624.20	1164.5			1228.3	1279.4	1321.4	1358.5	1392.8	1425.2	1486.9	1546.6	1605.6	1664.3	1723.2	1782.3
	s	0.8199	1.3274			1.3861	1.4312	1.4667	1.4968	1.5235	1.5478	1.5916	1.6312	1.6678	1.7022	1.7347	1.7657
1700 (613.13)	Sh					36.87	86.87	136.87	186.87	236.87	286.87	386.87	486.87	586.87	686.87	786.87	886.87
	v	0.02428	0.2361			0.2754	0.3147	0.3468	0.3751	0.4011	0.4255	0.4711	0.5140	0.5552	0.5951	0.6341	0.6724
	h	636.45	1158.6			1215.3	1270.5	1314.5	1352.9	1388.1	1421.2	1483.8	1544.0	1603.4	1662.5	1721.7	1781.0
	s	0.8309	1.3176			1.3697	1.4183	1.4555	1.4867	1.5140	1.5388	1.5833	1.6232	1.6601	1.6947	1.7274	1.7585
1800 (621.02)	Sh					28.98	78.98	128.98	178.98	228.98	278.98	378.98	478.98	578.98	678.98	778.98	878.98
	v	0.02472	0.2186			0.2505	0.2906	0.3223	0.3500	0.3752	0.3988	0.4426	0.4836	0.5229	0.5609	0.5980	0.6343
	h	648.49	1152.3			1201.2	1261.1	1307.4	1347.2	1383.3	1417.1	1480.6	1541.4	1601.2	1660.7	1720.1	1779.7
	s	0.8417	1.3079			1.3526	1.4054	1.4446	1.4768	1.5049	1.5302	1.5753	1.6156	1.6528	1.6876	1.7204	1.7516
1900 (628.56)	Sh					21.44	71.44	121.44	171.44	221.44	271.44	371.44	471.44	571.44	671.44	771.44	871.44
	v	0.02517	0.2028			0.2274	0.2687	0.3004	0.3275	0.3521	0.3749	0.4171	0.4565	0.4940	0.5303	0.5656	0.6002
	h	660.36	1145.6			1185.7	1251.3	1300.2	1341.4	1378.4	1412.5	1477.4	1538.8	1599.1	1658.8	1718.6	1778.4
	s	0.8522	1.2981			1.3346	1.3925	1.4338	1.4672	1.4960	1.5219	1.5677	1.6084	1.6458	1.6808	1.7138	1.7451
2000 (635.80)	Sh					14.20	64.20	114.20	164.20	214.20	264.20	364.20	464.20	564.20	664.20	764.20	864.20
	v	0.02565	0.1883			0.2056	0.2488	0.2805	0.3072	0.3312	0.3534	0.3942	0.4320	0.4680	0.5027	0.5365	0.5695
	h	672.11	1138.3			1168.3	1240.9	1292.6	1335.4	1373.5	1408.7	1474.1	1536.2	1596.9	1657.0	1717.0	1777.1
	s	0.8625	1.2881			1.3154	1.3794	1.4231	1.4578	1.4874	1.5138	1.5603	1.6014	1.6391	1.6743	1.7075	1.7389
2100 (642.76)	Sh					7.24	57.24	107.24	157.24	207.24	257.24	357.24	457.24	557.24	657.24	757.24	857.24
	v	0.02615	0.1750			0.1847	0.2304	0.2624	0.2888	0.3123	0.3339	0.3734	0.4099	0.4445	0.4778	0.5101	0.5418
	h	683.79	1130.5			1148.5	1229.8	1284.9	1329.3	1368.4	1404.4	1470.9	1533.6	1594.7	1655.2	1715.4	1775.7
	s	0.8727	1.2780			1.2942	1.3661	1.4125	1.4486	1.4790	1.5060	1.5532	1.5948	1.6327	1.6681	1.7014	1.7330
2200 (649.45)	Sh					.55	50.55	100.55	150.55	200.55	250.55	350.55	450.55	550.55	650.55	750.55	850.55
	v	0.02669	0.1627			0.1636	0.2134	0.2458	0.2720	0.2950	0.3161	0.3545	0.3897	0.4231	0.4551	0.4862	0.5165
	h	695.46	1122.2			1123.9	1218.0	1276.8	1323.1	1363.3	1400.0	1467.6	1530.9	1592.5	1653.3	1713.9	1774.4
	s	0.8828	1.2676			1.2691	1.3523	1.4020	1.4395	1.4708	1.4984	1.5463	1.5883	1.6266	1.6622	1.6956	1.7273
2300 (655.89)	Sh						44.11	94.11	144.11	194.11	244.11	344.11	444.11	544.11	644.11	744.11	844.11
	v	0.02727	0.1513				0.1975	0.2305	0.2566	0.2793	0.2999	0.3372	0.3714	0.4035	0.4344	0.4643	0.4935
	h	707.18	1113.2				1206.3	1268.4	1316.7	1358.1	1395.7	1464.2	1528.3	1590.3	1651.5	1712.3	1773.1
	s	0.8929	1.2569				1.3381	1.3914	1.4305	1.4628	1.4910	1.5397	1.5821	1.6207	1.6565	1.6901	1.7219

Sh = superheat, F
v = specific volume, cu ft per lb
h = enthalpy, Btu per lb
s = entropy, Btu per R per lb

Table 3. Superheated Steam – *Continued*

Abs Press Lb/Sq In (Sat Temp)		Sat Water	Sat Steam	700	750	800	850	900	950	1000	1050	1100	1150	1200	1300	1400	1500
2400	Sh			37.89	87.89	137.89	187.89	237.89	287.89	337.89	387.89	437.89	487.89	537.89	637.89	737.89	837.89
(662.11)	v	0.02790	0.1408	0.1824	0.2164	0.2424	0.2648	0.2850	0.3037	0.3214	0.3382	0.3545	0.3703	0.3856	0.4155	0.4443	0.4724
	h	716.95	1103.7	1191.6	1259.7	1310.1	1352.8	1391.2	1426.9	1460.9	1493.7	1525.6	1557.0	1588.1	1649.6	1710.8	1771.8
	s	0.9031	1.2460	1.3232	1.3808	1.4217	1.4549	1.4837	1.5095	1.5332	1.5553	1.5761	1.5959	1.6149	1.6509	1.6847	1.7167
2500	Sh			31.89	81.89	131.89	181.89	231.89	281.89	331.89	381.89	431.89	481.89	531.89	631.89	731.89	831.89
(668.11)	v	0.02859	0.1307	0.1681	0.2032	0.2293	0.2514	0.2712	0.2896	0.3068	0.3232	0.3390	0.3543	0.3692	0.3980	0.4259	0.4529
	h	731.71	1093.3	1176.7	1250.6	1303.4	1347.4	1386.7	1423.1	1457.5	1490.7	1522.9	1554.6	1585.9	1647.8	1709.2	1770.4
	s	0.9139	1.2345	1.3076	1.3701	1.4129	1.4472	1.4766	1.5029	1.5269	1.5492	1.5703	1.5903	1.6094	1.6456	1.6796	1.7116
2600	Sh			26.09	76.09	126.09	176.09	226.09	276.09	326.09	376.09	426.09	476.09	526.09	626.09	726.09	826.09
(673.91)	v	0.02938	0.1211	0.1544	0.1909	0.2171	0.2390	0.2585	0.2765	0.2933	0.3093	0.3247	0.3395	0.3540	0.3819	0.4088	0.4350
	h	744.47	1082.0	1160.2	1241.1	1296.5	1341.9	1382.1	1419.2	1454.1	1487.7	1520.2	1552.2	1583.7	1646.0	1707.7	1769.1
	s	0.9247	1.2225	1.2908	1.3592	1.4042	1.4395	1.4696	1.4964	1.5208	1.5434	1.5646	1.5848	1.6040	1.6405	1.6746	1.7068
2700	Sh			20.47	70.47	120.47	170.47	220.47	270.47	320.47	370.47	420.47	470.47	520.47	620.47	720.47	820.47
(679.53)	v	0.03029	0.1119	0.1411	0.1794	0.2058	0.2275	0.2468	0.2644	0.2809	0.2965	0.3114	0.3259	0.3399	0.3670	0.3931	0.4184
	h	757.34	1069.7	1142.0	1231.1	1289.5	1336.3	1377.5	1415.2	1450.7	1484.6	1517.5	1549.8	1581.5	1644.1	1706.1	1767.8
	s	0.9356	1.2097	1.2727	1.3481	1.3954	1.4319	1.4628	1.4900	1.5148	1.5376	1.5591	1.5794	1.5988	1.6355	1.6697	1.7021
2800	Sh			15.04	65.04	115.04	165.04	215.04	265.04	315.04	365.04	415.04	465.04	515.04	615.04	715.04	815.04
(684.96)	v	0.03134	0.1030	0.1278	0.1685	0.1952	0.2168	0.2358	0.2531	0.2693	0.2845	0.2991	0.3132	0.3268	0.3532	0.3785	0.4030
	h	770.69	1055.8	1121.2	1220.6	1282.2	1330.7	1372.8	1411.2	1447.2	1481.6	1514.8	1547.3	1579.3	1642.2	1704.5	1766.5
	s	0.9468	1.1958	1.2527	1.3368	1.3867	1.4245	1.4561	1.4838	1.5089	1.5321	1.5537	1.5742	1.5938	1.6306	1.6651	1.6975
2900	Sh			9.78	59.78	109.78	159.78	209.78	259.78	309.78	359.78	409.78	459.78	509.78	609.78	709.78	809.78
(690.22)	v	0.03262	0.0942	0.1138	0.1581	0.1853	0.2068	0.2256	0.2427	0.2585	0.2734	0.2877	0.3014	0.3147	0.3403	0.3649	0.3887
	h	785.13	1039.8	1095.3	1209.6	1274.7	1324.9	1368.0	1407.2	1443.7	1478.5	1512.1	1544.9	1577.0	1640.4	1703.0	1765.2
	s	0.9588	1.1803	1.2283	1.3251	1.3780	1.4171	1.4494	1.4777	1.5032	1.5266	1.5485	1.5692	1.5889	1.6259	1.6605	1.6931
3000	Sh			4.67	54.67	104.67	154.67	204.67	254.67	304.67	354.67	404.67	454.67	504.67	604.67	704.67	804.67
(695.33)	v	0.03428	0.0850	0.0982	0.1483	0.1759	0.1975	0.2161	0.2329	0.2484	0.2630	0.2770	0.2904	0.3033	0.3282	0.3522	0.3753
	h	801.84	1020.3	1060.5	1197.9	1267.0	1319.0	1363.2	1403.1	1440.2	1475.4	1509.4	1542.4	1574.8	1638.5	1701.4	1763.8
	s	0.9728	1.1619	1.1966	1.3131	1.3692	1.4097	1.4429	1.4717	1.4976	1.5213	1.5434	1.5642	1.5841	1.6214	1.6561	1.6888
3100	Sh				49.72	99.72	149.72	199.72	249.72	299.72	349.72	399.72	449.72	499.72	599.72	699.72	799.72
(700.28)	v	0.03681	0.0745		0.1389	0.1671	0.1887	0.2071	0.2237	0.2390	0.2533	0.2670	0.2800	0.2927	0.3170	0.3403	0.3628
	h	823.97	993.3		1185.4	1259.1	1313.0	1358.4	1399.0	1436.7	1472.3	1506.6	1539.9	1572.6	1636.7	1699.8	1762.5
	s	0.9914	1.1373		1.3007	1.3604	1.4024	1.4364	1.4658	1.4920	1.5161	1.5384	1.5594	1.5794	1.6169	1.6518	1.6847
3200	Sh				44.92	94.92	144.92	194.92	244.92	294.92	344.92	394.92	444.92	494.92	594.92	694.92	794.92
(705.08)	v	0.04472	0.0566		0.1300	0.1588	0.1804	0.1987	0.2151	0.2301	0.2442	0.2576	0.2704	0.2827	0.3065	0.3291	0.3510
	h	875.54	931.6		1172.3	1250.9	1306.9	1353.4	1394.9	1433.1	1469.2	1503.8	1537.4	1570.3	1634.8	1698.3	1761.2
	s	1.0351	1.0832		1.2877	1.3515	1.3951	1.4300	1.4600	1.4866	1.5110	1.5335	1.5547	1.5749	1.6126	1.6477	1.6806
3300	Sh																
	v				0.1213	0.1510	0.1727	0.1908	0.2070	0.2218	0.2357	0.2488	0.2613	0.2734	0.2966	0.3187	0.3400
	h				1158.2	1242.5	1300.7	1348.4	1390.7	1429.5	1466.1	1501.0	1534.9	1568.1	1632.9	1696.7	1759.9
	s				1.2742	1.3425	1.3879	1.4237	1.4542	1.4813	1.5059	1.5287	1.5501	1.5704	1.6084	1.6436	1.6767
3400	Sh																
	v				0.1129	0.1435	0.1653	0.1834	0.1994	0.2140	0.2276	0.2405	0.2528	0.2646	0.2872	0.3088	0.3296
	h				1143.2	1233.7	1294.3	1343.4	1386.4	1425.9	1462.9	1498.3	1532.4	1565.8	1631.1	1695.1	1758.5
	s				1.2600	1.3334	1.3807	1.4174	1.4486	1.4761	1.5010	1.5240	1.5456	1.5660	1.6042	1.6396	1.6728
3500	Sh																
	v				0.1048	0.1364	0.1583	0.1764	0.1922	0.2066	0.2200	0.2326	0.2447	0.2563	0.2784	0.2995	0.3198
	h				1127.1	1224.6	1287.8	1338.2	1382.2	1422.2	1459.7	1495.5	1529.9	1563.6	1629.2	1693.6	1757.2
	s				1.2450	1.3242	1.3734	1.4112	1.4430	1.4709	1.4962	1.5194	1.5412	1.5618	1.6002	1.6358	1.6691
3600	Sh																
	v				0.0966	0.1296	0.1517	0.1697	0.1854	0.1996	0.2128	0.2252	0.2371	0.2485	0.2702	0.2908	0.3106
	h				1108.6	1215.3	1281.2	1333.0	1377.9	1418.6	1456.5	1492.6	1527.4	1561.3	1627.3	1692.0	1755.9
	s				1.2281	1.3148	1.3662	1.4050	1.4374	1.4658	1.4914	1.5149	1.5369	1.5576	1.5962	1.6320	1.6654
3800	Sh																
	v				0.0799	0.1169	0.1395	0.1574	0.1729	0.1868	0.1996	0.2116	0.2231	0.2340	0.2549	0.2746	0.2936
	h				1064.2	1195.5	1267.6	1322.4	1369.1	1411.2	1450.1	1487.0	1522.4	1556.8	1623.6	1688.9	1753.2
	s				1.1868	1.2955	1.3517	1.3928	1.4265	1.4558	1.4821	1.5061	1.5284	1.5495	1.5886	1.6247	1.6584
4000	Sh																
	v				0.0631	0.1052	0.1284	0.1463	0.1616	0.1752	0.1877	0.1994	0.2105	0.2210	0.2411	0.2601	0.2783
	h				1007.4	1174.3	1253.4	1311.6	1360.2	1403.6	1443.6	1481.3	1517.3	1552.2	1619.8	1685.7	1750.6
	s				1.1396	1.2754	1.3371	1.3807	1.4158	1.4461	1.4730	1.4976	1.5203	1.5417	1.5812	1.6177	1.6516
4200	Sh																
	v				0.0498	0.0945	0.1183	0.1362	0.1513	0.1647	0.1769	0.1883	0.1991	0.2093	0.2287	0.2470	0.2645
	h				950.1	1151.6	1238.6	1300.4	1351.2	1396.0	1437.1	1475.5	1512.2	1547.6	1616.1	1682.6	1748.0
	s				1.0905	1.2544	1.3223	1.3686	1.4053	1.4366	1.4642	1.4893	1.5124	1.5341	1.5742	1.6109	1.6452
4400	Sh																
	v				0.0421	0.0846	0.1090	0.1270	0.1420	0.1552	0.1671	0.1782	0.1887	0.1986	0.2174	0.2351	0.2519
	h				909.5	1127.3	1223.3	1289.0	1342.0	1388.3	1430.4	1469.7	1507.1	1543.0	1612.3	1679.4	1745.3
	s				1.0556	1.2325	1.3073	1.3566	1.3949	1.4272	1.4556	1.4812	1.5048	1.5268	1.5673	1.6044	1.6389

Sh = superheat, F
v = specific volume, cu ft per lb
h = enthalpy, Btu per lb
s = entropy, Btu per R per lb

Table 3. Superheated Steam – *Continued*

Abs Press. Lb/Sq In. (Sat. Temp)		Sat Water	Sat Steam	Temperature – Degrees Fahrenheit 750	800	850	900	950	1000	1050	1100	1150	1200	1250	1300	1400	1500
4600	Sh																
	v			0.0380	0.0751	0.1005	0.1186	0.1335	0.1465	0.1582	0.1691	0.1792	0.1889	0.1982	0.2071	0.2242	0.2404
	h			883.8	1100.0	1207.3	1277.2	1332.6	1380.5	1423.7	1463.9	1501.9	1538.4	1573.8	1608.5	1676.3	1742.7
	s			1.0331	1.2084	1.2922	1.3446	1.3847	1.4181	1.4472	1.4734	1.4974	1.5197	1.5407	1.5607	1.5982	1.6330
4800	Sh																
	v			0.0355	0.0665	0.0927	0.1109	0.1257	0.1385	0.1500	0.1606	0.1706	0.1800	0.1890	0.1977	0.2142	0.2299
	h			866.9	1071.2	1190.7	1265.2	1323.1	1372.6	1417.0	1458.0	1496.7	1533.8	1569.7	1604.7	1673.1	1740.0
	s			1.0180	1.1835	1.2768	1.3327	1.3745	1.4090	1.4390	1.4657	1.4901	1.5128	1.5341	1.5543	1.592	1.6272
5000	Sh																
	v			0.0333	0.0591	0.0855	0.1028	0.1185	0.1312	0.1425	0.1529	0.1626	0.1718	0.1806	0.1890	0.7050	0.2203
	h			854.9	1042.9	1173.6	1252.9	1313.5	1364.6	1410.2	1452.1	1491.5	1529.1	1565.5	1600.9	1670.0	1737.4
	s			1.0070	1.1593	1.2612	1.3207	1.3645	1.4001	1.4309	1.4582	1.4831	1.5061	.5277	1.5481	1.5863	1.6216
5200	Sh																
	v			0.0326	0.0531	0.0789	0.0973	0.1119	0.1244	0.1356	0.1458	0.1553	0.1642	0.1728	0.1810	0.1966	0.2114
	h			845.8	1016.9	1156.0	1240.4	1303.7	1356.6	1403.4	1446.2	1486.3	1524.5	1561.3	1597.2	1666.8	1734.7
	s			0.9985	1.1370	1.2455	1.3088	1.3545	1.3914	1.4229	1.4509	1.4762	1.4995	1.5214	1.5420	1.5806	1.6161
5400	Sh																
	v			0.0317	0.0483	0.0728	0.0912	0.1058	0.1182	0.1292	0.1392	0.1485	0.1572	0.1656	0.1736	0.1888	0.2031
	h			838.5	994.3	1138.1	1227.7	1293.7	1348.4	1396.5	1440.3	1481.1	1519.8	1557.1	1593.4	1663.7	1732.1
	s			0.9915	1.1175	1.2296	1.2969	1.3446	1.3827	1.4151	1.4437	1.4694	1.4931	1.5153	1.5362	1.5750	1.6109
5600	Sh																
	v			0.0309	0.0447	0.0672	0.0856	0.1001	0.1124	0.1232	0.1331	0.1422	0.1508	0.1589	0.1667	0.1815	0.1954
	h			832.4	975.0	1119.9	1214.8	1283.7	1340.2	1389.6	1434.3	1475.9	1515.2	1552.9	1589.6	1660.5	1729.5
	s			0.9855	1.1008	1.2137	1.2850	1.3348	1.3742	1.4075	1.4366	1.4628	1.4869	1.5093	1.5304	1.5697	1.6058
5800	Sh																
	v			0.0303	0.0419	0.0622	0.0805	0.0949	0.1070	0.1177	0.1274	0.1363	0.1447	0.1527	0.1603	0.1747	0.1883
	h			827.3	958.8	1101.6	1201.8	1273.6	1332.0	1382.6	1428.3	1470.6	1510.5	1548.7	1585.8	1657.4	1726.8
	s			0.9803	1.0867	1.1981	1.2732	1.3250	[illegible]	1.3999	1.4297	1.4564	1.4808	1.5035	1.5248	1.5644	1.6008
6000	Sh																
	v			0.0298	0.0397	0.0579	0.0757	0.0900	0.1020	0.1126	0.1221	0.1309	0.1391	0.1469	0.1544	0.1684	0.1817
	h			822.9	945.1	1084.6	1188.8	1263.4	1323.6	1375.7	1422.3	1465.4	1505.9	1544.6	1582.0	1654.2	1724.2
	s			0.9758	1.0746	1.1833	1.2615	1.3154	1.3574	1.3925	1.4229	1.4500	1.4748	1.4978	1.5194	1.5593	1.5962
6500	Sh																
	v			0.0287	0.0358	0.0495	0.0655	0.0793	0.0909	0.1012	0.1104	0.1188	0.1266	0.1340	0.1411	0.1544	0.1669
	h			813.9	919.5	1046.7	1156.3	1237.8	1302.7	1358.1	1407.3	1452.2	1494.2	1534.1	1572.5	1646.4	1717.6
	s			0.9661	1.0515	1.1506	1.2328	1.2917	1.3370	1.3743	1.4064	1.4347	1.4604	1.4841	1.5062	1.5471	1.5844
7000	Sh																
	v			0.0279	0.0334	0.0438	0.0573	0.0704	0.0816	0.0915	0.1004	0.1085	0.1160	0.1231	0.1298	0.1424	0.1542
	h			806.9	901.8	1016.5	1124.9	1212.6	1281.7	1340.5	1392.2	1439.1	1482.6	1523.7	1563.1	1638.6	1711.1
	s			0.9582	1.0350	1.1243	1.2055	1.2689	1.3171	1.3567	1.3904	1.4200	1.4466	1.4710	1.4938	1.5355	1.5735
7500	Sh																
	v			0.0272	0.0318	0.0399	0.0512	0.0631	0.0737	0.0833	0.0918	0.0996	0.1068	0.1136	0.1200	0.1321	0.1433
	h			801.3	889.0	992.9	1097.7	1188.3	1261.0	1322.9	1377.2	1426.0	1471.0	1513.3	1553.7	1630.8	1704.6
	s			0.9514	1.0224	1.1033	1.1818	1.2473	1.2980	1.3397	1.3751	1.4059	1.4335	1.4586	1.4819	1.5245	1.5632
8000	Sh																
	v			0.0267	0.0306	0.0371	0.0465	0.0571	0.0671	0.0762	0.0845	0.0920	0.0989	0.1054	0.1115	0.1230	0.1338
	h			796.6	879.1	974.4	1074.3	1165.4	1241.0	1305.5	1362.2	1413.7	1459.6	1503.1	1544.5	1623.1	1698.1
	s			0.9455	1.0122	1.0864	1.1613	1.2271	1.2798	1.3233	1.3603	1.3924	1.4208	1.4467	1.4705	1.5140	1.5533
8500	Sh																
	v			0.0262	0.0296	0.0350	0.0429	0.0522	0.0615	0.0701	0.0780	0.0853	0.0919	0.0982	0.1041	0.1151	0.1254
	h			792.7	871.2	959.8	1054.5	1144.0	1221.9	1288.5	1347.5	1400.2	1448.2	1492.9	1525.3	1615.4	1691.7
	s			0.9402	1.0037	1.0727	1.1437	1.2084	1.2627	1.3076	1.3460	1.3793	1.4087	1.4352	1.4597	1.5040	1.5439
9000	Sh																
	v			0.0258	0.0288	0.0335	0.0402	0.0483	0.0568	0.0649	0.0724	0.0794	0.0858	0.0918	0.0975	0.1081	0.1179
	h			789.3	864.7	948.0	1037.6	1125.4	1204.1	1272.1	1333.0	1387.5	1437.1	1482.9	1526.3	1607.9	1685.3
	s			0.9354	0.9964	1.0613	1.1285	1.1918	1.2468	1.2926	1.3323	1.3667	1.3970	1.4243	1.4492	1.4944	1.5349
9500	Sh																
	v			0.0254	0.0282	0.0327	0.0380	0.0451	0.0529	0.0603	0.0675	0.0742	0.0804	0.0862	0.0917	0.1019	0.1113
	h			786.4	859.2	938.3	1023.4	1108.9	1187.7	1256.6	1318.9	1375.1	1426.1	1473.1	1517.3	1600.4	1679.0
	s			0.9310	0.9900	1.0516	1.1153	1.1771	1.2320	1.2785	1.3191	1.3546	1.3858	1.4137	1.4392	1.4851	1.5263
10000	Sh																
	v			0.0251	0.0276	0.0312	0.0362	0.0425	0.0495	0.0565	0.0633	0.0697	0.0757	0.0812	0.0865	0.0963	0.1054
	h			783.8	854.5	930.2	1011.3	1094.2	1172.6	1242.0	1305.3	1362.5	1415.2	1463.4	1508.6	1593.1	1672.8
	s			0.9270	0.9842	1.0432	1.1039	1.1638	1.2185	1.2652	1.3065	1.3429	1.3749	1.4035	1.4295	1.4763	1.5180
10500	Sh																
	v			0.0248	0.0271	0.0303	0.0347	0.0404	0.0467	0.0532	0.0595	0.0656	0.0714	0.0768	0.0818	0.0913	0.1001
	h			781.5	850.5	923.4	1001.0	1081.3	1158.9	1228.4	1292.4	1351.1	1404.7	1453.9	1500.0	1585.8	1666.7
	s			0.9232	0.9790	1.0358	1.0939	1.1519	1.2060	1.2529	1.2946	1.3371	1.3644	1.3937	1.4202	1.4677	1.5100

Sh = superheat, F
v = specific volume, cu ft per lb

h = enthalpy, Btu per lb
s = entropy, Btu per F per lb

Table 3. Superheated Steam – *Continued*

Abs Press Lb/Sq In (Sat. Temp)		Sat Water	Sat Steam	Temperature – Degrees Fahrenheit 750	800	850	900	950	1000	1050	1100	1150	1200	1250	1300	1400	1500
11000	v			0.0245	0.0267	0.0296	0.0335	0.0386	0.0443	0.0503	0.0562	0.0620	0.0676	0.0727	0.0776	0.0868	0.0952
	h			779.5	846.9	917.5	992.1	1069.9	1146.3	1215.9	1280.2	1339.7	1394.4	1444.6	1491.5	1578.7	1666.6
	s			0.9196	0.9742	1.0292	1.0851	1.1412	1.1945	1.2414	1.2833	1.3209	1.3544	1.3842	1.4112	1.4595	1.5023
11500	v			0.0243	0.0263	0.0290	0.0325	0.0370	0.0423	0.0478	0.0534	0.0588	0.0641	0.0691	0.0739	0.0827	0.0909
	h			777.7	843.8	912.4	984.5	1059.8	1134.9	1204.3	1268.7	1328.8	1384.4	1435.5	1483.2	1571.8	1654.7
	s			0.9163	0.9698	1.0232	1.0772	1.1316	1.1840	1.2308	1.2727	1.3107	1.3446	1.3750	1.4025	1.4515	1.4949
12000	v			0.0241	0.0260	0.0284	0.0317	0.0357	0.0405	0.0456	0.0508	0.0560	0.0610	0.0659	0.0704	0.0790	0.0869
	h			776.1	841.0	907.9	977.8	1050.9	1124.5	1193.7	1258.0	1318.5	1374.7	1426.6	1475.1	1564.9	1648.8
	s			0.9131	0.9657	1.0177	1.0701	1.1229	1.1742	1.2209	1.2627	1.3010	1.3353	1.3662	1.3941	1.4438	1.4877
12500	v			0.0238	0.0256	0.0279	0.0305	0.0346	0.0390	0.0437	0.0486	0.0535	0.0583	0.0629	0.0673	0.0756	0.0832
	h			774.7	838.6	903.9	971.9	1043.1	1115.2	1184.1	1247.9	1308.8	1365.4	1418.0	1467.2	1558.2	1643.1
	s			0.9101	0.9618	1.0127	1.0637	1.1151	1.1653	1.2117	1.2534	1.2916	1.3264	1.3576	1.3860	1.4363	1.4808
13000	v			0.0236	0.0253	0.0275	0.0302	0.0336	0.0376	0.0420	0.0466	0.0512	0.0558	0.0602	0.0645	0.0725	0.0799
	h			773.5	836.3	900.4	966.8	1036.2	1106.7	1174.8	1238.5	1299.6	1356.5	1409.6	1459.4	1551.6	1637.4
	s			0.9073	0.9582	1.0080	1.0578	1.1079	1.1571	1.2030	1.2445	1.2831	1.3179	1.3494	1.3781	1.4291	1.4741
13500	v			0.0235	0.0251	0.0271	0.0297	0.0328	0.0364	0.0405	0.0448	0.0492	0.0535	0.0577	0.0619	0.0696	0.0768
	h			772.3	834.4	897.2	962.2	1030.0	1099.1	1166.3	1229.7	1291.0	1348.1	1401.5	1451.8	1545.2	1631.9
	s			0.9045	0.9548	1.0037	1.0524	1.1014	1.1495	1.1948	1.2361	1.2749	1.3098	1.3415	1.3705	1.4221	1.4675
14000	v			0.0233	0.0248	0.0267	0.0291	0.0320	0.0354	0.0392	0.0432	0.0474	0.0515	0.0555	0.0595	0.0670	0.0740
	h			771.3	832.6	894.3	958.0	1024.5	1092.3	1158.5	1221.4	1283.0	1340.2	1393.8	1444.4	1538.8	1626.5
	s			0.9019	0.9515	0.9996	1.0473	1.0953	1.1426	1.1872	1.2282	1.2671	1.3021	1.3339	1.3631	1.4153	1.4612
14500	v			0.0231	0.0246	0.0264	0.0287	0.0314	0.0345	0.0380	0.0418	0.0458	0.0496	0.0534	0.0573	0.0646	0.0714
	h			770.4	831.0	891.7	954.3	1019.6	1086.2	1151.4	1213.8	1275.4	1332.9	1386.4	1437.3	1532.6	1621.1
	s			0.8994	0.9484	0.9957	1.0426	1.0897	1.1362	1.1801	1.2208	1.2597	1.2949	1.3266	1.3560	1.4087	1.4551
15000	v			0.0230	0.0244	0.0261	0.0282	0.0308	0.0337	0.0365	0.0405	0.0443	0.0479	0.0516	0.0552	0.0624	0.0690
	h			769.6	829.5	889.3	950.9	1015.1	1080.6	1144.9	1206.8	1268.1	1326.0	1379.4	1430.3	1526.4	1615.9
	s			0.8970	0.9455	0.9920	1.0382	1.0846	1.1302	1.1735	1.2139	1.2525	1.2880	1.3197	1.3491	1.4022	1.4491
15500	v			0.0228	0.0242	0.0258	0.0278	0.0302	0.0329	0.0360	0.0393	0.0429	0.0464	0.0499	0.0534	0.0603	0.0668
	h			768.9	828.2	887.2	947.8	1011.1	1075.7	1139.0	1200.3	1261.1	1319.6	1372.8	1423.6	1520.4	1610.8
	s			0.8946	0.9427	0.9886	1.0340	1.0797	1.1247	1.1674	1.2073	1.2457	1.2815	1.3131	1.3424	1.3959	1.4433

Sh = superheat, F
v = specific volume, cu ft per lb
h = enthalpy, Btu per lb
s = entropy, Btu per R per lb

SECTION ONE

Principles of Nuclear Power Plant Operation
Thermodynamics, Heat Transfer, and Fluid Flow

*Question
1.01 (1.0)

Multiple Choice (Select the correct response.)

The Required Net Positive Suction Head ($NPSH_R$) of a pump is the minimum suction head required to prevent cavitation in a pump.

Which of the following conditions will cause $NPSH_R$ for the main feedwater pump to increase?

a. Decreasing main feedwater pump turbine speed.

b. Increasing condensate system pressure.

c. Increasing main feedwater pump discharge flow.

d. Decreasing condensate system temperature.

*ANSWER
1.01 (1.0)

c.

*Thermal-Hydraulic Principles and applications Chapter 10, Pages 10-55 to 10-61.
191004K115

*QUESTION
1.02 (1.0)

Multiple Choice (Select the correct response.)

One of the steam generator safety valves has lifted at a steam generator pressure of 1040 psig. Use the steam tables provided.

What will be the temperature of the steam when it reaches atmospheric pressure?

a. 551 ^{o}F

b. 549 ^{o}F

c. 305 ^{o}F

d. 296 ^{o}F

*ANSWER
1.02 (1.0)

c or d

*REFERENCE
Thermal-Hydraulic Principles and Applications, Chapter 2.
KSA 193004K115

*QUESTION
1.03 (1.0)

Multiple Choice (Select the correct response.)

A centrifugal pump is being driven by a two (2) speed motor. The pumps speeds are 1200 and 1800 RPM.

By what factor will the pump head change if the pump speed is increased from 1200 to 1800 RPM?

a. Pump head will increase by a factor of 1.5.

b. Pump head will increase by a factor of 0.67.

c. Pump head will increase by a factor of 0.45.

d. Pump head will increase by a factor of 2.25.

*ANSWER
1.03 (1.0)

d.

*REFERENCE
Thermal-Hydraulic Principles and Applications Chapter 10, Pages 10-37, -38, -39.

191004K115

*QUESTION
1.04 (1.0)

Multiple Choice (Select the correct response.)

A centrifugal pump is being driven by two (2) speed motor. The pump speeds are 1200 and 1800 RPM.

By what factor will power change if the speed of a two (2) speed motor is reduced from 1800 RPM to 1200 RPM?

a. Power will decrease by a factor of 0.30.

b. Power will increase by a factor of 0.30.

c. Power will decrease by a factor of 0.44.

d. Power will increase by a factor of 0.44.

*ANSWER

1.04 (1.0)

a.

*REFERENCE
Thermal-Hydraulic Principles and Applications Chapter 10, Pages 10-37, -38, -39.

191004K115

*QUESTION
1.05 (1.0)

Multiple Choice (Select the correct response.)

Which one of the following conditions will cause the Available Net Positive Suction Head ($NPSH_A$) of a centrifugal pump to increase?

a. Decreasing the level of the storage tank being filled.

b. Decreasing the level of the storage tank being pumped from.

c. Increasing the flow rate by opening the discharge valve.

d. Decreasing the temperature of the fluid being pumped.

*ANSWER
1.05 (1.0)

d.

*REFERENCE
Thermal-Hydraulic Principles and Applications Chapter 10, Pages 10-54 through 10-61.

191004K115

*QUESTION
1.06 (2.0)

Unit 1 is operating with all steam generator pressures at 785 psig, a feedwater temperature of 432°F and a total feedwater flow rate of 1.45×10^7 lbm/hr. Rated thermal power for unit 1 is 3338 Mwt. Using the steam tables and the Mollier diagram answer the following questions. Without considering blowdown:

What is the actual percent power of Unit 1 with the secondary plant conditions stated above? (2.0)

*ANSWER
1.06 (2.0)

a. $Q = \dot{m} \Delta h$, $[Q = \dot{m} (h_{steam} - h_{feedwater})]$ (0.5)

$h_{steam\ (800\ psia)}$ = 1199.4 BTU/LBM, (0.25)

$h_{feedwater\ (432^oF)}$ = 410.1 BTU/LBM (0.25)

Q = 1.45×10^7 LBM/HR (1199.4 BTU/LBM - 410.1 BTU/LBM) (0.25)

Q = 1.45×10^7 LBM/HR (789.3 BTU/LBM)

Q = 1.144×10^{10} BTU/HR (0.15)

Mw = 1.144×10^{10} BTU/HR (1Mw / 3.41×10^6 BTU/HR) (0.25)

Mw = 3356.3 Mw (0.1)

3356.3 Mw / 3338 Mw = 1.005 or 101% +/- 2% (0.25)

*REFERENCE
Thermal-Hydraulic Principles and Applications, Chapters 2 and 12.

193007K108

*QUESTION
1.07 (2.0)

Matching

The attached figure 1.07 is a simplified temperature - entropy diagram of the Diablo Canyon Power Plant steam cycle. The numbered points on the figure are parts of the steam cycle which identify a change in phase or the condition of the process fluid, steam or water.

Match each System/Component action (a through d) with its correct number range Choice, given below, that corresponds with its associated cycle process identified on figure 1.07.

(0.5 points for each correct choice.)

System/Component Action:	Matching Response	Choices
a. Work out LP Turbine	________________	1 to 2 2 to 3 3 to 4 4 to 5 5 to 6 6 to 7 7 to 8
b. Reheater Superheating	________________	
c. Vaporization in Steam Generator	________________	
d. Condensing	________________	

*ANSWER
1.07 (2.0) (0.5 points each maximum 2.0 points)

a. 7 to 8

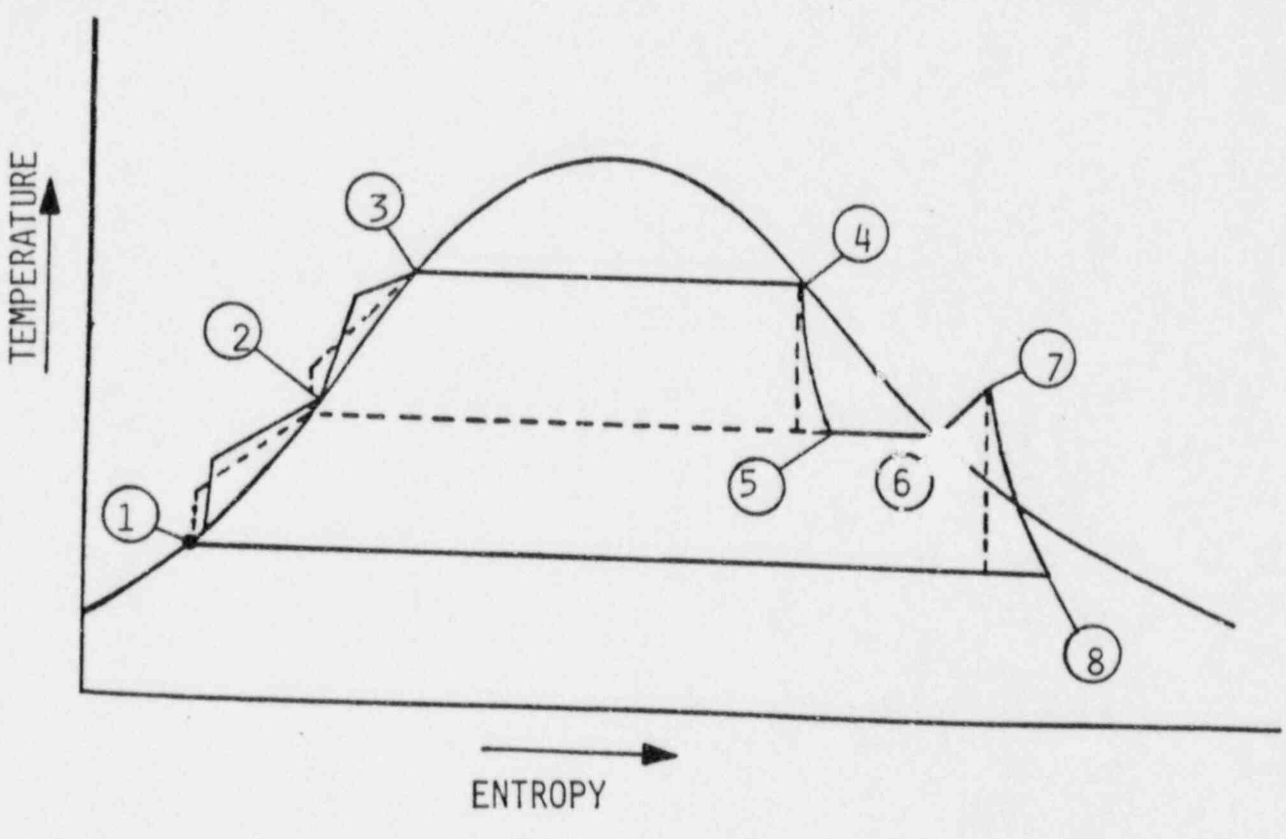
b. 6 to 7

c. 3 to 4

d. 8 to 1

*Reference
Thermal-Hydraulic Principles and Applications, Chapter 7, Page 7-91.
193008K101

FIGURE 1.07



*QUESTION
1.08 (1.5)

Multiple Choice (Select the correct response.)

Delayed neutrons are less than one percent (1%) of all fission neutrons, but are significant in operating and controlling a reactor.

Which of the following statements correctly describes the average delayed neutron fraction cause and effect on reactor operations with respect to core life?

a. The average delayed neutron fraction decreases over core life causing reactor transients to be faster at the end of core life.

b. The average delayed neutron fraction decreases over core life causing reactor transients to be slower at the end of core life.

c. The average delayed neutron fraction increases over core life causing reactor transients to be faster at the end of core life.

d. The average delayed neutron fraction increases over core life causing reactor transients to be slower at the end of core life.

*ANSWER
1.08 (1.5)

a.

*Reference
Fundamentals of Nuclear Reactor Physics, Chapter 7, Pgs. 7-5 through 7-38.
192003K107

*QUESTION
1.09 (1.0)

Multiple Choice (Select the correct response.)

The count rate of a reactor that has no fuel in it is 150 counts per minute. After adding 10 fuel assemblies the count rate increases to 600 counts per minute.

What is the multiplication factor (Keff) for the count rate increase?

a. 0.25

b. 0.30

c. 0.65

d. 0.75

*ANSWER
1.09 (1.0)

d. (Keff = 1 - C_o / $C_{(10)}$, 1 - 150/600 = 0.75)

*REFERENCE
Fundamentals of Nuclear Reactor Physics, Chapter 8, Pgs. 8-18 through 8-28.

192003K102

*QUESTION
1.10 (1.0)

Multiple Choice (Select the correct response.)

The secondary neutron source is used as the only installed neutron source after the initial fuel cycle.

What statement below DOES NOT correctly state the purpose of installed neutron source assemblies?

a. To provide a base neutron level to insure an orderly and controlled approach to criticality.

b. Used to check radiation monitors on the refueling floor during refueling operations.

c. To provide a means to monitor reactivity changes in the core when the reactor is shutdown.

d. To provide for verification of the proper operation of nuclear instrumentation.

*ANSWER
1.10 (1.0)

b.

*REFERENCE
Fundamentals of Nuclear Reactor Physics, Chapter 8, Pgs. 8-3 through 8-12.

192003K111

*QUESTION
1.11 (1.0)

Multiple Choice (select the correct response.)

The Doppler temperature coefficient is the rate at which reactivity changes with fuel temperature.

Which of the following factors would be the predominate reason for the Doppler Temperature Coefficient becoming LESS NEGATIVE over core life?

a. The half life of samarium and its buildup in the core.

b. The decrease in boron concentration over the life of the core.

c. The increasing strength of the installed neutron sources under power conditions.

d. The effect of fuel cladding creep which causes the fuel clad gap to decrease.

*ANSWER
1.11 (1.0)

d.

*REFERENCE
Reactor Core Control, Chapter 2, Pgs. 2-40 through 2-46.

*QUESTION
1.12 (1.5)

Multiple Choice (Select the correct response.)

How much reactivity (in pcm) must be added to the Unit 1 reactor if it is just critical at 10^{-8} amps and you are to take it to 3% power at a startup rate of 0.75 DPM.

$Beta_{eff}(\beta) = 0.007$, Lamda (λ) = $0.1 \ sec^{-1}$,

$\ell^* = 2x10^{-5}$ sec.

a. 0.156 pcm

b. 1.56 pcm

c. 15.6 pcm

d. 156 pcm

*ANSWER
1.12 (1.5)

d.

(T = 26.06/SUR = 26.06/0.75 = 34.75,

$p = \ell^*/T + Beta_{eff} / 1 + Lamda \times T$

$p = 2x10^{-5}/34.75 + .007/ 1 + 0.1 \times 34.75$

$p = 0.00156 \ \Delta K/K$

p = 156 pcm)

*Reference
Reactor Core Control, Chapter 6, Pgs. 6-3 through 6-19.

001000K547

*QUESTION
1.13 (1.5)

Multiple Choice (Select the correct response.)

The Unit 2 reactor is shutdown (mode 4) by a calculated -4.75% ΔK/K. All rod control cluster assemblies (RCCA's) are fully inserted.

What is Keff for the Unit 2 reactor when it is shutdown by -4.75% ΔK/K?

a. 0.83

b. 0.95

c. 0.97

d. 0.98

*ANSWER
1.13 (1.5)

b.

(Δ K/K = -4.75 = Keff - 1 / Keff

1 = Keff + 0.0475 Keff

Keff = 0.95)

*Reference
Fundamentals of Nuclear Reactor Physics, Chapter 7.

001000K508

*QUESTION
1.14 (1.0)

Multiple Choice (Select the correct response.)

The unit 1 reactor is shutdown by -4% Δ K/K, with all RCCA's fully inserted. The most reactive RCCA is worth 2% Δ K/K.

What is the shutdown margin of the reactor in % Δ K/K?

a. 1.6% Δ K/K

b. 2.0% Δ K/K

c. 2.4% Δ K/K

d. 4.0% Δ K/K

*ANSWER
1.14 (1.0)

b.

(4% Δ K/K - 2% Δ K/K = 2% Δ K/K)

*Reference
Technical Specification 3/4.1.1, Pg. 3/4 1-1. Reactor Core Control, Chapter 7, Pgs. 7-21 - 7-23.

192002K113

*QUESTION
1.15 (1.0)

Multiple Choice (Select the correct response.)

Which of the following statements concerning Axial Flux Difference (AFD) is correct?

a. When power is distributed equally throughout the core the AFD is equal to one (1).

b. When AFD is negative more power is being produced in the top of the core.

c. As power level increases cooler water enters the bottom of the core causing the AFD to be more negative.

d. At beginning of core life (BOL) axial power distribution peaks in the top of the core making AFD more negative.

*ANSWER
1.15 (1.0)

c.

*REFERENCE
Reactor Core Control, Chapter 8, Pgs. 8-25 through 8-29.

001000K553

*QUESTION
1.16 (0.5)

True or False

At the end of core life the Doppler coefficient becomes less negative due to the increased absorption of neutrons by Plutonium 240.

*ANSWER
1.16 (0.5)

False

*Reference
Reactor Core Control, Chapter 2, Pgs. 23 through 30.
001000K549

*QUESTION
1.17 (1.5)

Multiple Choice (Select the correct response.)

Figure 1.17 is an illustration of the behavior of Xenon as a result of step power changes in a reactor.

Which of the following statements correctly describes the reason the Xenon concentration decreases at point A on figure 1.17?

a. The xenon poison build-in is from increased neutron absorbtion rate at increased higher power levels and a decrease in the production of iodine.

b. The xenon poison burn-out is from the decreased neutron absorbtion rate at increased higher power levels and a decrease in the production of iodine.

c. The xenon poison build-in is from the slow decrease in the production of iodine and the build-in of xenon directly from increasing neutron flux.

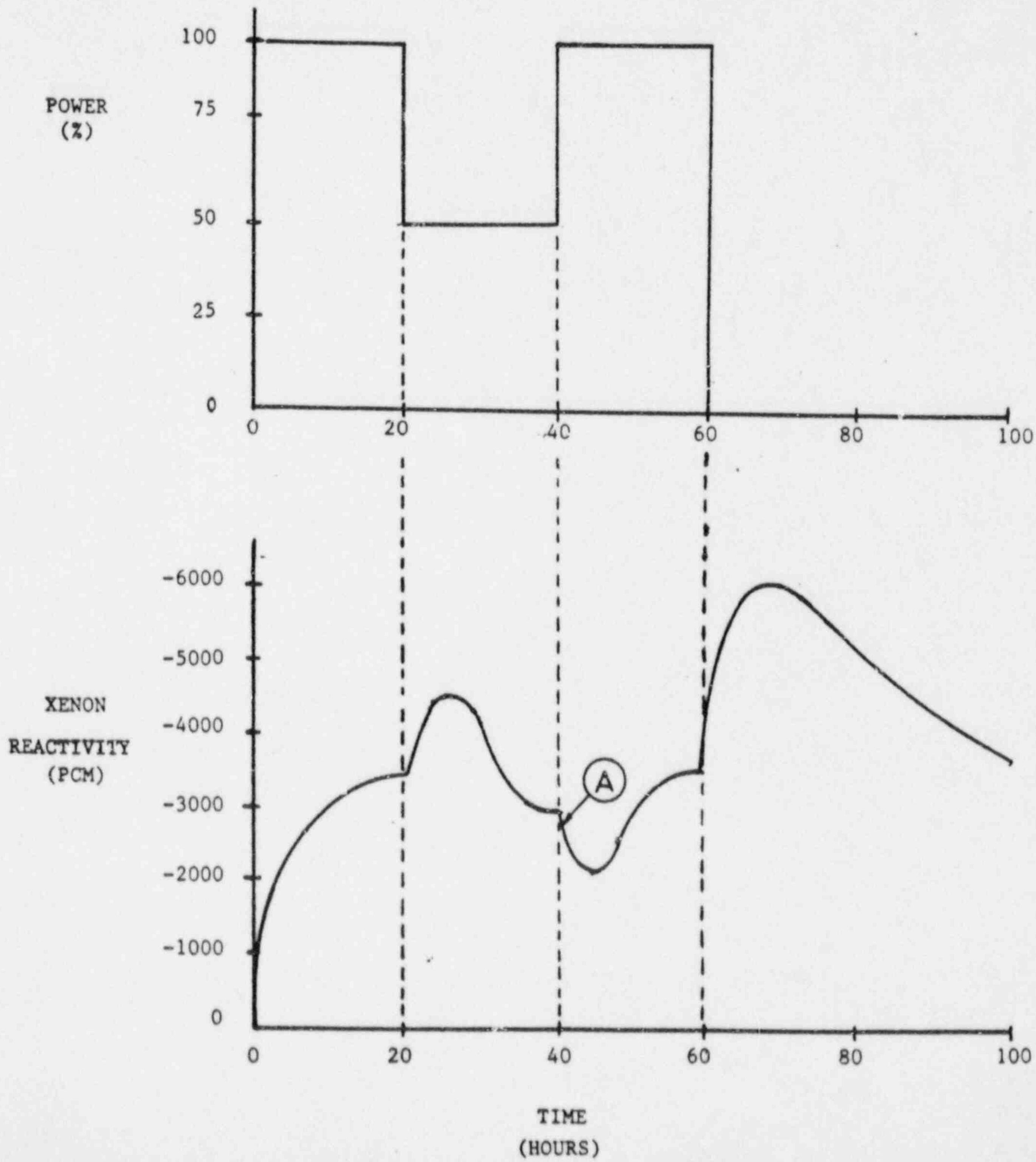
d. The xenon poison burn-out is from the slow increase in the production of iodine and the burn-out rate of xenon directly from neutron flux.

*ANSWER
1.17 (1.5)

d.

*Reference
Reactor Core Control, Chapter 4, Pgs. 4-20 through 4-27.
192006K106

FIGURE 1.17



POWER
(%)
100
75
50
25
0
0
20
40
60
80
100
XENON
REACTIVITY
(PCM)
-6000
-5000
-4000
-3000
-2000
-1000
0
A
0
20
40
60
80
100
TIME
(HOURS)

*QUESTION
1.18 (1.5)

Diesel generator 1-1 is operating in manual and is paralleled to the grid on Bus H for testing.

Which of the following statements correctly describes the response of control board indications if you lower the voltage control switch?

a. Line voltage increases, VARS increase, and out-put frequency decreases.

b. Line voltage decreases, VARS decrease, and out-put frequency increases.

c. Line voltage remains constant, VARS decrease, and out-put frequency remains constant.

d. Line voltage remains constant, VARS increase, and out-put frequency remains constant.

*ANSWER
1.18 (1.5)

c or d

*Reference
DCPP System Description J-6B, Diesel Generators, Pg. 52 and DCPP OP-J6B: IV.
191005K107

*QUESTION
1.19 (2.0)

Multiple Choice (Select the correct response.)

The Unit 2 reactor is operating at 80% power, BOL, boron concentration of 1500 ppm. Assume no Xenon effects and 10 pcm/ppm worth for boron.

What is the volume of 12% boric acid required to reduce power from 80% to 40% without changing control rod positions? Use attached figures 1.19-1, and 1.19-2.

a. 140 gallons

b. 120 gallons

c. 100 gallons

d. 75 gallons

*ANSWER
1.19 (2.0)

a or b

*Reference
DCPP OP-L4 Power Change Worksheet Pgs. 1 and 2 of 2. DCPP Volume 9, Curves and Miscellaneous Data.
004000K506

FIGURE 1.19-1

2
UNIT

TOTAL POWER DEFECT AS A FUNCTION OF POWER LEVEL AT BOL
CYCLE 2 FOR BURNUP 0-5000 MWD/MTU

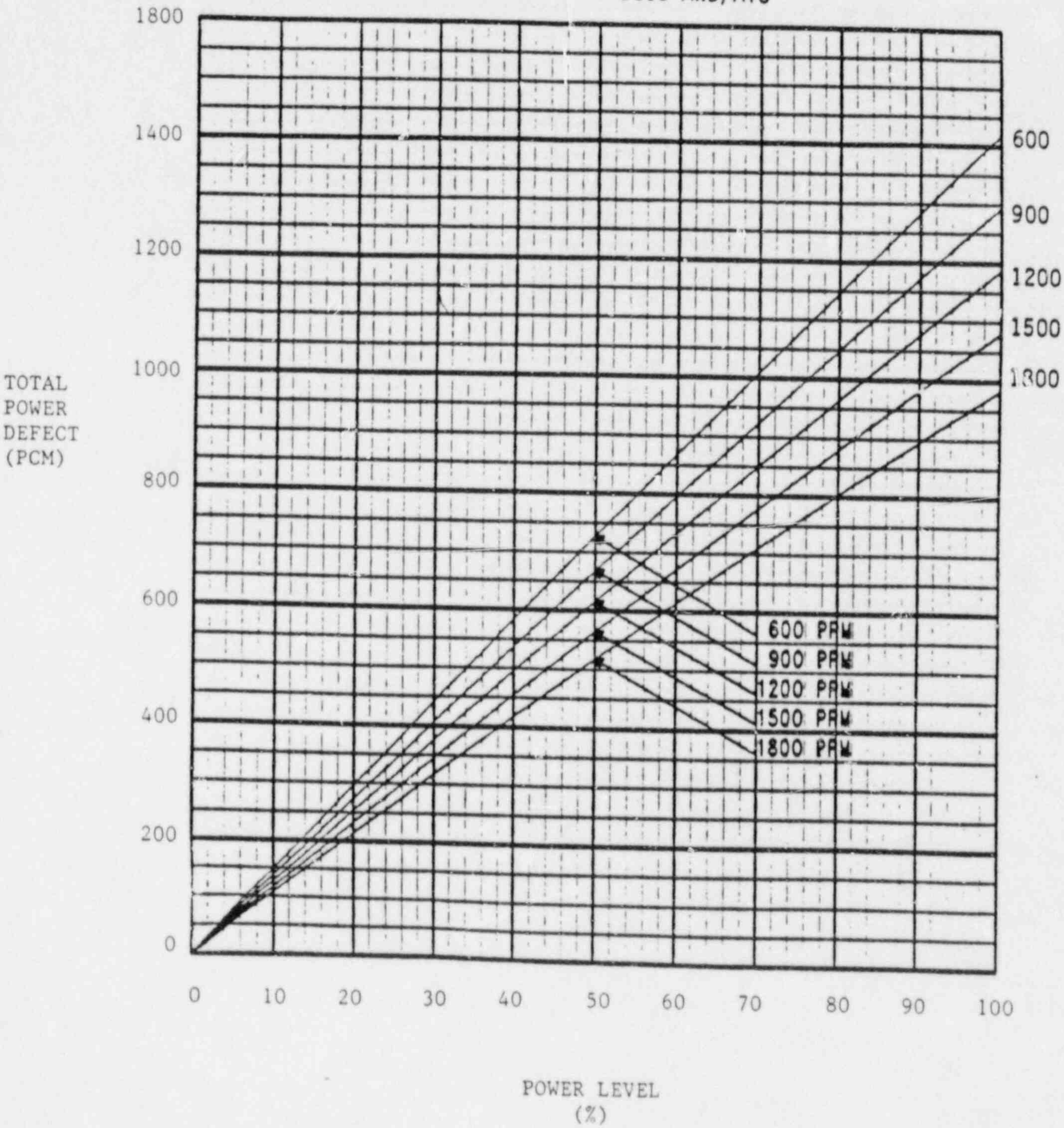
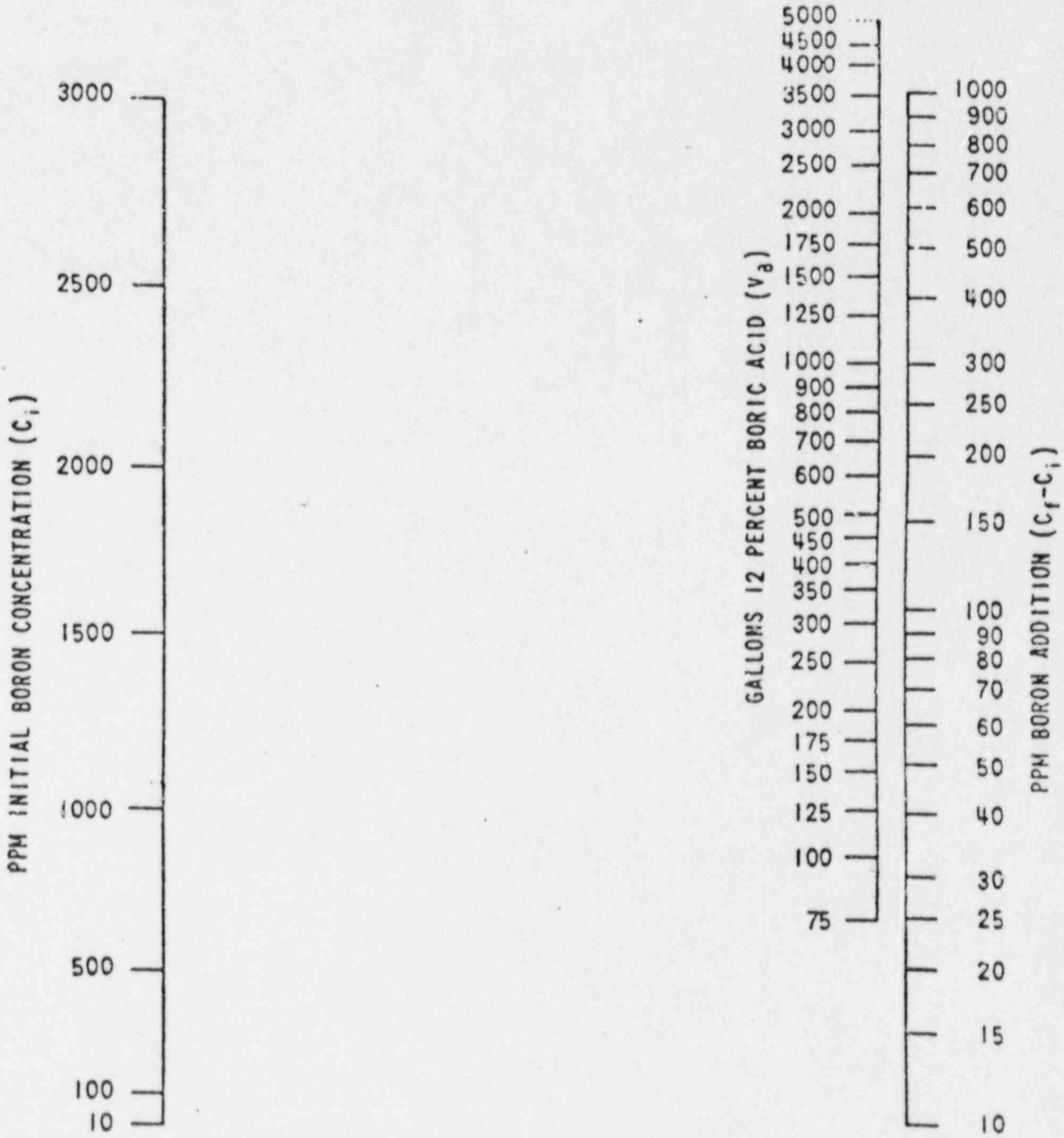


FIGURE 1.19-2

BORATION NOMOGRAPHS

BORON ADDITION



*QUESTION
1.20 (1.0)

Multiple Choice (Select the correct response.)

Which of the following statements correctly describes the results of placing the cation demineralizer in the Chemical and Volume Control System (CVCS) in service?

a. The cation demineralizer adds lithium lithium to the reactor coolant to increase pH.

b. The cation demineralizer removes lithium from the reactor coolant to increase pH.

c. The cation demineralizer adds lithium and reduces pH in the reactor coolant.

d. The cation demineralizer removes lithium and reduces the pH of the reactor coolant.

*ANSWER
1.20 (1.0)

d.

*Reference
DCPP System Description B-1a, Chemical and Volume Control System, Pgs. 23 and 24.
004020K501

END OF SECTION ONE

CONTINUE ONTO SECTION TWO

SECTION TWO
PLANT DESIGN, INCLUDING SAFETY AND EMERGENCY SYSTEMS

*QUESTION
2.01 (2.5)

Matching

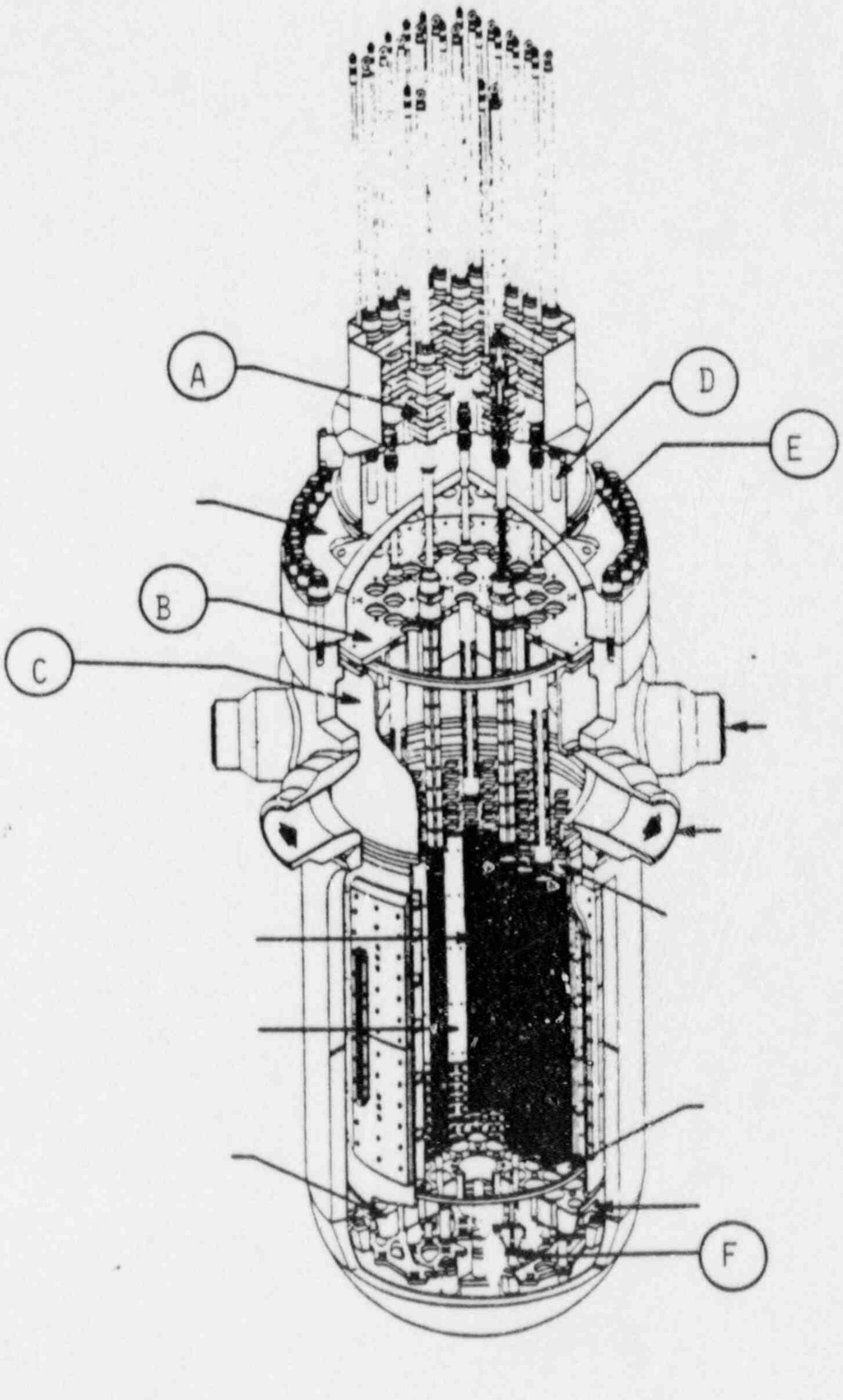
Item "C" DELETED.
For the parts labeled A through F on Figure 2.01 correctly match the letter (A through F) with the list of component names given below. (0.5 pts. each maximum 2.5 points.)

Part Name	Matching Letter
1. Instrumentation thimble guides (neutron detector).	______
2. Bottom Support Forging.	______
3. Lower Core Plate.	______
4. Upper Core Plate.	______
5. Outlet Nozzle.	______
6. Inlet Nozzle.	______
7. Rod Cluster Control Guide Tube.	______
8. Thermal Sleeve.	______
9. Control Rod Drive Mechanism.	______
10. Closure Head Assembly.	______
11. Upper Support Plate.	______
12. Core Plate.	______
13. Fuel Assemblies.	______
14. Baffle.	______
15. Lower Core Support Plate.	______

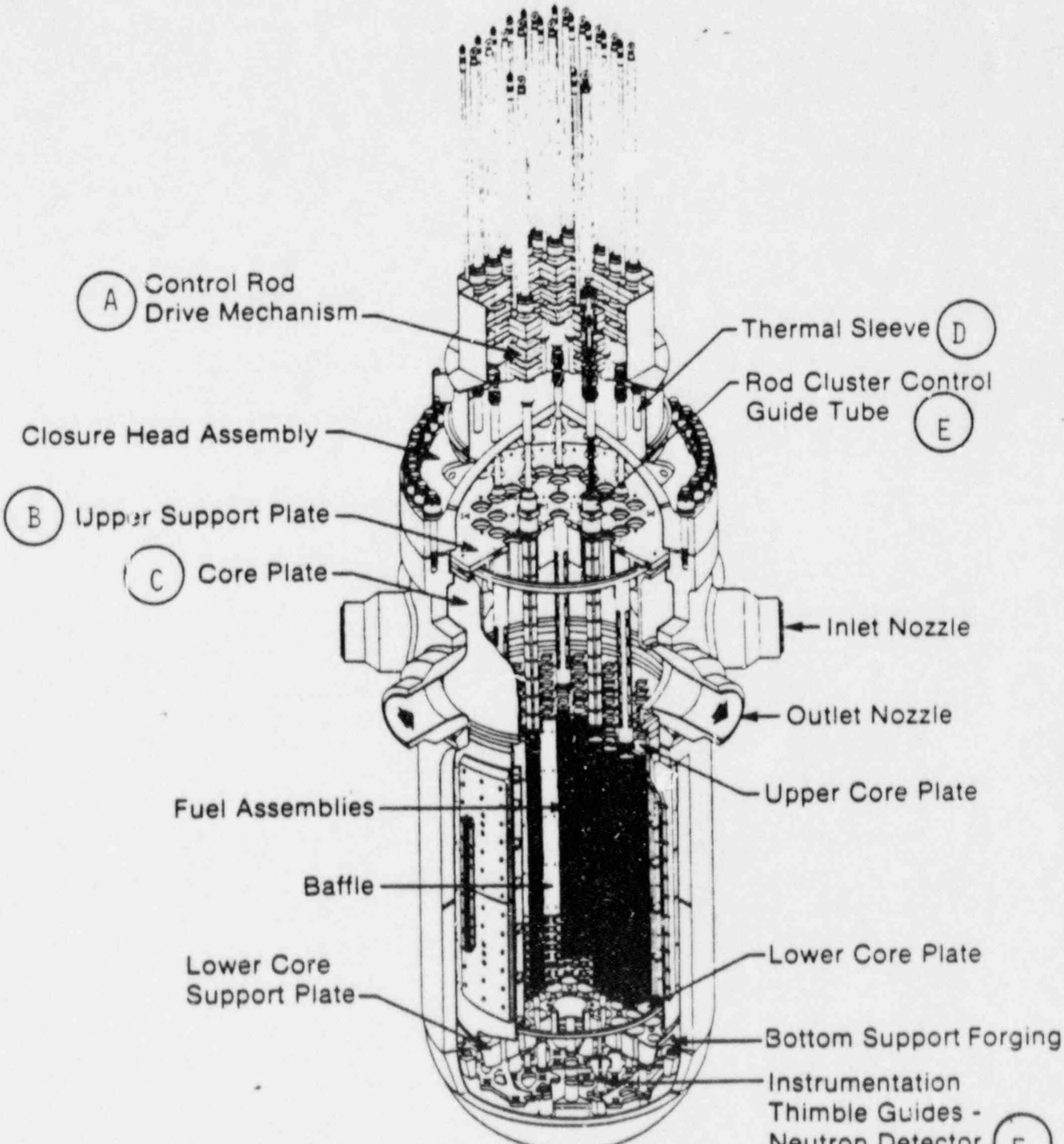
*ANSWER
2.01 (2.5) 0.5 pts. each max 2.5 points.

9-A, 11-B, (12-C DELETED), 8-D, 7-E, 1-F
*Reference
DCPP System Description A-1 Figure RCS-36.
002000K613

CROSS-SECTIONAL CUTAWAY OF REACTOR
UNIT 2



CROSS-SECTIONAL CUTAWAY OF REACTOR
UNIT 2



I[3] 1001-1143/T23006.024

*QUESTION
2.02 (1.5)

During normal plant operations the Residual Heat Removal System (RHR) is aligned to act as part of the Emergency Core Cooling System (ECCS). A single line from the source of water supplies both trains of RHR.

a. What is the normal source of water to the RHR pumps when it is aligned to act as part of the ECCS system? (0.5)

b. What action, besides valve line up checks, is taken to insure that the valve from the normal source of water to the RHR pumps during ECCS alignment remains open? (1.0)

*ANSWER
2.02 (1.5)

a. Refueling Water T nk (RWST) (0.5)

b. Power Removed (Motor De-energized, supply beaker opened) or (Verification of valve position on the monitor box or STP done every shift verify position). (1.0)

*Reference
DCPP System Description B-2, Pg. 15. DCPP P&ID 102010 & 102009.

005000K106

*QUESTION
2.03 (2.5)

The Residual Heat Removal System (RHR) is placed in service to remove decay heat during phase II cooldown by opening RHR loop isolation suction Valves 8701 and 8702. Before opening valve 8701, for phase II cooldown, the RCS system must below 475^{O}F and less than 390 psig.

a. From what reactor coolant system loop does the RHR system take suction from during phase II cooldown? (0.5)

b. What is the source of the 475^{O}F signal? (0.5)

c. What signal will automatically close valve 8702 (source and set point)? (1.0)

d. What is the source of the 390 psig pressure signal? (0.5)

*ANSWER
2.03 (2.5)

a. Loop 4 (0.5)

b. Pressurizer vapor space temperature (TE-454). (0.5)

c. Reactor coolant system loop 4 (PT-403) pressure, (0.5)
at 700 psig. (0.5)

d. Reactor coolant loop 3 or 4 (PT-405 or PT-403) (hot leg) pressure. (0.5)

*Reference
DCPP system Description B-2, Pgs. 17 and 18.

005000K106

*QUESTION
2.04 (2.0)

The reactor coolant pumps move large volumes of reactor coolant to remove heat from the reactor core.

a. What are the two (2) 12 Kv busses that supplies power to reactor coolant pumps 1-1 and 1-2, respectively? (0.5)

b. How does the anti-reverse rotation device used on the reactor coolant pump protect the pump motor? (1.0)

c. What component of the reactor coolant pump ensures short term continuation of forced reactor coolant flow if all AC power is lost to the reactor coolant pumps simultaneously? (0.5)

*ANSWER
2.04 (2.0)

a. RCP 1-1, BUS E (0.25)

RCP 1-2, BUS D (0.25)

b. Over heating of reactor coolant pump motor if the pump is started while rotating in the reverse direction. (Starting of a reactor coolant pump while it is rotating in the reverse rotation would result in overheating of the motor, due to excessive starting currents). (1.0) (By the pawls on the flywheel engaging the frame mounted ratchet as the rotor comes to a stop thereby preventing reverse rotation. [0.5 points])

c. RCP Flywheel. (0.5)

*Reference
DCPP System Description A-5, Pg. 20 & 21 and System Description J-5, figure 12Kv.3.
003000K201

*QUESTION
2.05 (2.5)

The Reactor Vessel Level Indication System (RVLIS) is designed to provide the operator with reactor vessel level indication during abnormal and emergency operating events.

a. What connection does the upper tap for the RVLIS come from? (0.5)

b. From what two loop connections does the RVLIS loop connections tap off of? (Provide loops (0.25 each) and connection name (0.5), connection numbers not required.)

c. How are the RVLIS transmitters protected from the harsh LOCA environment? (1.0)

*ANSWER
2.05 (2.5)

a. Start-up head vent (Reactor vessel head vent). (0.5)

b. Loop (wide range) pressure connection, (0.5)

Loop 3 (PT-405) (0.25)

Loop 4 (PT-403) (0.25)

c. The transmitters are located outside of the reactor containment. (1.0)

*Reference
DCPP System Description A-2d, Pgs. 5 through 9.
002000K603

*QUESTION
2.06 (2.0)

The Pressurizer Relief Tank (PRT) is normally operated at 81 to 87% full of water, 1600 ft^3 of the 1800 ft^3.

a. What component protects the PRT from exceeding 100 psig? (0.5)

b. What gas is added to the PRT to prevent the formation of an explosive mixture of hydrogen and oxygen in the PRT during normal operation? (0.5)

c. Where is the steam from a PORV released into the PRT that insures that the large volume of steam entering the tank is able to be handled by the tank? (1.0)

*ANSWER
2.06 (2.0)

a. Rupture Disc. (0.5)

b. Nitrogen. (0.5)

c. Steam is released below the water, (Where the steam is condensed.) (Released into sparger ring or sparged.)(1.0)

*Reference
DCPP System Description A-4b, Pgs 9 through 13.
010000K604

*QUESTION
2.07 (2.0)

The Chemical and Volume Control System (CVCS) provides a path for make-up and let down to the reactor coolant system.

a. What are the normal and alternate reactor coolant loops the CVCS charges directly into during normal power operations? (0.5)

b. What reactor coolant system loop does normal letdown come from? (0.5)

c. What is the normal actuating fluid for the CVCS letdown orifice stop valves? (0.5)

d. What is the back-up actuating fluid used to operate the letdown orifice stop valves? (0.5)

*ANSWER
2.07 (2.0)

a. Loop 4 (RCS cold Leg, normal) (0.25)

Loop 3 (RCS cold leg, alternate) (0.25)

b. Loop 2 (RCS cold leg, crossover) (0.5)

c. (Instrument) air. (0.5)

d. Nitrogen. (0.5)

*Reference
DCPP System Description B-1a, Pgs. 15 through 41. DCPP P&ID 102008.
004000K101

*QUESTION
2.08 (2.0)

The main steam line flow restrictor limits the main steam velocity and flow rate during a main steam line break to reduce the magnitude of pipe whip and contributes to the pressure drop for steam flow measurements.

What are the two (2) other reasons for the main steam line flow restrictor during a main steam line break? (2.0)

*ANSWER
2.08 (2.0)

1. Limits the mass flow rate (OR differential pressure Delta P) the main steam isolation valve must close against (during a main steam line break). (1.0)

2. Limits the cooldown rate of the reactor coolant system. (1.0)

*Reference
DCPP System Description C-2a, Pgs. 9 through 11.
000040EK202

*QUESTION
2.09 (3.0)

There is a main steam isolation valve (MSIV) and a main steam check valve in each of the main steam lines from the steam generators.

a. What fluid is used to open the MSIV? (0.5)

b. What two (2), component(s) or fluid(s), close the MSIV when a MSIV control switch is turned to the closed position while steam is flowing through the pipe? (1.0)

c. What design accident (0.5) and subsequent reactor transient (0.5) is he MSIV designed to minimize?

d. What main steam line accident is the main steam line check valve designed for? (0.5)

*ANSWER
2.09 (3.0)

a. (Instrument) air. (0.5)

b. 1. Spring, (0.5)

2. steam flow. (0.5)

c. Excess reactor coolant system cooldown, (0.5)
from main steam line breaks downstream of the main steam isolation valves. (0.5)

d. Main steam line break upstream of the main steam isolation valves. (0.5)

*Reference
DCPP System Description C-2a, Pgs. 16 and 17.
000040EK301

*QUESTION
2.10 (3.0)

The steam dump system is designed to remove excess heat from to reactor coolant system. The 10% power operated relief valves can operate independently or as a group.

a. How many atmospheric dump valves are available to dump main steam down stream of the main steam isolation valves? (0.5)

b. in what operating modedo the 10% atmospheric dump valves act independently, other than manual? (1.0)

c. How are the 10% atmospheric dump valves designed to operate if there is a loss of control air and electrical power to the valve? (1.0)

d. Which group of steam dump valves (10%, 35%, and/or 40) can be operated from the hot shutdown panel? (0.5)

*ANSWER
2.10 (3.0)

a. nine (9) (0.5)

b. When in the overpressure protection mode. (1.0)

c. Valves have local manual control (direct linkage handwheel) or fail closed. (1.0)

d. 10%. (0.5)

*Reference
DCPP System Description C-2b, Pgs. 17, 21, 22, SDS.1 and P&ID 102004.
041020K603

*QUESTION
2.11 (1.5)

Why are the rod insertion limits higher for unit 2 than they are for unit 1? (1.5)

*ANSWER
2.11 (1.5)

The power defect for unit 2 is greater (because of the higher thermal rating) or higher rod worth.

*Reference
DCPP System Description A-3a, Pgs. 85 and 86.
001000K504

END OF SECTION TWO

CONTINUE ONTO SECTION THREE

SECTION THREE

INSTRUMENTS AND CONTROLS

*QUESTION
3.01 (2.5)

Tave, Tref, and nuclear power instrumentation are used to control rod speed and direction.

a. What signal is used to produce Tref? (0.5)

b. What is the control rod speed for the following conditions? (1.0)

   1. Tave = 571°F

   2. Tref = 565°F

   3. Nuclear power = 100%?

c. Why does the out-motion bistable and relay de-energize at a Tref minus Tave of 1°F? (1.0)

*ANSWER
3.01 (2.5)

a. P impulse (PT-505 First stage turbine pressure). (0.5)

b. 72 spm (Steps per Minute) (1.0)

c. Prevent system oscillations. (1.0)

*Reference
DCPP System Description A-3a, Pgs. 30 through 36, 73 and figures RC.8 and 11.
001000K403

*QUESTION
3.02 (3.0)

Control Rod stops C-5, turbine power less than 15%, and C-11, control bank D withdrawal limit greater than 220 steps, stops only AUTOMATIC outward rod motion.

What are the four (4) control rod stops (0.5 points each)and their set points (0.25 points each) that will stop all outward rod motion? (3.0)

*ANSWER
3.02 (3.0)

1. Intermediate range nuclear overpower (C-1) (0.5), 20% (0.25).

2. Power range (high range) nuclear overpower (C-2) (0.5), 103% (0.25).

3. Overtemperature delta T (C-3)(0.5), 3% (0.25).

4. Overpower delta T (C-4)(0.5), 3% (0.25).

*Reference
DCPP System Description A-3a, table RC-2.
001000K407

*QUESTION
3.03 (3.5)

The pressurizer heaters are powered from 480 volt vital (emergency) and non vital power supplies. Back-up heater control switches for groups 1-2, 1-3, and 1-4, have five (5) breaker status lights, green, white, blue, red, and amber. When back-up heater groups 1-2 and 1-3 are aligned to their vital (emergency) power supply there is no power available for any of the associated breaker status lights.

a. What are the two (2) 480 volt vital busses that supply back-up power to back-up heater groups 1-2 and 1-3 respectively? (0.5)

b. What does the AMBER breaker status light for the back-up heater control switches for heater groups 1-2 and 1-3 indicate? (0.5)

c. What instrument indication is available to the operator to indicate the operation of back-up heater groups 1-2 and/or 1-3 are being supplied from their vital power source (besides no breaker status lights)? (1.0)

d. What two (2) back-up heater groups have both an individual back-up heater control transfer switch and an individual back-up heater local control switch on the Hot Shutdown Panel (HSP)? (1.5)

*ANSWER
3.03 (3.5)

a. 1-2 (vital bus) 1G (0.25)

1-3 (vital bus) 1H (0.25)

b. Back-up heater control switch (on CC-1) is in the Auto-after-off position (available for auto). (0.5)

c. Wattmeter (is provided to indicate power drawn by these back-up heater groups). (1.0)

d. Back-up heater groups 1-2 (0.75)

and 1-4. (0.75)

*Reference
DCPP System Description A-4a, Pgs. 51 through 55.
010000K201

*QUESTION
3.04 (1.0)

Figure 3.04 is a diagram of the gas amplification curve for gas filled detectors.

a. In what region of the curve dose the BF_3 source range detectors operate? (0.5)

b. In what region of the curve do the power range, operate? (0.5)

*ANSWER
3.04 (1.0)

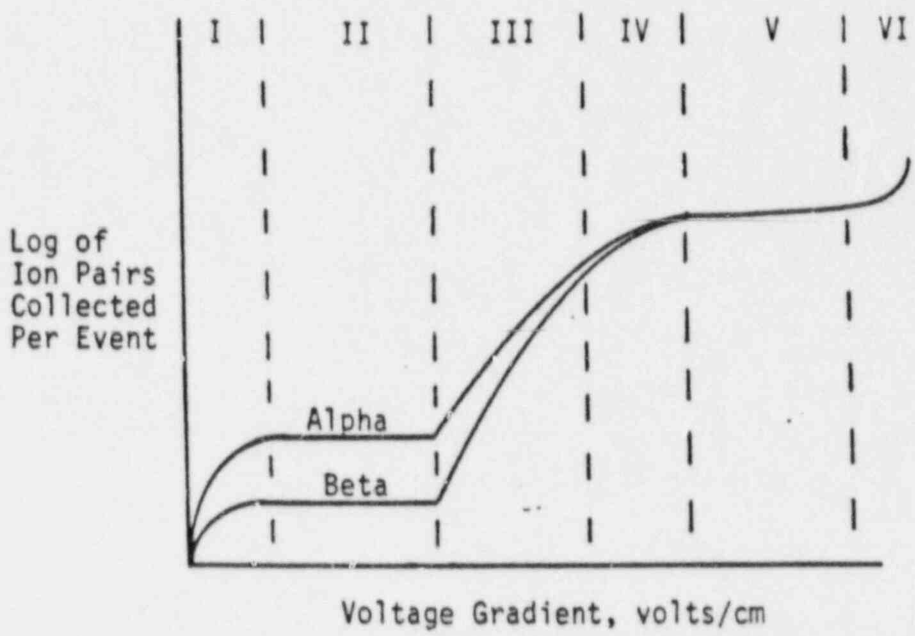
a. III (Proportional) (0.5)

b. II (Ionization Chamber Region) (0.5)

*Reference
DCPP System Description B-4, Pgs. 19 through 32.
015000K501

FIGURE 3.04

Gas Amplification Curve



I: Recombination Region

II: Ionization Chamber Region

III: Proportional Region

IV: Limited Proportional Region

V: Geiger-Mueller Region

VI: Continuous Discharge Region

*QUESTION
3.05 (1.5)

The pressurizer level control system has four (4) pressurizer differential pressure detectors for level control and indication. Three of the level sensors are hot calibrated and the fourth is cold calibrated.

a. How will the cold calibrated level sensor read during normal 100% power operating temperatures and pressures, (high, low, same as hot calibrated)? (0.5)

b. How will the charging flow rate change if the reference leg for the selected pressurizer level control channel leaked and drained dry? (1.0)

*ANSWER
3.05 (1.5)

a. Low (0.5)

b. Decrease (flow to pressurizer). (1.0)

*Reference
DCPP System Description A-4a, Pgs. 6? through 66, figure Pz. 4 and 23.
011000K301

*QUESTION
3.06 (1.0)

The output of the master level controller (MLC) for the pressurizer level control system can be thought of as the charging flow demand signal. Reference level (Lref) is one signal input to the MLC.

a. What other signal is required to produce the correct output signal from the MLC (besides Lref)? (0.5)

b. What signal is used to generate Lref? (0.5)

*ANSWER
3.06 (1.0)

a. Actual (pressurizer) level. (0.5)

b. Auctioneered high Tave. (0.5)

*Reference
DCPP System Description A-4a, Pgs. 68 through 72.
011000K404

*QUESTION
3.07 (1.25)

The reactor is operating at 100% power with pressurizer level at 60% and pressurizer pressure at 2200 psig. An operator places the master pressure controller in manual to increase pressure to 2235 psig (normal operating pressure) by pressing the increase button.

At what pressurizer pressure will the reactor trip at if the operator maintains the increase signal to the master pressure controller? (1.25)

*ANSWER
3.07 (1.25)

1950 psig (pressurizer low pressure.)
(2385 psig, to increase the pressurizer pressure the signal from the master pressure controller is decreased.)
*Reference
DCPP System Description A-4a, Pgs. 43 and 77.
010000K302

*QUESTION
3.08 (2.5)

There are three plant signals which can produce a feedwater isolation signal. One of the signals is P-4, reactor trip permissive, in coincidence with low Tave on two of four loops.

a. What are the other two (2) plant signals that can cause a main feedwater isolation? (1.0)

b. Why are the main feedwater regulating bypass valves closed on a main feedwater isolation signal initiated by a low Tave? (1.0)

c. What is the set point for the two out of four Taves' that will initiate a main feedwater isolation? (0.5)

*ANSWER
3.08 (2.5)

a. 1. Steam generator high-high level (67%) (on two of three level detectors on one steam generator) (P-14). (0.5)

   2. Safety Injection. (0.5)

b. Prevents excess RCS cooldown (which could cause excess positive reactivity to be added to the core). (1.0)

c. 554°F (0.5)

*Reference
DCPP System Description B-6a, Pgs. 51 and 52 and System Description C-8b, Pgs. 23 and 31.
059000K419

*QUESTION
3.09 (0.75)

The unit is being started up, a steady positive startup rate is indicated, when it is discovered that the intermediate range nuclear instrumentation is undercompensated.

Will the actual Startup rate be higher or lower than the intermediate range instruments are showing? (0.75)

*ANSWER
3.09 (0.75)

Higher

*Reference
DCPP System Description B-4, Pgs. 19 through 32.
015000K502

*QUESTION
3.10 (2.0)

The motor driven auxiliary feedwater pumps are provided with control switches and four status lights above each control switch.

a. What does the white status light above the control switch indicate? (0.5)

b. What does the blue status light indicate? (0.5)

c. What 4160 volt busses are motor driven auxiliary feedwater pump motors 12 and 13 powered from? (1.0)

*ANSWER
3.10 (2.0)

a. Power is available (for the pump and control circuit). (0.5)

b. The breaker has tripped on overcurrent. (0.5)

c. 12 Bus H (0.5), 13 Bus F (0.5)

*Reference
DCPP System Description D-1, Pg. 14 and 43
061000K202

*QUESTION
3.11 (2.5)

The motor driven and steam driven auxiliary feedwater pumps automatically start on a two of three low-low water level in one steam generator. The turbine driven pump also starts on a loss reactor coolant pump bus power.

a. What are three (3) other signals or conditions that will automatically start the motor driven auxiliary feedwater pumps? (1.5)

b. What two (2) valve groups are closed by the same signal that starts the turbine driven auxiliary feedwater pump, (valves are not aux FW pump related)? (1.0)

*ANSWER
3.11 (2.5)

a. 1. Both main feedwater pumps tripped, (0.5)

2. Safety injection signal, (0.5)

3. Transfer to diesel generator (Loss of power). (0.5)

b. Steam generator blowdown valves outside containment, (0.5)

Steam generator sample valves. (0.5)

*Reference
DCPP System Description D-1, Pgs. 17 and AFW.4 & 5, and System Description B-6a, Pgs. 52 and 53.
061000K402

*QUESTION
3.12 (2.0)

A safety injection signal on two of two trains will initiate a containment ventilation isolation (CVI) signal. High radioactivity readings on RE-11 and RE-12 will also initiate a CVI.

a. What are the two other radiation detectors that will initiate a CVI signal? {Name or number (0.25 points each) and type of activity, gaseous or particulate (0.25) points each), required; A/B counts as one detector.)(1.0)

b. What type of detectors are RE-11 and RE-12 (0.5 points each)?
(Geiger-Mueller, Ion Chamber detector, or scintillation.) (1.0)

*ANSWER
3.12 (2.0)

a. 1. RE-28 A/B (Plant vent air) (0.25) particulate, (0.25)

2. RE-14 (Plant vent air) (0.25), Radiogas (0.25).

b. RE-11, Scintillation, (0.5)

RE-12, Geiger-Mueller. (0.5)

*Reference
DCPP System Description B-6c, Pgs. 7, 8, and CIS.1 and DCPP System Description G-4, Pgs. 26 through 28.
103000K406

*QUESTION
3.13 (1.5)

Liquid radioactive wastes are monitored by radiation element RE-18 prior to being discharged.

a. What type of detector is radiation element RE-18? (0.5)
   (Geiger-Mueller, Ion chamber, Scintillation.)

b. What two (2) automatic valves change position (0.5 points each), if RE-18 reaches its Hi radiation alarm set point?
   (Valve numbers or name required) (1.0)

*ANSWER
3.13 (1.5)

a. Scintillation (0.5)

b. RCV-18 (shut off to circulating water discharge) (0.5),

   FCV-477 (liquid radwaste equipment drain receiver dump valve) (0.5).

*Reference
DCPP System Description G-1, Pgs. 34 and 35, and System Description G-4, Pg. 33.
068000K610

END OF SECTION THREE

CONTINUE ONTO SECTION FOUR

PROCEDURES

NORMAL, ABNORMAL, EMERGENCY, and

RADIOLOGICAL CONTROL

*QUESTION
4.01 (2.0)

The Technical Specifications state that if a pressurizer power operated relief valve (PORV) block valve is inoperable, in modes 1, 2, and 3, the PORV block valve must be restored to operability within one hour.

What two actions must be taken if the PORV block can not be returned to the operable status within one (1) hour?

*ANSWER
4.01 (2.0)

1. Close the PORV block valve, (1.0)

2. Remove power from the block valve. (1.0)

*Reference
DCPP Technical Specifications 3/4.4.4, Pg. 3/4 4-10
010000K5G5

*QUESTION
4.02 (2.0)

Unit 1 is in mode 6 with diesel generator 1-2 out of service, diesel generator 1-3 supplying power to unit 2 and auxiliary transformer 1-2 is out of service.

What four (4) immediate actions , other than restore source to operable, must be taken to be in compliance with Technical Specification 3.8.1.2 if the engine mounted diesel fuel tank for diesel generator 1-1 has drained and is not refilling?

*ANSWER
4.02 (2.0)

1. Suspend all core alterations, (0.5)

2. Suspend positive reactivity changes, (0.5)

3. Suspend irradiated fuel movement in the spent fuel pool, (0.5)

4. Suspend any crane operations with loads over fuel storage pool. (0.5)

*Reference
DCPP Technical Specification 3/4.8.1, Pg. 3/4 8-11.
064050KSG8

*QUESTION
4.03 (3.5)

The unit 2 reactor trip actuated alarm has come in and the unit has not tripped. You have entered FR-S.1, Response to Nuclear Power Generation/ATWS, from EP E-0, Reactor Trip or Safety Injection. The first immediate response is to manually trip the reactor.

a. What immediate action will you take if after manually initiating a reactor trip the reactor does not indicate that a trip has taken place? (1.0)

b. What immediate action will you take if the turbine generator stop valves are not closed after a manual trip and run back of the turbine has failed? (1.0)

c. What are the three ways of verifying that the reactor has tripped in accordance with EP E-0? (1.5)

*ANSWER
4.03 (3.5)

a. Manually de-energize 480 volt busses (23 D & E) or (13 D & E [0.5 points]) feeding rod drive motor generators. (1.0)

b. Close the MSIVs (0.5)
and bypass valves. (0.5)

c. 1. Verify reactor trip, (0.25)
and bypass breakers are open. (0.25)

2. Rod bottom lights lit, (0.5)

3. Decreasing neutron flux. (0.5)

*Referance
DCPP EP E-0 and FR-S.1.
000029EK301

*QUESTION
4.04 (1.0)

A reactor trip has occurred and the EP E-0.1, Reactor Trip Response has been entered. During the recovery the subcooling monitor fails.

What two (2) indications will you use, by procedure, to determine subcooling? (0.5 points each)

*ANSWER
4.04 (1.0)

Wide range RCS pressure, (0.5)

Core exit thermocouples. (0.5)

*Reference
DCPP EP E-0.1
001000K556

*QUESTION
4.05 (2.5)

During a loss of all AC power EP ECA-0.0 is entered. One of the immediate operator actions is to verify that the reactor coolant system (RCS) has been isolated and to verify that auxiliary feedwater is in operation.

a. What are the four (4) things (not specific valve numbers) that must be checked to verify that the RCS has been isolated? (2.0)

b. What flow rate (GPM) must auxiliary feedwater flow be greater than to meet its safety function? (0.5)

*ANSWER
4.05 (2.5)

a. 1. PZR PORVs closed, (0.5)

2. Letdown isolated, (0.5)

3. Excess letdown isolated, (0.5)

4. RCP Seal return valves isolated. (0.5)

b. 460 GPM +/- 10 (0.5)

*Reference
DCPP EP ECA-0.0
000055EK302

*QUESTION
4.06 (2.0)

EP ECA-0.0, Loss of All AC Power, notes that the steam generators should be depressurized at the maximum rate to minimize the loss of reactor coolant inventory due to a component failure but EP ECA-0.0 Cautions the operator not to allow steam generator pressure to go below 160 psig. During the depressuriz tion of the steam generators upper reactor vessel head voiding may occur.

a. What component failure is being anticipated when reducing the steam generator pressure as rapidly as possible?(1.0)

b. What condition is prevented by not reducing the steam generator pressure below 160 psig? (1.0)

*ANSWER
4.06 (2.0)

a. Reactor coolant pump seal failure. (1.0)

b. Injection of nitrogen into the RCS from the SI accumulators. (1.0)

*Reference
DCPP EP ECA-0.0.
000056EK302

*QUESTION
4.07 (2.5)

The Unit 2 reactor is operating at 100% power with all rods out (ARO). One of the control rods drops into the core and is declared inoperable but trippable. A shutdown margin calculation is completed and shutdown margin is 1.1% delta K/K. After shut down margin is restored continued operation is allowed at a reduced thermal power of level in accordance with Technical Specification 3.1.3.1.

a. What minimum flow rate and boron solution concentration are you required to borate at according to Technical Specification 3.1.1.1 to restore required shutdown margin? (1.0)

b. What percent of rated thermal power is the reactor allowed to operate at with the inoperable control rod? (1.0)

c. How many steps is a control rod allowed to out of indicated position before it is considered misaligned? (0.5)

*ANSWER
4.07 (2.5)

a. 10 gpm (0.5)

20,000 ppm (0.5)

b. 75% (of rated thermal power). (1.0)

c. +/- 12 steps. (0.5)

*Reference
DCPP Technical Specification 3.1.1.1 and ..1.3.1.
000005EK306

*QUESTION
4.08 (1.5)

Reactor core safety limits as specified by Technical Specification 2.1 state that the combination of thermal power , pressurizer pressure, and the highest operating loop coolant Tave shall not exceed the limits shown in Figure 4.08.

a. What action must be taken within one (1) hour of exceeding the limits shown on figure 4.08? (1.0)

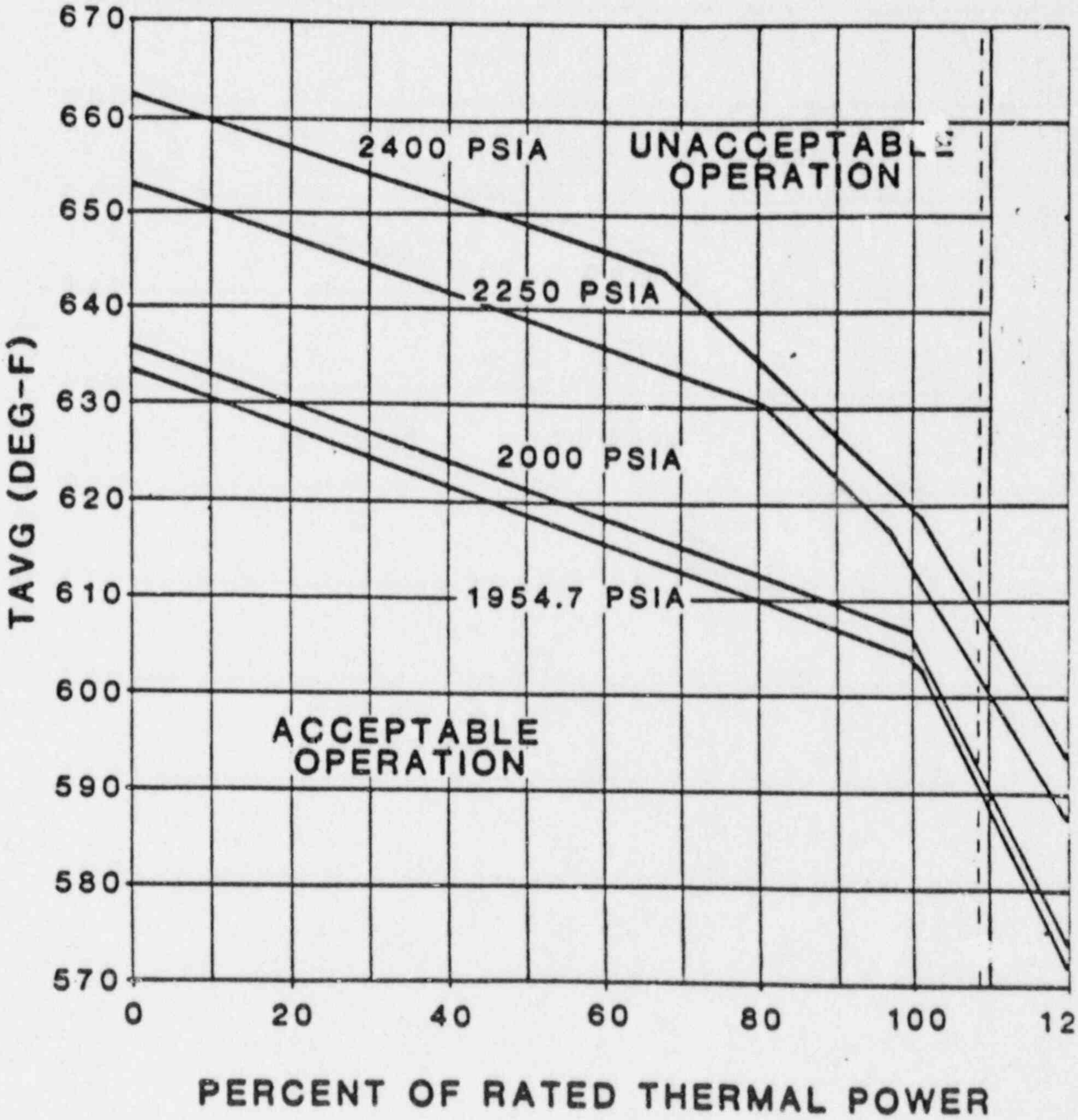
b. Who must be notified within one (1) or less if the limits shown on figure 4.08 are exceeded? (0.5)

*ANSWER
4.08 (1.5)

a. Be in Hot Standby (within one hour). (1.0)

b. NRC (By phone). (0.5)

*Reference
DCPP Technical Specification 2.1, Pg. 2-1, and Specification 6.7, Pg. 6-13.
010000SGK5


670
660
650
640
630
620
610
600
590
580
570
2400 PSIA
UNACCEPTABLE
OPERATION
2250 PSIA
2000 PSIA
1954.7 PSIA
ACCEPTABLE
OPERATION
TAVG (DEG-F)
0
20
40
60
80
100
120
PERCENT OF RATED THERMAL POWER

*QUESTION
4.09 (1.0)

The unit 1 reactor announced as critical at 1:00 am. At 1:30 am the loop 3 Tave has been confirmed as being less than 541 °F.

a. How long do you have to restore Tave to within its limits? (1.0)

b. At what time must you be in Hot Shutdown if Tave can not be restored to within its limits? (DELETED)

*ANSWER
4.09 (2.0)

a. 15 minutes. (1.0)

b. **DELETED**

*Reference
DCPP Technical Specification 3.1.1.4, Pg. 3/4 1-6.
002020SGK5

*QUESTION
4.10 (3.0)

An elbow in the CVCS system is emitting a dose rate of 1500 mrem per hour at one (1) meter. You have just started a calendar year and have zero accumulated dose.

a. How long can you work at a position 2 meters from the elbow before you meet your 10 CFR 20 whole body quarterly dose limit? (1.5)

b. What are the two (2) criteria that allows your 10 CFR 20 quarterly limit to be increased up to 3 rem per quarter? (1.0)

c. What is your DCPP emergency lifesaving action whole body limit? (0.5)

*ANSWER
4.10 (3.0)

a. 3.33 Hours (0.5)

1500 mrem = 1.5 rem

$1.5 \text{ rem/hr} \times (1)^2 \text{ meter} = D_2 \times (2)^2 \text{ meters}$ (0.5)

(1.5 x 1) / 4 = 0.375 rem/hr

1.25 rem / quarter (0.5)

(1.25 rem) / 0.375 rem/hr

3.33 hours

b. 1. Form NRC-4 is current, (0.5)

2. Life time dose dose not exceed 5(N-18). (0.5)

c. 75 rem (0.5)

*Reference
DCPP Operator Information Manual, and 10 CFR 20.
194001K103

*QUESTION
4.11 (3.0)

Emergency Operating Procedure EP E-0, Reactor Trip or Safety Injection, and EP E-1.1, Safety Injection Termination, provide termination criteria for safety injection after a reactor trip and safety injection. One of the criteria for termination of safety injection is at least one (1) narrow range steam generator level indication greater than 4%.

a. What are the other four criteria that need to be met before safety injection can be terminated or reduced?(2.0)

b. What are the two conditions that require that safety injection be reinitiated after it has been terminated? (1.0)

*ANSWER
4.11 (3.0)

a.(2.0 points)
{a.1, a.3, a.4 required for full credit 0.667 points each)

1. RCS subcooling greater than 20°F (based on core exit thermal couples).

2. Total auxiliary feedwater flow to steam generators greater than 460 GPM.(Not required)

3. RCS pressure - stable or increasing.

4. Pressurizer level greater than 4%.

b. (0.5 points each maximum 1.0 points)

1. RCS subcooling less than 20°F.

2. Pressurizer level can not be maintained greater than 4%.

*Reference
DCPP EP E-0 and EP E-1.1.

END OF SECTION FOUR

END OF EXAMINATION

CORRECTED EXAM KEY

U.S. NUCLEAR REGULATORY COMMISSION

SENIOR REACTOR OPERATOR LICENSE EXAMINATION

Facility: DIABLO CANYON
Reactor Type: WESTINGHOUSE FOUR LOOP
Date Administered: DECEMBER 8, 1987
Examiner: P.J. MORRILL
Candidate: N/A

INSTRUCTIONS TO CANDIDATE

Use separate paper for the answers. Write answers on one side only. Staple question sheet on top of the answer sheets. Points for each question are indicated in parentheses after the question. The passing grade requires at least 70% in each category 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	Candidate's Score	% of Category Value	Category
25.00	25.73			5. Theory of Nuclear Power Plant Operation, Fluids, and Thermodynamics
24.67 ~~25~~	25.39 ~~25~~			6. Plant Systems Design, Control and Instrumentation
24.50 ~~25~~	25.21 ~~25~~			7. Procedures - Normal, Abnormal, Emergency, and Radiological Control
23.00 ~~25~~	23.67 ~~25~~			8. Administrative Procedures, Conditions, and Limitations
97.17 ~~100~~		Final Grade		TOTALS

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

Candidate's Signature

REQUIREMENTS FOR ADMINISTRATION OF WRITTEN EXAMINATIONS

1. A single room shall be provided for completing the written examination. The location of this room and supporting restroom facilities shall be such as to prevent contact with all other facility and/or contractor personnel during the duration of the written examination. If necessary, the facility should make arrangements for the use of a suitable room at a local school, motel, or other building. Obtaining this room is the responsibility of the licensee.

2. Minimum spacing is required to ensure examination integrity as determined by the chief examiner. Minimum spacing should be one candidate per table, with a 3-ft space between tables. No wall charts, models, and/or other training materials shall be present in the examination room.

3. Suitable arrangements shall be made by the facility if the candidates are to have lunch, coffee, or other refreshments. These arrangements shall comply with Item 1 above. These arrangements shall be reviewed by the examiner and/or proctor.

4. The facility staff shall be provided a copy of the written examination and answer key after the last candidate has completed and handed in his written examination. The facility staff shall then have five working days to provide formal written comments with supporting documentation on the examination and answer key to the chief examiner or to the regional office section chief.

5. The facility licensee shall provide pads of 8-1/2 by 11 in. lined paper in unopened packages for each candidate's use in completing the examination. The examiner shall distribute these pads to the candidates. All reference material needed to complete the examination shall be furnished by the examiner. Candidates can bring pens, pencils, calculators, or slide rules into the examination room, and no other equipment or reference material shall be allowed.

6. Only black ink or dark pencils should be used for writing answers to questions.

NRC RULES AND GUIDELINES FOR LICENSE EXAMINATIONS

During the administration of this examination the following rules apply:

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

2. Restroom trips are to be limited and only one candidate at a time may leave. You must avoid all contacts with anyone outside the examination room to avoid even the appearance or possibility of cheating.

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

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

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

6. Use only the paper provided for answers.

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

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

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

10. Skip at least three lines between each answer.

11. Separate answer sheets from pad and place finished answer sheets face down on your desk or table.

12. Use abbreviations only if they are commonly used in facility literature.

13. The point value for each question is indicated in parentheses after the question and can be used as a guide for the depth of answer required.

14. Show all calculations, methods, or assumptions used to obtain an answer to mathematical problems whether indicated in the question or not.

15. Partial credit may be given. Therefore, ANSWER ALL PARTS OF THE QUESTION AND DO NOT LEAVE ANY ANSWER BLANK.

16. If parts of the examination are not clear as to intent, ask questions of the examiner only.

17. You must sign the statement on the cover sheet that indicates that the work is your own and you have not received or been given assistance in completing the examination. This must be done after the examination has been completed.

18. When you complete your examination, you shall:

    a. Assemble your examination as follows:

        (1) Exam questions on top.

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

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

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

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

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

EQUATION SHEET

$f = ma$

$w = mg$

$E = mC^2$

$KE = \frac{1}{2}mv^2$

$PE = mgh$

$W = v\Delta P$

$\Delta E = 931\Delta m$

$\dot{Q} = \dot{m}C_p\Delta T$

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

$Pwr = W_f\,\dot{m}$

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

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

$SUR = 26.06/T$

$T = 1.44\ DT$

$SUR = 26\left(\frac{\lambda_{eff}\rho}{\bar{\beta} - \rho}\right)$

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

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

$T = (\bar{\beta} - \rho)/\lambda_{eff}\rho$

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

$\rho = [\ell^*/TK_{eff}] + [\bar{\beta}/(1 + \lambda_{eff}T)]$

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

$\Sigma = N\sigma$

$v = s/t$

$s = v_o t + \frac{1}{2}at^2$

$a = (v_f - v_o)/t$

$v_f = v_o + at$

$\omega = \theta/t$

Cycle efficiency $= \frac{\text{Net Work (out)}}{\text{Energy (in)}}$

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

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

$t_{1/2}(eff) = \frac{(t_{1/2})(t_b)}{(t_{1/2} + t_b)}$

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

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

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

$TVL = 1.3/\mu$

$HVL = 0.693/\mu$

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

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

$CR_1(1 - K_{eff})_1 = CR_2(1 - K_{eff})_2$

$M = 1/(1 - K_{eff}) = CR_1/CR_0$

$M = (1 - K_{eff})_0/(1 - K_{eff})_1$

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

$\ell^* = 1 \times 10^{-5}$ seconds

$\lambda_{eff} = 0.1$ seconds^{-1}

$I_1 d_1 = I_2 d_2$

$I_1 d_1^2 = I_2 d_2^2$

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

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

WATER PARAMETERS

1 gal. = 8.345 lbm

1 gal. = 3.78 liters

1 ft^3 = 7.48 gal.

Density = 62.4 lbm/ft^3

Density = 1 gm/cm^3

Heat of vaporization = 970 Btu/lbm

Heat of fusion = 144 Btu/lbm

1 Atm = 14.7 psi = 29.9 in. Hg.

1 ft. H_2O = 0.4333 lbf/in^2

MISCELLANEOUS CONVERSIONS

1 Curie = 3.7×10^{10} dps

1 kg = 2.21 lbm

1 hp = 2.54×10^3 BTU/hr

1 Mw = 3.41×10^6 Btu/hr

1 Btu = 778 ft-lbf

1 inch = 2.54 cm

$^oF = 9/5\,^oC + 32$

$^oC = 5/9\,(^oF - 32)$

Properties of Saturated Steam and Saturated Water*

Absolute Pressure Lbs. per Sq. In. P′	Absolute Pressure Inches of Hg	Vacuum Inches of Hg	Temperature t Degrees F.	Heat of the Liquid Btu/lb.	Latent Heat of Evaporation Btu/lb.	Total Heat of Steam h_g Btu/lb.	Specific Volume $\bar{V}$ Water Cu. ft. per lb.	Specific Volume $\bar{V}$ Steam Cu. ft. per lb.
0.0087	0.02	29.90	32.018	0.0003	1075.5	1075.5	0.016022	3302.4
0.10	0.20	29.72	35.023	3.026	1073.8	1076.8	0.016020	2945.5
0.15	0.31	29.61	45.453	13.498	1067.9	1081.4	0.016020	2004.7
0.20	0.41	29.51	53.160	21.217	1053.5	1084.7	0.016025	1526.3
0.25	0.51	29.41	59.323	27.382	1060.1	1087.4	0.016032	1235.5
0.30	0.61	29.31	64.484	32.541	1057.1	1089.7	0.016040	1039.7
0.35	0.71	29.21	68.939	36.992	1054.6	1091.6	0.016048	898.6
0.40	0.81	29.11	72.869	40.917	1052.4	1093.3	0.016056	792.1
0.45	0.92	29.00	76.387	44.430	1050.5	1094.9	0.016063	708.8
0.50	1.02	28.90	79.586	47.623	1048.6	1096.3	0.016071	641.5
0.60	1.22	28.70	85.218	53.245	1045.5	1098.7	0.016085	540.1
0.70	1.43	28.49	90.09	58.10	1042.7	1100.8	0.016099	466.94
0.80	1.63	28.29	94.38	62.39	1040.3	1102.6	0.016112	411.69
0.90	1.83	28.09	98.24	66.24	1038.1	1104.3	0.016124	368.43
1.0	2.04	27.88	101.74	69.73	1036.1	1105.8	0.016136	333.60
1.2	2.44	27.48	107.91	75.90	1032.6	1108.5	0.016158	280.96
1.4	2.85	27.07	113.26	81.23	1029.5	1110.7	0.016178	243.02
1.6	3.26	26.66	117.98	85.95	1026.8	1112.7	0.016196	214.33
1.8	3.66	26.26	122.22	90.18	1024.3	1114.5	0.016213	191.85
2.0	4.07	25.85	126.07	94.03	1022.1	1116.2	0.016230	173.76
2.2	4.48	25.44	129.61	97.57	1020.1	1117.6	0.016245	158.87
2.4	4.89	25.03	132.88	100.84	1018.2	1119.0	0.016260	146.40
2.6	5.29	24.63	135.93	103.88	1016.4	1120.3	0.016274	135.80
2.8	7.70	24.22	138.78	106.73	1014.7	1121.5	0.016287	126.67
3.0	6.11	23.81	141.47	109.42	1013.2	1122.6	0.016300	118.73
3.5	7.13	22.79	147.56	115.51	1009.6	1125.1	0.016331	102.74
4.0	8.14	21.78	152.96	120.92	1006.4	1127.3	0.016358	90.64
4.5	9.16	20.76	157.82	125.77	1003.5	1129.3	0.016384	83.03
5.0	10.18	19.74	162.24	130.20	1000.9	1131.1	0.016407	73.532
5.5	11.20	18.72	166.29	134.26	998.5	1132.7	0.016430	67.249
6.0	12.22	17.70	170.05	138.03	996.2	1134.2	0.016451	61.984
6.5	13.23	16.69	173.56	141.54	994.1	1135.6	0.016472	57.506
7.0	14.25	15.67	176.84	144.83	992.1	1136.9	0.016491	53.650
7.5	15.27	14.65	179.93	147.93	990.2	1138.2	0.016510	50.294
8.0	16.29	13.63	182.86	150.87	988.5	1139.3	0.016527	47.345
8.5	17.31	12.61	185.63	153.65	986.8	1140.4	0.016545	44.733
9.0	18.32	11.60	188.27	156.30	985.1	1141.4	0.016561	42.402
9.5	19.34	10.58	190.80	158.84	983.6	1142.4	0.016577	40.310
10.0	20.36	9.56	193.21	161.26	982.1	1143.3	0.016592	38.420
11.0	22.40	7.52	197.75	165.82	979.3	1145.1	0.016622	35.142
12.0	24.43	5.49	201.96	170.05	976.6	1146.7	0.016650	32.394
13.0	26.47	3.45	205.88	174.00	974.2	1148.2	0.016676	30.057
14.0	38.50	1.42	209.56	177.71	971.9	1149.6	0.016702	28.043

Pressure Lbs. per Sq. In. Absolute P′	Pressure Lbs. per Sq. In. Gage P	Temperature t Degrees F.	Heat of the Liquid Btu/lb.	Latent Heat of Evaporation Btu/lb.	Total Heat of Steam h_g Btu/lb.	Specific Volume $\bar{V}$ Water Cu. ft. per lb.	Specific Volume $\bar{V}$ Steam Cu. ft. per lb.
14.696	0.0	212.00	180.17	970.3	1150.5	0.016719	26.799
15.0	0.3	213.03	181.21	969.7	1150.9	0.016726	26.290
16.0	1.3	216.32	184.52	967.6	1152.1	0.016749	24.750
17.0	2.3	219.44	187.66	965.6	1153.2	0.016771	23.385
18.0	3.3	222.41	190.66	963.7	1154.3	0.016793	22.168
19.0	4.3	225.24	193.52	961.8	1155.3	0.016814	21.074
20.0	5.3	227.96	196.27	960.1	1156.3	0.016834	20.087
21.0	6.3	230.57	198.90	958.4	1157.3	0.016854	19.190
22.0	7.3	233.07	201.44	956.7	1158.1	0.016873	18.373
23.0	8.3	235.49	203.88	955.1	1159.0	0.016891	17.624
24.0	9.3	237.82	206.24	953.6	1159.8	0.016909	16.936
25.0	10.3	240.07	208.52	952.1	1160.6	0.016927	16.301
26.0	11.3	242.25	210.7	950.6	1161.4	0.016944	15.7138
27.0	12.3	244.36	212.9	949.2	1162.1	0.016961	15.1684
28.0	13.3	246.41	214.9	947.9	1162.8	0.016977	14.6607
29.0	14.3	248.40	217.0	946.5	1163.5	0.016993	14.1869
30.0	15.3	250.34	218.9	945.2	1164.1	0.017009	13.7436
31.0	16.3	252.22	220.8	943.9	1164.8	0.017024	13.3280
32.0	17.3	254.05	222.7	942.7	1165.4	0.017039	12.9376
33.0	18.3	255.84	224.5	941.5	1166.0	0.017054	12.5700
34.0	19.3	257.58	226.3	940.3	1166.6	0.017069	12.2234

Properties of Saturated Steam and Saturated Water—continued

Pressure Lbs. per Sq. In. Absolute P′	Pressure Lbs. per Sq. In. Gage P	Temperature t Degrees F.	Heat of the Liquid Btu/lb.	Latent Heat of Evaporation Btu/lb.	Total Heat of Steam h_g Btu/lb.	Specific Volume $\overline{V}$ Water Cu. ft. per lb.	Specific Volume $\overline{V}$ Steam Cu. ft. per lb.
35.0	20.3	259.29	228.0	939.1	1167.1	0.017083	11.8959
36.0	21.3	260.95	229.7	938.0	1167.7	0.017097	11.5860
37.0	22.3	262.58	231.4	936.9	1168.2	0.017111	11.2923
38.0	23.3	264.17	233.0	935.8	1168.8	0.017124	11.0136
39.0	24.3	265.72	234.6	934.7	1169.3	0.017138	10.7487
40.0	25.3	267.25	236.1	933.6	1169.8	0.017151	10.4965
41.0	26.3	268.74	237.7	932.6	1170.2	0.017164	10.2563
42.0	27.3	270.21	239.2	931.5	1170.7	0.017177	10.0272
43.0	28.3	271.65	240.6	930.5	1171.2	0.017189	9.8083
44.0	29.3	273.06	242.1	929.5	1171.6	0.017202	9.5991
45.0	30.3	274.44	243.5	928.6	1172.0	0.017214	9.3988
46.0	31.3	275.80	244.9	927.6	1172.5	0.017226	9.2070
47.0	32.3	277.14	246.2	926.6	1172.9	0.017238	9.0231
48.0	33.3	278.45	247.6	925.7	1173.3	0.017250	8.8465
49.0	34.3	279.74	248.9	924.8	1173.7	0.017262	8.6770
50.0	35.3	281.02	250.2	923.9	1174.1	0.017274	8.5140
51.0	36.3	282.27	251.5	923.0	1174.5	0.017285	8.3571
52.0	37.3	283.50	252.8	92[illegible]	1174.9	0.017296	8.2061
53.0	38.3	284.71	254.0	921.2	1175.2	0.017307	8.0606
54.0	39.3	285.90	255.2	920.4	1175.6	0.017319	7.9203
55.0	40.3	287.08	256.4	919.5	1175.9	0.017329	7.7850
56.0	41.3	288.24	257.6	918.7	1176.3	0.017340	7.6543
57.0	42.3	289.38	258.8	917.8	1176.6	0.017351	7.5280
58.0	43.3	290.50	259.9	917.0	1177.0	0.017362	7.4059
59.0	44.3	291.62	261.1	916.2	1177.3	0.017372	7.2879
60.0	45.3	292.71	262.2	915.4	1177.6	0.017383	7.1736
61.0	46.3	293.79	263.3	914.6	1177.9	0.017393	7.0630
62.0	47.3	294.86	264.4	913.8	1178.2	0.017403	6.9558
63.0	48.3	295.91	265.5	913.0	1178.6	0.017413	6.8519
64.0	49.3	296.95	266.6	912.3	1178.9	0.017423	6.7511
65.0	50.3	297.98	267.6	911.5	1179.1	0.017433	6.6533
66.0	51.3	298.99	268.7	910.8	1179.4	0.017443	6.5584
67.0	52.3	299.99	269.7	910.0	1179.7	0.017453	6.4662
68.0	53.3	300.99	270.7	909.3	1180.0	0.017463	6.3767
69.0	54.3	301.96	271.7	908.5	1180.3	0.017472	6.2896
70.0	55.3	302.93	272.7	907.8	1180.6	0.017482	6.2050
71.0	56.3	303.89	273.7	907.1	1180.8	0.017491	6.1226
72.0	57.3	304.83	274.7	906.4	1181.1	0.017501	6.0425
73.0	58.3	305.77	275.7	905.7	1181.4	0.017510	5.9645
74.0	59.3	306.69	276.6	905.0	1181.6	0.017519	5.8885
75.0	60.3	307.61	277.6	904.3	1181.9	0.017529	5.8144
76.0	61.3	308.51	278.5	903.6	1182.1	0.017538	5.7423
77.0	62.3	309.41	279.4	902.9	1182.4	0.017547	5.6720
78.0	63.3	310.29	280.3	902.3	1182.6	0.017556	5.6034
79.0	64.3	311.17	281.3	901.6	1182.8	0.017565	5.5364
80.0	65.3	312.04	282.1	900.9	1183.1	0.017573	5.4711
81.0	66.3	312.90	283.0	900.3	1183.3	0.017582	5.4074
82.0	67.3	313.75	283.9	899.6	1183.5	0.017591	5.3451
83.0	68.3	314.60	284.8	899.0	1183.8	0.017600	5.2843
84.0	69.3	315.43	285.7	898.3	1184.0	0.017608	5.2249
85.0	70.3	316.26	286.5	897.7	1184.2	0.017617	5.1669
86.0	71.3	317.08	287.4	897.0	1184.4	0.017625	5.1101
87.0	72.3	317.89	288.2	896.4	1184.6	0.017634	5.0546
88.0	73.3	318.69	289.0	895.8	1184.8	0.017642	5.0004
89.0	74.3	319.49	289.9	895.2	1185.0	0.017651	4.9473
90.0	75.3	320.28	290.7	894.6	1185.3	0.017659	4.8953
91.0	76.3	321.06	291.5	893.9	1185.5	0.017667	4.8445
92.0	77.3	321.84	292.3	893.3	1185.7	0.017675	4.7947
93.0	78.3	322.61	293.1	892.7	1185.9	0.017684	4.7459
94.0	79.3	323.37	293.9	892.1	1186.0	0.017692	4.6982
95.0	80.3	324.13	294.7	891.5	1186.2	0.017700	4.6514
96.0	81.3	324.88	295.5	891.0	1186.4	0.017708	4.6055
97.0	82.3	325.63	296.3	890.4	1186.6	0.017716	4.5606
98.0	83.3	326.36	297.0	889.8	1186.8	0.017724	4.5166
99.0	84.3	327.10	297.8	889.2	1187.0	0.017732	4.4734
100.0	85.3	327.82	298.5	888.6	1187.2	0.017740	4.4310
101.0	86.3	328.54	299.3	888.1	1187.3	0.01775	4.3895
102.0	87.3	329.26	300.0	887.5	1187.5	0.01776	4.3487
103.0	88.3	329.97	300.8	886.9	1187.7	0.01776	4.3087
104.0	89.3	330.67	301.5	886.4	1187.9	0.01777	4.2695
105.0	90.3	331.37	302.2	885.8	1188.0	0.01778	4.2309
106.0	91.3	332.06	303.0	885.2	1188.2	0.01779	4.1931
107.0	92.3	332.75	303.7	884.7	1188.4	0.01779	4.1560
108.0	93.3	333.44	304.4	884.1	1188.5	0.01780	4.1195
109.0	94.3	334.11	305.1	883.6	1188.7	0.01781	4.0837

Properties of Saturated Steam and Saturated Water--continued

Pressure Lbs. per Sq. In.		Temperature	Heat of the Liquid	Latent Heat of Evaporation	Total Heat of Steam	Specific Volume $\bar{V}$	
Absolute P'	Gage P	t Degrees F.	Btu/lb.	Btu/lb.	h_g Btu/lb.	Water Cu. ft. per lb.	Steam Cu. ft. per lb.
110.0	95.3	334.79	305.8	883.1	1188.9	0.01782	4.0484
111.0	96.3	335.46	306.5	882.5	1189.0	0.01782	4.0138
112.0	97.3	336.12	307.2	882.0	1189.2	0.01783	3.9798
113.0	98.3	336.78	307.9	881.4	1189.3	0.01784	3.9464
114.0	99.3	337.43	308.6	880.9	1189.5	0.01785	3.9136
115.0	100.3	338.08	309.3	880.4	1189.6	0.01785	3.8813
116.0	101.3	338.73	309.9	879.9	1189.8	0.01786	3.8495
117.0	102.3	339.37	310.6	879.3	1189.9	0.01787	3.8183
118.0	103.3	340.01	311.3	878.8	1190.1	0.01787	3.7875
119.0	104.3	340.64	311.9	878.3	1190.2	0.01788	3.7573
120.0	105.3	341.27	312.6	877.8	1190.4	0.01789	3.7275
121.0	106.3	341.89	313.2	877.3	1190.5	0.01790	3.6983
122.0	107.3	342.51	313.9	876.8	1190.7	0.01790	3.6695
123.0	108.3	343.13	314.5	876.3	1190.8	0.01791	3.6411
124.0	109.3	343.74	315.2	875.8	1190.9	0.01792	3.6132
125.0	110.3	344.35	315.8	875.3	1191.1	0.01792	3.5857
126.0	111.3	344.95	316.4	874.8	1191.2	0.01793	3.5586
127.0	112.3	345.55	317.1	874.3	1191.3	0.01794	3.5320
128.0	113.3	346.15	317.7	873.8	1191.5	0.01794	3.5057
129.0	114.3	346.74	318.3	873.3	1191.6	0.01795	3.4799
130.0	115.3	347.33	319.0	872.8	1191.7	0.01796	3.4544
131.0	116.3	347.92	319.6	872.3	1191.9	0.01797	3.4293
132.0	117.3	348.50	320.2	871.8	1192.0	0.01797	3.4046
133.0	118.3	349.08	320.8	871.3	1192.1	0.01798	3.3802
134.0	119.3	349.65	321.4	870.8	1192.2	0.01799	3.3562
135.0	120.3	350.23	322.0	870.4	1192.4	0.01799	3.3325
136.0	121.3	350.79	322.6	869.9	1192.5	0.01800	3.3091
137.0	122.3	351.36	323.2	869.4	1192.6	0.01801	3.2861
138.0	123.3	351.92	323.8	868.9	1192.7	0.01801	3.2634
139.0	124.3	352.48	324.4	868.5	1192.8	0.01802	3.2411
140.0	125.3	353.04	325.0	868.0	1193.0	0.01803	3.2190
141.0	126.3	353.59	325.5	867.5	1193.1	0.01803	3.1972
142.0	127.3	354.14	326.1	867.1	1193.2	0.01804	3.1757
143.0	128.3	354.69	326.7	866.6	1193.3	0.01805	3.1546
144.0	129.3	355.23	327.3	866.2	1193.4	0.01805	3.1337
145.0	130.3	355.77	327.8	865.7	1193.5	0.01806	3.1130
146.0	131.3	356.31	328.4	865.2	1193.6	0.01806	3.0927
147.0	132.3	356.84	329.0	864.8	1193.8	0.01807	3.0726
148.0	133.3	357.38	329.5	864.3	1193.9	0.01808	3.0528
149.0	134.3	357.91	330.1	863.9	1194.0	0.01808	3.0332
150.0	135.3	358.43	330.6	863.4	1194.1	0.01809	3.0139
152.0	137.3	359.48	331.8	862.5	1194.3	0.01810	2.9760
154.0	139.3	360.51	332.8	861.6	1194.5	0.01812	2.9391
156.0	141.3	361.53	333.9	860.8	1194.7	0.01813	2.9031
158.0	143.3	362.55	335.0	859.9	1194.9	0.01814	2.8679
160.0	145.3	363.55	336.1	859.0	1195.1	0.01815	2.8336
162.0	147.3	364.54	337.1	858.2	1195.3	0.01817	2.8001
164.0	149.3	365.53	338.2	857.3	1195.5	0.01818	2.7674
166.0	151.3	366.50	339.2	856.5	1195.7	0.01819	2.7355
168.0	153.3	367.47	340.2	855.6	1195.8	0.01820	2.7043
170.0	155.3	368.42	341.2	854.8	1196.0	0.01821	2.6738
172.0	157.3	369.37	342.2	853.9	1196.2	0.01823	2.6440
174.0	159.3	370.31	343.2	853.1	1196.4	0.01824	2.6149
176.0	161.3	371.24	344.2	852.3	1196.5	0.01825	2.5864
178.0	163.3	372.16	345.2	851.5	1196.7	0.01826	2.5585
180.0	165.3	373.08	346.2	850.7	1196.9	0.01827	2.5312
182.0	167.3	373.98	347.2	849.9	1197.0	0.01828	2.5045
184.0	169.3	374.88	348.1	849.1	1197.2	0.01830	2.4783
186.0	171.3	375.77	349.1	848.3	1197.3	0.01831	2.4527
188.0	173.3	376.65	350.0	847.5	1197.5	0.01832	2.4276
190.0	175.3	377.53	350.9	846.7	1197.6	0.01833	2.4030
192.0	177.3	378.40	351.9	845.9	1197.8	0.01834	2.3790
194.0	179.3	379.26	352.8	845.1	1197.9	0.01835	2.3554
196.0	181.3	380.12	353.7	844.4	1198.1	0.01836	2.3322
198.0	183.3	380.96	354.6	843.6	1198.2	0.01838	2.3095
200.0	185.3	381.80	355.5	842.8	1198.3	0.01839	2.28728
205.0	190.3	383.88	357.7	840.9	1198.7	0.01841	2.23349
210.0	195.3	385.91	359.9	839.1	1199.0	0.01844	2.18217
215.0	200.3	387.91	362.1	837.2	1199.3	0.01847	2.13315
220.0	205.3	389.88	364.2	835.4	1199.6	0.01850	2.08629
225.0	210.3	391.80	366.2	833.6	1199.9	0.01852	2.04143
230.0	215.3	393.70	368.3	831.8	1200.1	0.01855	1.99846
235.0	220.3	395.56	370.3	830.1	1200.4	0.01857	1.95725
240.0	225.3	397.39	372.3	828.4	1200.6	0.01860	1.91769
245.0	230.3	399.19	374.2	826.6	1200.9	0.01863	1.87970

Properties of Saturated Steam and Saturated Water—concluded

Pressure Lbs. per Sq. In. Absolute P′	Pressure Lbs. per Sq. In. Gage P	Temperature t Degrees F.	Heat of the Liquid Btu/lb.	Latent Heat of Evaporation Btu/lb.	Total Heat of Steam h_g Btu/lb.	Specific Volume $\bar{V}$ Water Cu. ft. per lb.	Specific Volume $\bar{V}$ Steam Cu. ft. per lb.
250.0	235.3	400.97	376.1	825.0	1201.1	0.01865	1.84317
255.0	240.3	402.72	378.0	823.3	1201.3	0.01868	1.80802
260.0	245.3	404.44	379.9	821.6	1201.5	0.01870	1.77418
265.0	250.3	406.13	381.7	820.0	1201.7	0.01873	1.74157
270.0	255.3	407.80	383.6	818.3	1201.9	0.01875	1.71013
275.0	260.3	409.45	385.4	816.7	1202.1	0.01878	1.67978
280.0	265.3	411.07	387.1	815.1	1202.3	0.01880	1.65049
285.0	270.3	412.67	388.9	813.6	1202.4	0.01882	1.62218
290.0	275.3	414.25	390.6	812.0	1202.6	0.01885	1.59482
295.0	280.3	415.81	392.3	810.4	1202.7	0.01887	1.56835
300.0	285.3	417.35	394.0	808.9	1202.9	0.01889	1.54274
320.0	305.3	423.31	400.5	802.9	1203.4	0.01899	1.44801
340.0	325.3	428.99	406.8	797.0	1203.8	0.01908	1.36405
360.0	345.3	434.41	412.8	791.3	1204.1	0.01917	1.28910
380.0	365.3	439.61	418.6	785.8	1204.4	0.01925	1.22177
400.0	385.3	444.60	424.2	780.4	1204.6	0.01934	1.16095
420.0	405.3	449.40	429.6	775.2	1204.7	0.01942	1.10573
440.0	425.3	454.03	434.8	770.0	1204.8	0.01950	1.05535
460.0	445.3	458.50	439.8	765.0	1204.8	0.01959	1.00921
480.0	465.3	462.82	444.7	760.0	1204.8	0.01967	0.96677
500.0	485.3	467.01	449.5	755.1	1204.7	0.01975	0.92762
520.0	505.3	471.07	454.2	750.4	1204.5	0.01982	0.89137
540.0	525.3	475.01	458.7	745.7	1204.4	0.01990	0.85771
560.0	545.3	478.84	463.1	741.0	1204.2	0.01998	0.82637
580.0	565.3	482.57	467.5	736.5	1203.9	0.02006	0.79712
600.0	585.3	486.20	471.7	732.0	1203.7	0.02013	0.76975
620.0	605.3	489.74	475.8	27.5	1203.4	0.02021	0.74408
640.0	625.3	493.19	479.9	723.1	1203.0	0.02028	0.71995
660.0	645.3	496.57	483.9	718.8	1202.7	0.02036	0.69724
680.0	665.3	499.86	487.8	714.5	1202.3	0.02043	0.67581
700.0	685.3	503.08	491.6	710.2	1201.8	0.02050	0.65556
720.0	705.3	506.23	495.4	706.0	1201.4	0.02058	0.63639
740.0	725.3	509.32	499.1	701.9	1200.9	0.02065	0.61822
760.0	745.3	512.34	502.7	697.7	1200.4	0.02072	0.60097
780.0	765.3	515.30	506.3	693.6	1199.9	0.02080	0.58457
800.0	785.3	518.21	509.8	689.6	1199.4	0.02087	0.56896
820.0	805.3	521.06	513.3	685.5	1198.8	0.02094	0.55408
840.0	825.3	523.86	516.7	681.5	1198.2	0.02101	0.53988
860.0	845.3	526.60	520.1	677.6	1197.7	0.02109	0.52631
880.0	865.3	529.30	523.4	673.6	1197.0	0.02116	0.51333
900.0	885.3	531.95	526.7	669.7	1196.4	0.02123	0.50091
920.0	905.3	534.56	530.0	665.8	1195.7	0.02130	0.48901
940.0	925.3	537.13	533.2	661.9	1195.1	0.02137	0.47759
960.0	945.3	539.65	536.3	658.0	1194.4	0.02145	0.46662
980.0	965.3	542.14	539.5	654.2	1193.7	0.02152	0.45609
1000.0	985.3	544.58	542.6	650.4	1192.9	0.02159	0.44596
1050.0	1035.3	550.53	550.1	640.9	1191.0	0.02177	0.42224
1100.0	1085.3	556.28	557.5	631.5	1189.1	0.02195	0.40058
1150.0	1135.3	561.82	564.8	622.2	1187.0	0.02214	0.38073
1200.0	1185.3	567.19	571.9	613.0	1184.8	0.02232	0.36245
1250.0	1235.3	572.38	578.8	603.8	1182.6	0.02250	0.34556
1300.0	1285.3	577.42	585.6	594.6	1180.2	0.02269	0.32991
1350.0	1335.3	582.32	592.2	585.6	1177.8	0.02288	0.31536
1400.0	1385.3	587.07	598.8	567.5	1175.3	0.02307	0.30178
1450.0	1435.3	591.70	605.3	567.6	1172.9	0.02327	0.28909
1500.0	1485.3	596.20	611.7	558.4	1170.1	0.02346	0.27719
1600.0	1585.3	604.87	624.2	540.3	1164.5	0.02387	0.25545
1700.0	1685.3	613.13	636.5	522.2	1158.6	0.02428	0.23607
1800.0	1785.3	621.02	648.5	503.8	1152.3	0.02472	0.21861
1900.0	1885.3	628.56	660.4	485.2	1145.6	0.02517	0.20278
2000.0	1985.3	635.80	672.1	466.2	1138.3	0.02565	0.18831
2100.0	2085.3	642.76	683.8	446.7	1130.5	0.02615	0.17501
2200.0	2185.3	649.45	695.5	426.7	1122.2	0.02669	0.16272
2300.0	2285.3	655.89	707.2	406.0	1113.2	0.02727	0.15133
2400.0	2385.3	662.11	719.0	384.8	1103.7	0.02790	0.14076
2500.0	2485.3	668.11	731.7	361.6	1093.3	0.02859	0.13068
2600.0	2585.3	673.91	744.5	337.6	1082.0	0.02938	0.12110
2700.0	2685.3	679.53	757.3	312.3	1069.7	0.03029	0.11194
2800.0	2785.3	684.96	770.7	285.1	1055.8	0.03134	0.10305
2900.0	2885.3	690.22	785.1	254.7	1039.8	0.03262	0.09420
3000.0	2985.3	695.33	801.8	218.4	1020.3	0.03428	0.08500
3100.0	3085.3	700.28	824.0	169.3	993.3	0.03681	0.07452
3200.0	3185.3	705.08	875.5	56.1	931.6	0.04472	0.05663
3208.2	3193.5	705.47	906.0	0.0	906.0	0.05078	0.05078

CATEGORY 5
THEORY OF NUCLEAR POWER PLANT OPERATION
FLUIDS AND THERMODYNAMICS

*QUESTION
5-1 (0.5)
MULTIPLE CHOICE - SELECT THE BEST ANSWER

Refer to Figure 5-1, which shows two test manometers connected to a liquid waste hold-up tank for testing the tank level instrumentation.

The liquid level in the tank is:

(a) 5 feet
(b) 7 feet
(c) 12 feet
(d) 19 feet

*ANSWER
(c)
*REFERENCE
Thermo-Hydraulic Principles, 2-17 to 26 and 11-27
*KW

*QUESTION
5-2 (0.5)
MULTIPLE CHOICE - SELECT THE BEST ANSWER

Refer to Figure 5-1, which shows two test manometers connected to a liquid waste hold-up tank for testing the tank level instrumentation.

The pressure in the tank is equivalent to:

(a) 5 feet of water gauge pressure.
(b) 7 feet of water gauge pressure.
(c) 27 feet of water absolute pressure.
(d) 29 feet of water absolute pressure.

*ANSWER
(a)
*REFERENCE
Thermo-Hydraulic Principles, 2-17 to 26 and 11-27
*KW

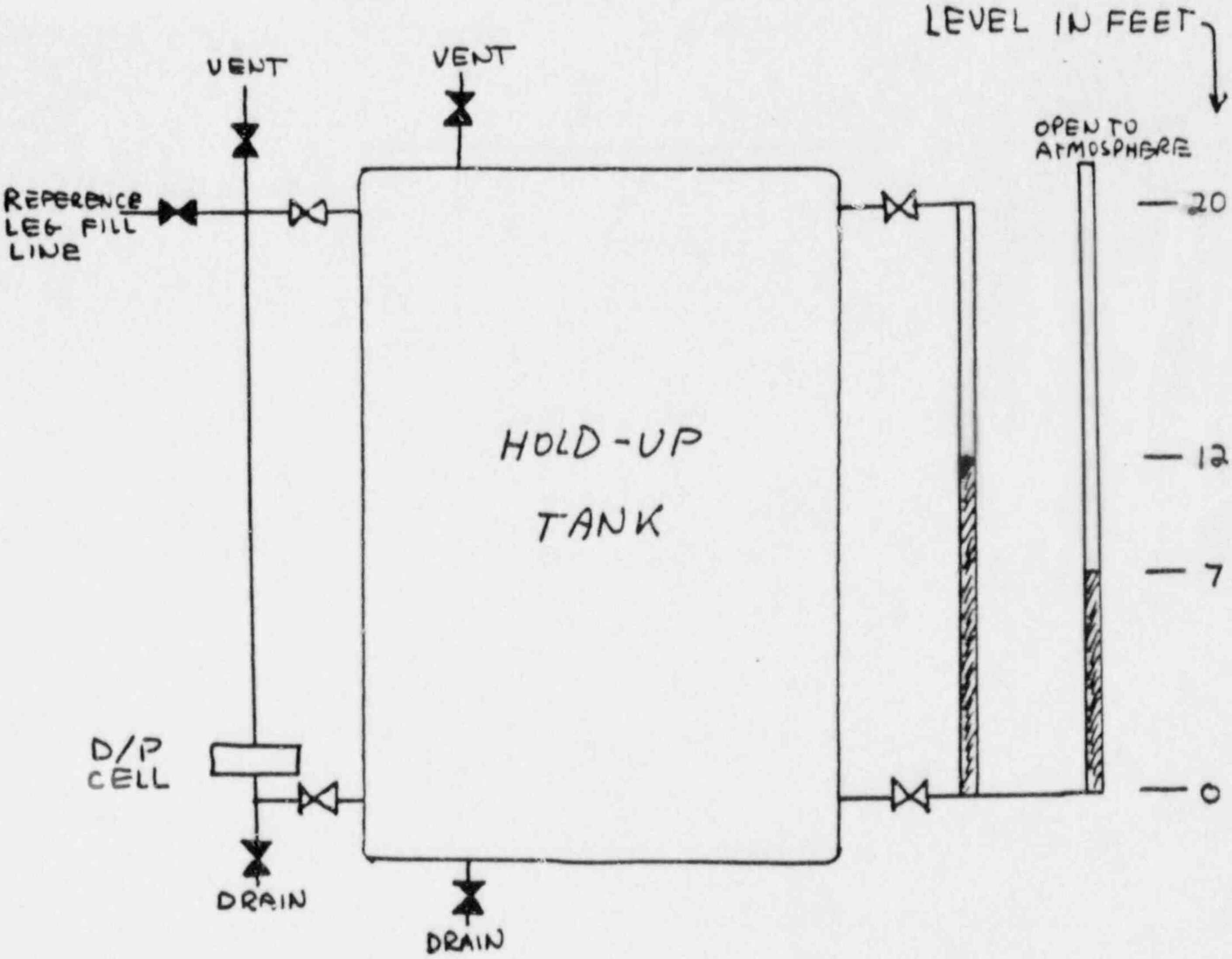

LEVEL IN FEET
VENT
VENT
OPEN TO ATMOSPHERE
REFERENCE LEG FILL LINE
20
HOLD-UP TANK
12
7
D/P CELL
0
DRAIN
DRAIN

FIGURE 5-1

*QUESTION
5-3 (0.5)
MULTIPLE CHOICE - SELECT THE BEST ANSWER
Refer to Figure 5-1, which shows two test manometers connected to a liquid waste hold-up tank for testing the tank level instrumentation. The level instrument is a differential pressure cell with a reference leg which has been filled with air.

As tank level is increased the indication from the D/P cell:

(a) will not indicate correct initial level but will indicate correct changes in level.
(b) will indicate correct initial level but will indicate changes smaller than actual.
(c) will not indicate correct initial level and will indicate changes smaller than actual.
(d) will indicate correct initial level but will indicate changes in level larger than actual.

*ANSWER
(a)
*REFERENCE
Thermo-Hydraulic Principles, 2-17 to 26 and 11-27
*KW

*QUESTION
5-4 (0.5)
MULTIPLE CHOICE - SELECT THE BEST ANSWER
Refer to Figure 5-1, which shows two test manometers connected to a liquid waste hold-up tank for testing the tank level instrumentation. The level instrument is a differential pressure cell with a reference leg which is filled with of water.

When the reference leg is colder than the tank the indication from the D/P cell:

(a) may not indicate correct initial level but will indicate correct changes in level.
(b) will indicate correct initial level but will indicate changes smaller than actual.
(c) may not indicate correct initial level and will indicate changes smaller than actual.
(d) will indicate correct initial level but will indicate changes in level larger than actual.

*ANSWER
(a) or (c)
*REFERENCE
Thermo-Hydraulic Principles, 2-17 to 26 and 11-27
*KW

*QUESTION
5-5 (0.5)
MULTIPLE CHOICE - SELECT THE BEST ANSWER

Refer to Figure 5-2 "Enthalpy vs Entropy for Water" to answer the following question.

A line of constant temperature is depicted by line:

(a) line A.
(b) line B.
(c) line C.
(d) line D.

*ANSWER
(a)
*REFERENCE
Thermal-Hydraulic Principles, 2-69 and 7-8 to 7-16
*KW

*QUESTION
5-6 (0.5)
MULTIPLE CHOICE - SELECT THE BEST ANSWER

Refer to Figure 5-3 "Temperature vs Entropy for Water" to answer the following question.

A region of compressed liquid is indicated by:

(a) region A.
(b) region B.
(c) region C.
(d) region D.

*ANSWER
(a)
*REFERENCE
Thermal-Hydraulic Principles, 2-69 and 7-8 to 7-16
*KW

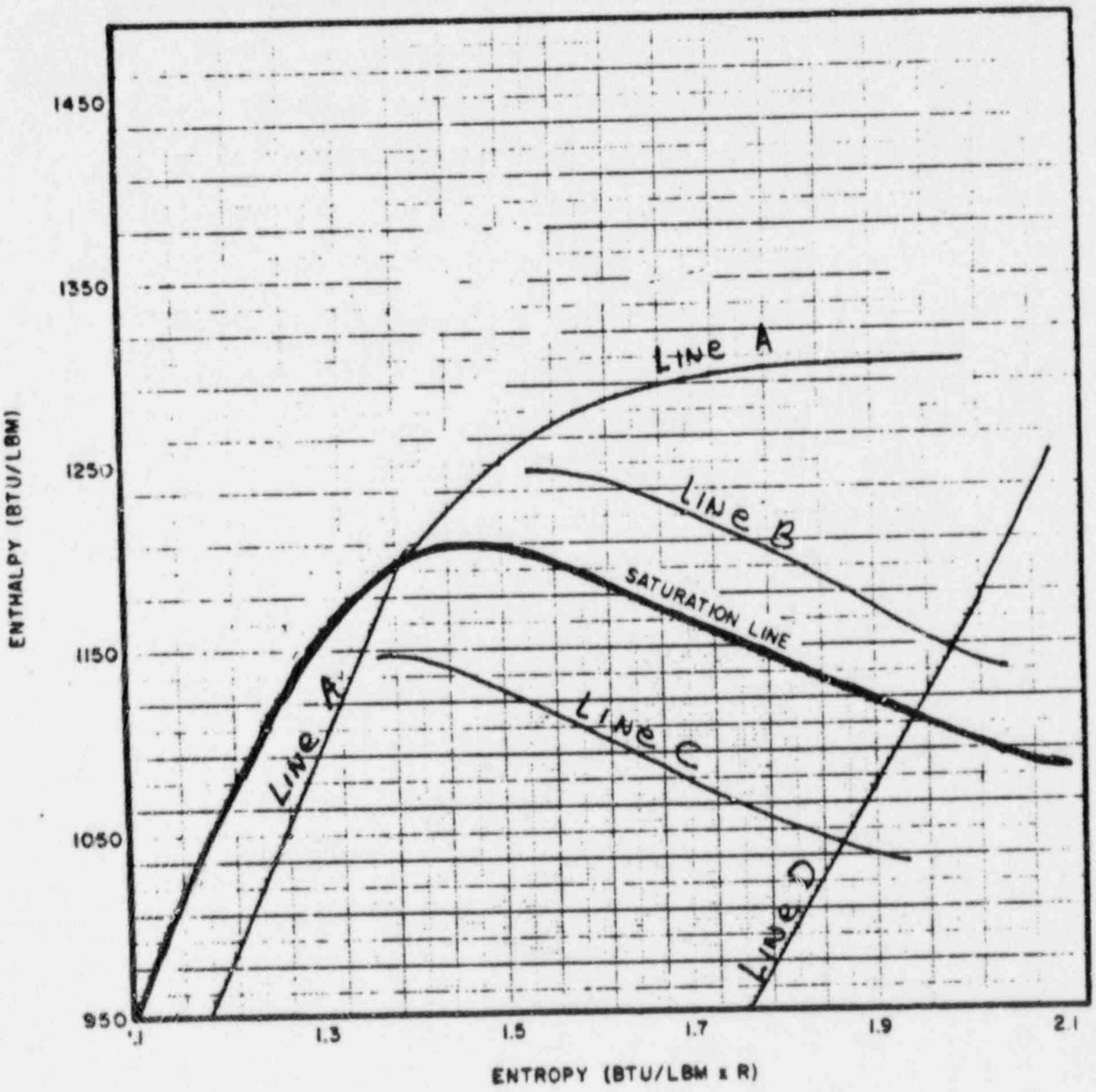


FIGURE 5-2 ENTHALPY VS. ENTROPY FOR WATER

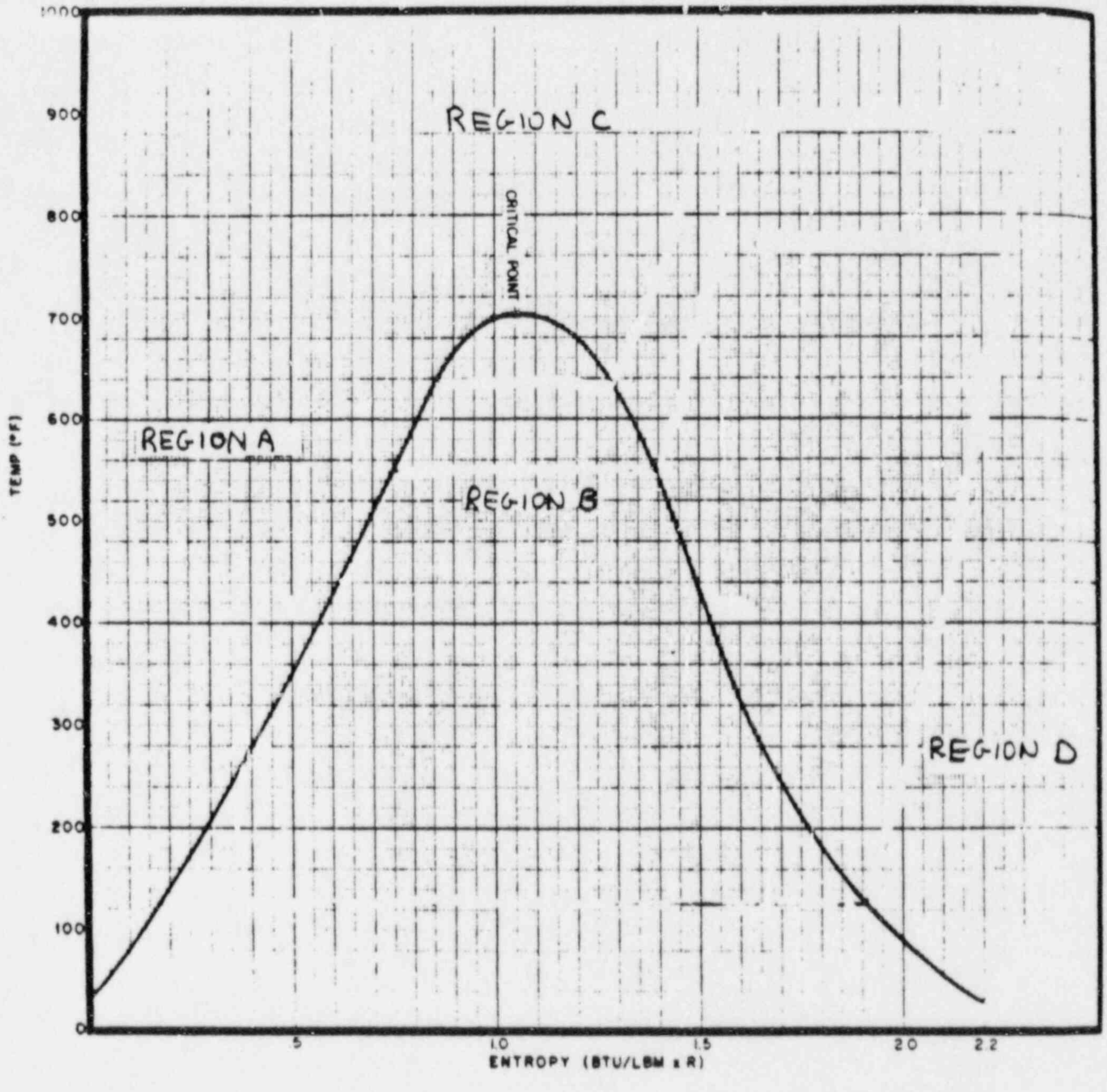


FIGURE 5-3. TEMPERATURE VS. SPECIFIC ENTROPY

*QUESTION
5-7 (2.0)
MATCHING - SELECT THE BEST CHOICE

Refer to the attached Figure 5-4, which is a simplified temperature - entropy (T-s) diagram of the Diablo Canyon Power Plant steam cycle. The numbered points on the figure are parts of the steam cycle which identify beginning or end points of various processes.

Match each process listed below (a through f) with its' corresponding numbers on the T-s diagram. Allowable choices are at least two numbers and may include three numbers. (examples: "1-2" or "1-2-3" are possible answers while "1" or "1-2-3-4" are not acceptable.) (0.33 each)

(a) Work out of the HP turbine
(b) Vaporization in steam generator
(c) Feedwater heating
(d) Reheater superheating
(e) Condensing in the condenser
(f) Heat addition by the steam generators

*ANSWER
(a) 4-5
(b) 3-4
(c) 1-2 or 1-2-3 [with 3-4 selected for (f)]
(d) 6-7
(e) 8-1
(f) 2-3-4 or 3-4 [with 1-2-3 selected for (c)]
*REFERENCE
Thermal-Hydraulic Principles, 7-80 through 7-91
*KW

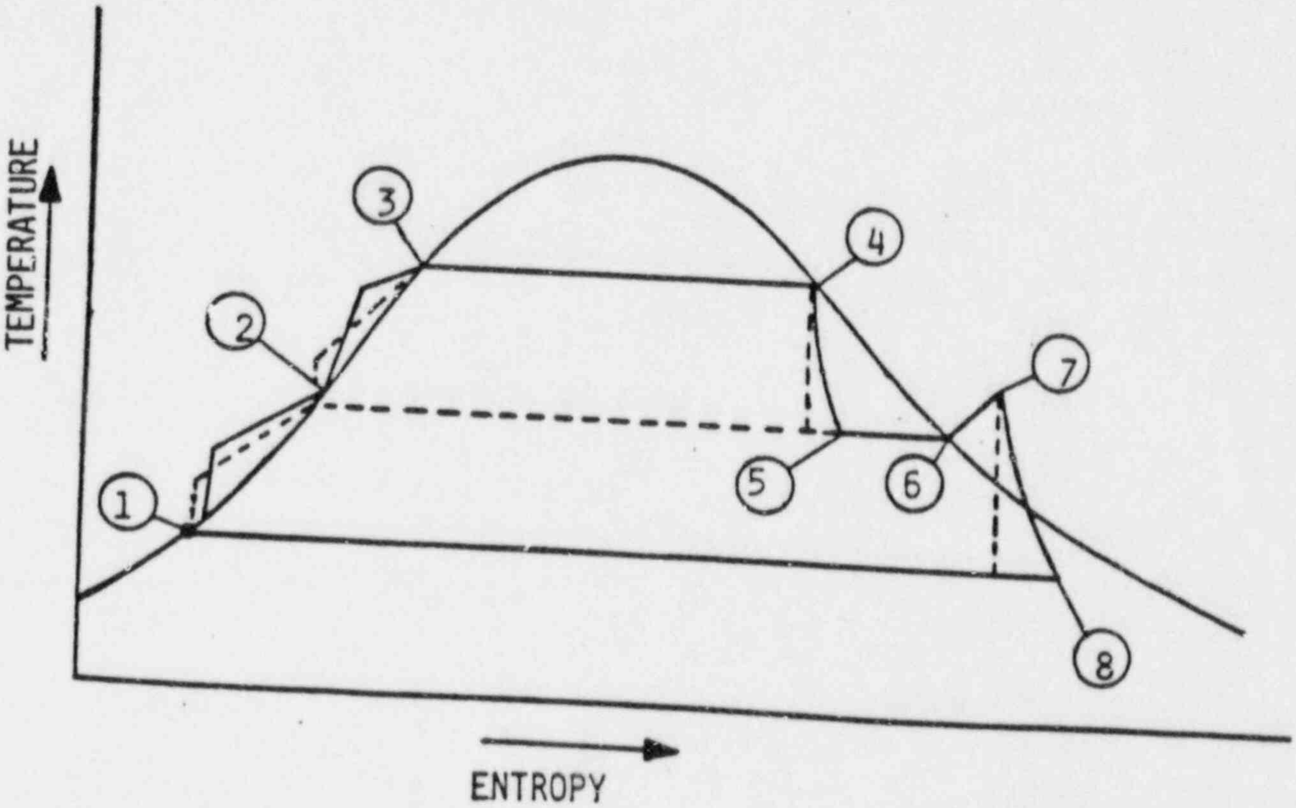
*QUESTION
5-8 (1.5)

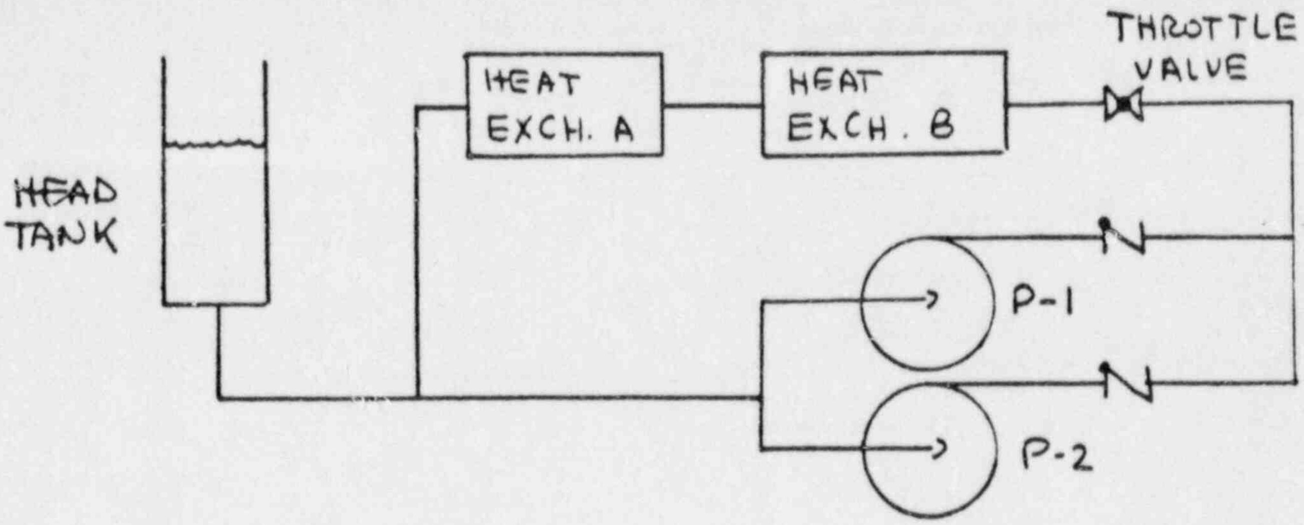
Refer to Figure 5-5 which is a sketch of a closed cooling water system, the system characteristic curve, and pump P-1 characteristic curve. Both pumps are identical.

(a) On Figure 5-5 sketch and label the new pump curve when both pumps P-1 and P-2 are running. Indicate the new operating point. (0.75)
(b) On Figure 5-5 sketch and label the new system curve when the throttle valve is partially closed. Indicate the new operating point with pump P-1 running. (0.75)

*ANSWER
See attached drawing
*REFERENCE
Thermal-Hydraulic Principles, 10-41 THROUGH 10-48
*KW

FIGURE 5-4




THROTTLE VALVE
HEAT EXCH. A
HEAT EXCH. B
HEAD TANK
P-1
P-2

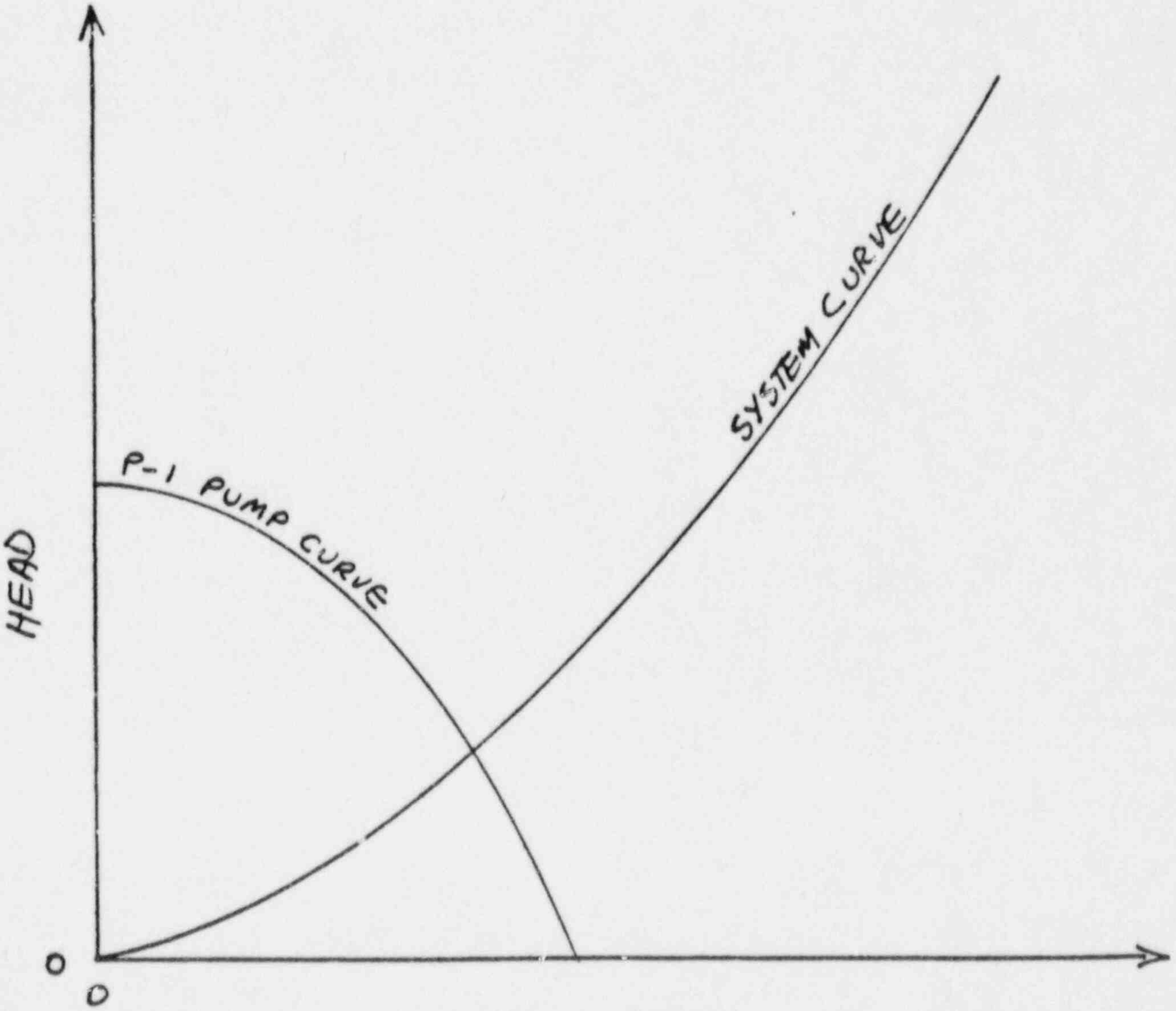
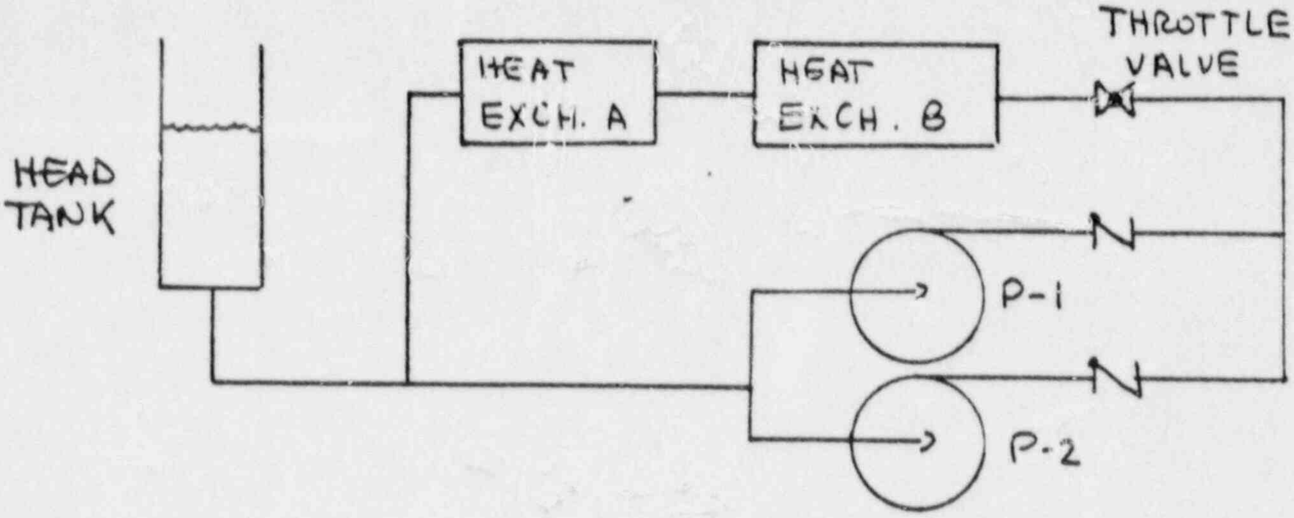

HEAD
SYSTEM CURVE
P-1 PUMP CURVE
0
0
FLOW RATE

FIGURE 5-5



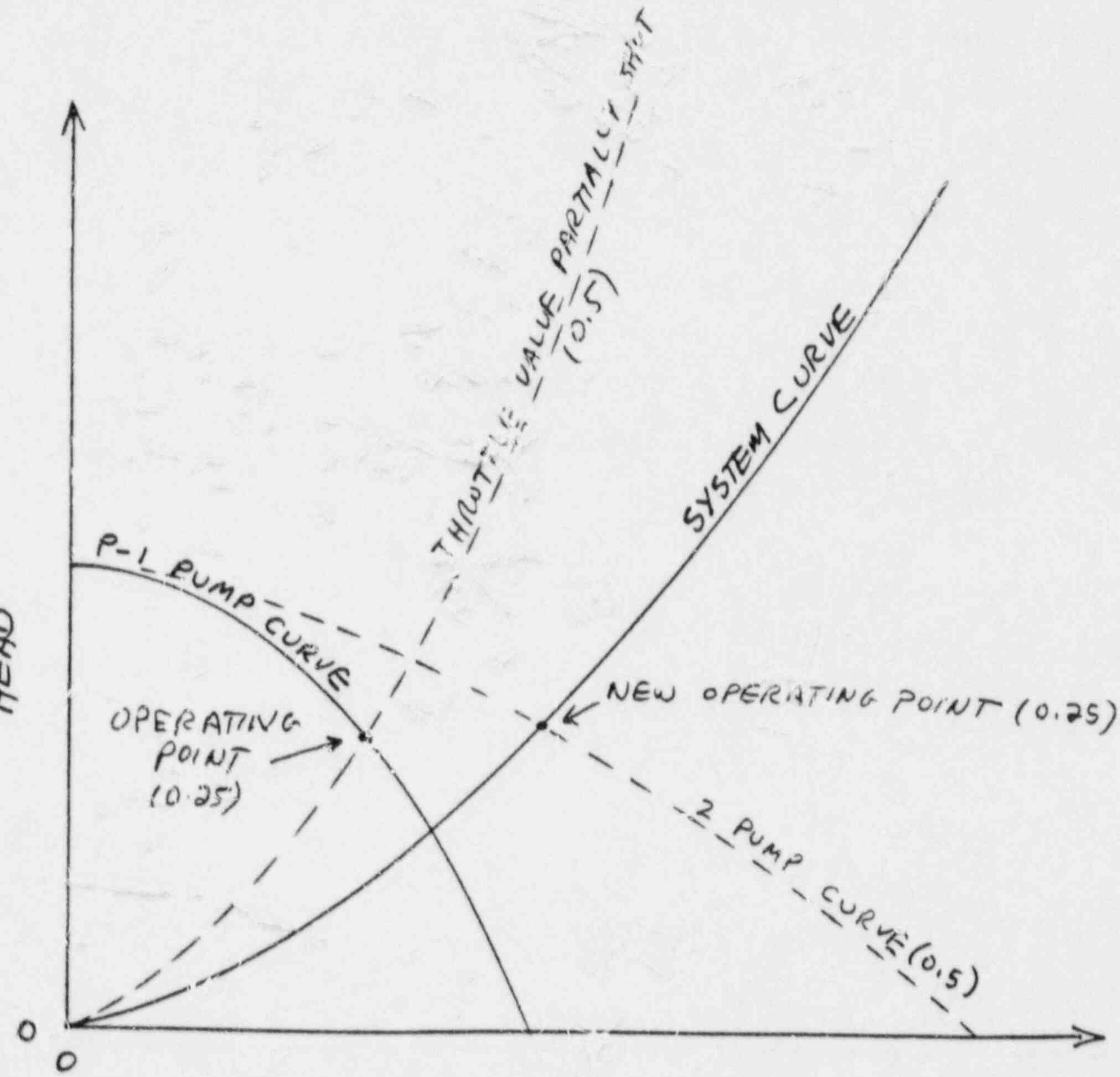


FIGURE 5-5 (KEY)

*QUESTION
5-9 (1.5)

Refer to Figure 5-5 which is a sketch of an idealized closed cooling water system, the system characteristic curve, and one pumps' characteristic curve. Pump P-1 is initially operating at 36 PSID, 1000 GPM, 24 amps, and 1800 RPM. Pump P-2 is off.

(a) If pump speed is changed to 1200 RPM, what is the new flow rate? (0.75)

(b) If pump speed is changed to 1200 RPM, what is the new current? (0.75)

*ANSWER

(a) N1/N2=Q1/Q2, 1200/1800=X/1000, X= 667 GPM (0.75)

(B) (N1/N2)**3=P1/P2, 0.296=X/24(power proportional to current), X= 7 AMPS (0.75)

*REFERENCE
Thermal-Hydraulic Principles, 10-34 through 10-41
*KW

*QUESTION
5-10 (2.0)

A calorimetric is being conducted to calibrate nuclear instrumentation. The following data has been recorded or is known.

Indicated power NIs	99.5%	99.4%	99.5%	99.4%
Feedwater temperature	440 F			
Loop---------->	1	2	3	4
Feedwater flows (x 10+6 lbm/hr)	3.75	3.78	3.77	3.77
Steam pressure (PSIG)	994	989	990	990

Reactor coolant pumping power 20 MW

Losses to ambient 7 MW

Steam generator blowdown 0 gpm

(a) What is the total reactor power in Megawatts? (1.5)

(b) If blowdown flow was actually 400 gpm how would the calculated power be affected? (higher, lower, or stay the same) (0.5)

*ANSWER

(a) QRx + QRCPs = M(Hst-Hfw) + Qamb (0.4)
QR = 1.507x10+7 * (1193-419) - 20MW + 7MW (0.4)
QR = (1.1664x10+10 Btu/hr/3413000 Btu/hr-MW) - 13MW (0.4)
QR = 3418MW - 13MW = 3405MW (0.3)

(b) The calculated power would be lower (since the blowdown would have a lower enthalpy than steam) (0.5)

*REFERENCE
Thermal-Hydraulic Principles, 13-41 through 13-44
*KW

*QUESTION
5-11 (0.5)
MULTIPLE CHOICE - SELECT THE BEST ANSWER

The primary coolant system is maintained at a pH between 4.2 and 10.5. PH is:

(a) a measure of the oxidation-reduction potential of a water solution.
(b) a measure of the hydrogen ion concentration on a logarithmic scale.
(c) a measure of disassociation of water into hydrogen and oxygen as temperature rises.
(d) a measure of the chemical activity of dissolved solids in a water solution.

*ANSWER
(b)
*REFERENCE
Radiation, Chemistry, and Corrosion Considerations, page 6-5
*KW

*QUESTION
5-12 (0.5)
MULTIPLE CHOICE - SELECT THE BEST ANSWER

Corrosion rates of most metals in a water environment will decrease when:

(a) flow velocity increases and pH is neutral or slightly higher.
(b) flow velocity increases and pH is neutral or slightly lower.
(c) flow velocity decreases and pH is neutral or slightly higher.
(d) flow velocity decreases and pH is neutral or slightly lower.

*ANSWER
(c)
*REFERENCE
Radiation, Chemistry, and Corrosion Considerations, page 6-13
*KW

*QUESTION
5-13 (0.5)
MULTIPLE CHOICE - SELECT THE BEST ANSWER

The recombination of oxygen and hydrogen in a nuclear reactor is promoted by:

(a) a high temperature.
(b) a high gamma flux.
(c) a high neutron flux.
(d) a high radiation flux.

*ANSWER
(b)
*REFERENCE
Radiation, Chemistry, and Corrosion Considerations, page 7-5
*KW

*QUESTION
5-14 (0.5)
MULTIPLE CHOICE - SELECT THE BEST ANSWER

Lithium hydroxide is added to the primary coolant system to:

(a) prevent the formation of nitric acid.
(b) reduce the disassociation of water to oxygen.
(c) control the pH of the coolant water.
(d) strip metal surfaces of deposits removed by purification.

*ANSWER
(c)
*REFERENCE
Radiation, Chemistry, and Corrosion Considerations, page 7-17
*KW

*QUESTION
5-15 (0.5)
MULTIPLE CHOICE - SELECT THE BEST ANSWER

Most of the tritium in the reactor coolant comes from:

(a) activation of hydrogen in water.
(b) activation of deuterium in water.
(c) fission product leaking through the cladding.
(d) neutron reactions with boron in the coolant.

*ANSWER
(d)
*REFERENCE
Radiation, Chemistry, and Corrosion Considerations, page 7-14
*KW

*QUESTION
5-16 (0.5)
MULTIPLE CHOICE - SELECT THE BEST ANSWER

When reactor power is rapidly increasing:

(a) reactor period is a large positive value and startup rate is a large positive value.
(b) reactor period is a large positive value and startup rate is a small positive value.
(c) reactor period is a small positive value and startup rate is a large positive value.
(d) reactor period is a small positive value and startup rate is a small positive value.

*ANSWER
(c)
*REFERENCE
Fundamentals of Nuclear Reactor Physics, page 7-17
*KW

*QUESTION
5-17 (0.75)
MULTIPLE CHOICE - SELECT THE BEST ANSWER

A reactor is at 10E-10 amps power and has a start-up rate of 0.5 DPM. How long will it take to reach 10E-6 amps?

(a) 2 minutes
(b) 4 minutes
(c) 8 minutes
(d) 20 minutes

*ANSWER
(c)
*REFERENCE
Fundamentals of Nuclear Reactor Physics, page 7-19
*KW

*QUESTION
5-18 (1.0)
MULTIPLE CHOICE - SELECT THE BEST ANSWER

A reactor is at 10E-10 amps power and has a start-up rate of + 1.3 DPM. What amount of reactivity must be added to cause the reactor to be just critical? (Note: b= 0.005 and L=0.1)

(a) -250 pcm
(b) -210 pcm
(c) -167 pcm
(d) -114 pcm

*ANSWER
26/1.3=20 20=(b-p)/Lp 20=(0.005-p)/0.1(p) 2p=0.005-p 3p=0.005
p=0.00167 p=+167 pcm with +1.3 DPM
(c)
*REFERENCE
Fundamentals of Nuclear Reactor Physics, page 7-21 and 7-42
*KW

*QUESTION
5-19 (1.0)
MULTIPLE CHOICE - SELECT THE BEST ANSWER

A reactor is subcritical with 10 counts per second indicated, Keff=0.93, hot, no xenon, and all rods in. The shutdown banks, worth 4000 pcm are withdrawn. What is the new count rate?

(a) 21 CPS
(b) 41 CPS
(d) 64 CPS
(d) 90 CPS

*ANSWER
0.04=(x-0.93)/0.93(x) 0.0372(x)=x-0.93 0.9626(x)=0.93 x=0.9661
CR0/CR1=(1-K1)/(1-K0) 10/CR=(0.0339/0.07) CR=21 CPS
(a) 21 CPS
*REFERENCE
Fundamentals of Nuclear Reactor Physics, Chapter 8
*KW

*QUESTION
5-20 (1.0)

Refer to Figure 5-6 which shows negative reactivity being inserted into an initially supercritical core Sketch the resulting (log scale) fission rate as a function of time. Specific numbers are not desired, however the shape and slope of the curve describing the fission rate should be shown.

*ANSWER
See attached sheet
*REFERENCE
Fundamentals of Nuclear Reactor Physics, page 7-67
*KW

*QUESTION
5-21 (1.0)

Refer to Figure 5-7 which shows positive reactivity being inserted into an initially subcritical core. Sketch the resulting fission rate as a function of time. The shape of the curve describing the fission rate and steady state values (if any) should be shown.

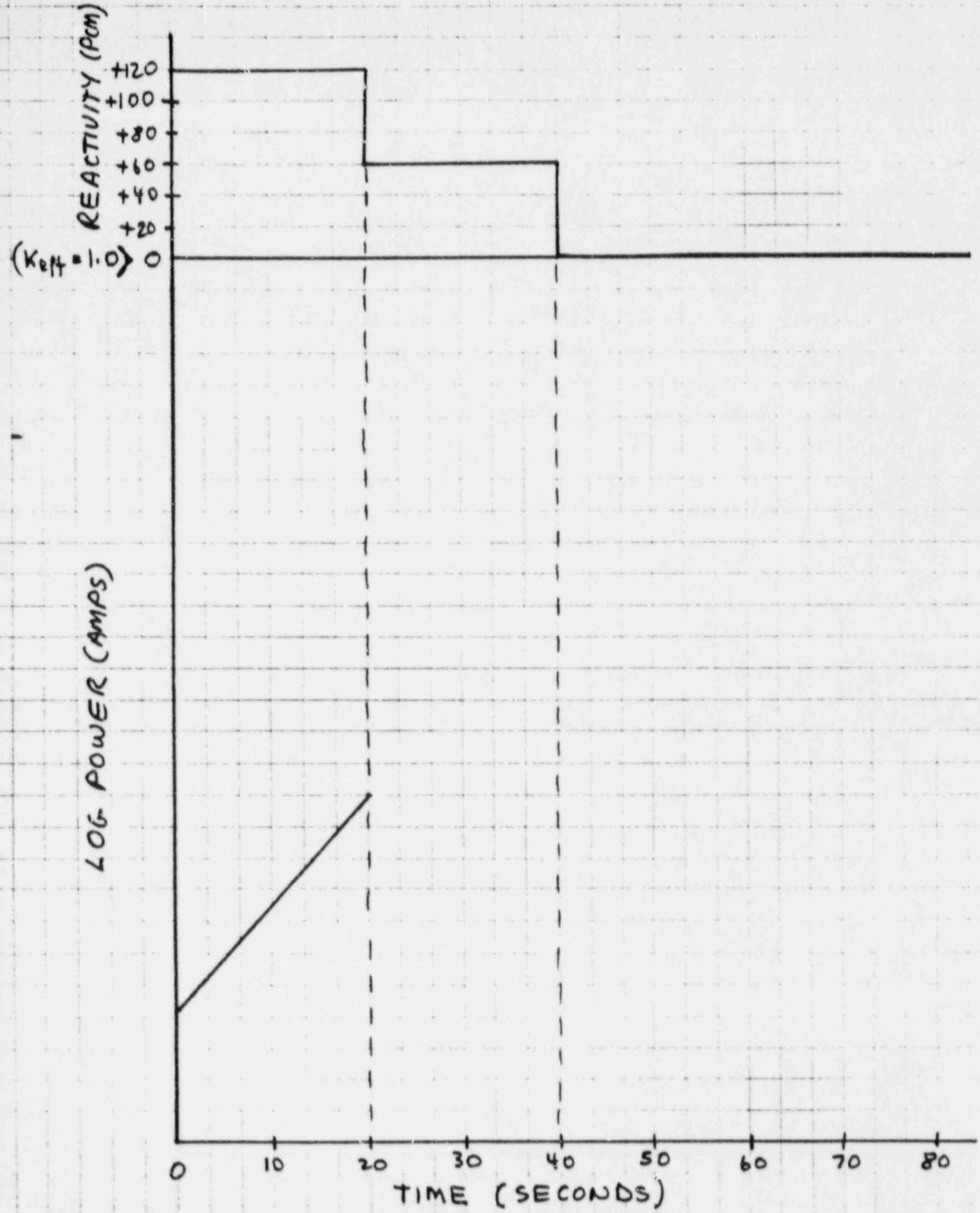
*ANSWER
See attached sheet
*REFERENCE
Fundamentals of Nuclear Reactor Physics, page 8-55
*KW

*QUESTION
5-22 (1.0)
MULTIPLE CHOICE - SELECT THE BEST ANSWER

The difference between delta I and Axial Offset is:

(a) delta I =P(lower)-P(upper) while axial offset=P(upper)-P(lower) devided by P(upper)+P(lower)
(b) delta I =P(upper)-P(lower) while axial offset=P(upper)-P(lower) devided by P(upper)+P(lower)
(c) delta I =P(lower)-P(upper) while axial offset=P(lower)-P(upper) devided by P(lower)+P(upper)
(d) delta I =P(upper)-P(lower) while axial offset=P(lower)-P(upper) devided by P(lower)+P(upper)

*ANSWER
(b)
*REFERENCE
Reactor Core Control for Large PWRs, Chapter 8
*KW



REACTIVITY (PCM)
+120
+100
+80
+60
+40
+20
(Keff = 1.0) 0
LOG POWER (AMPS)
0
10
20
30
40
50
60
70
80
TIME (SECONDS)

FIGURE 5-6

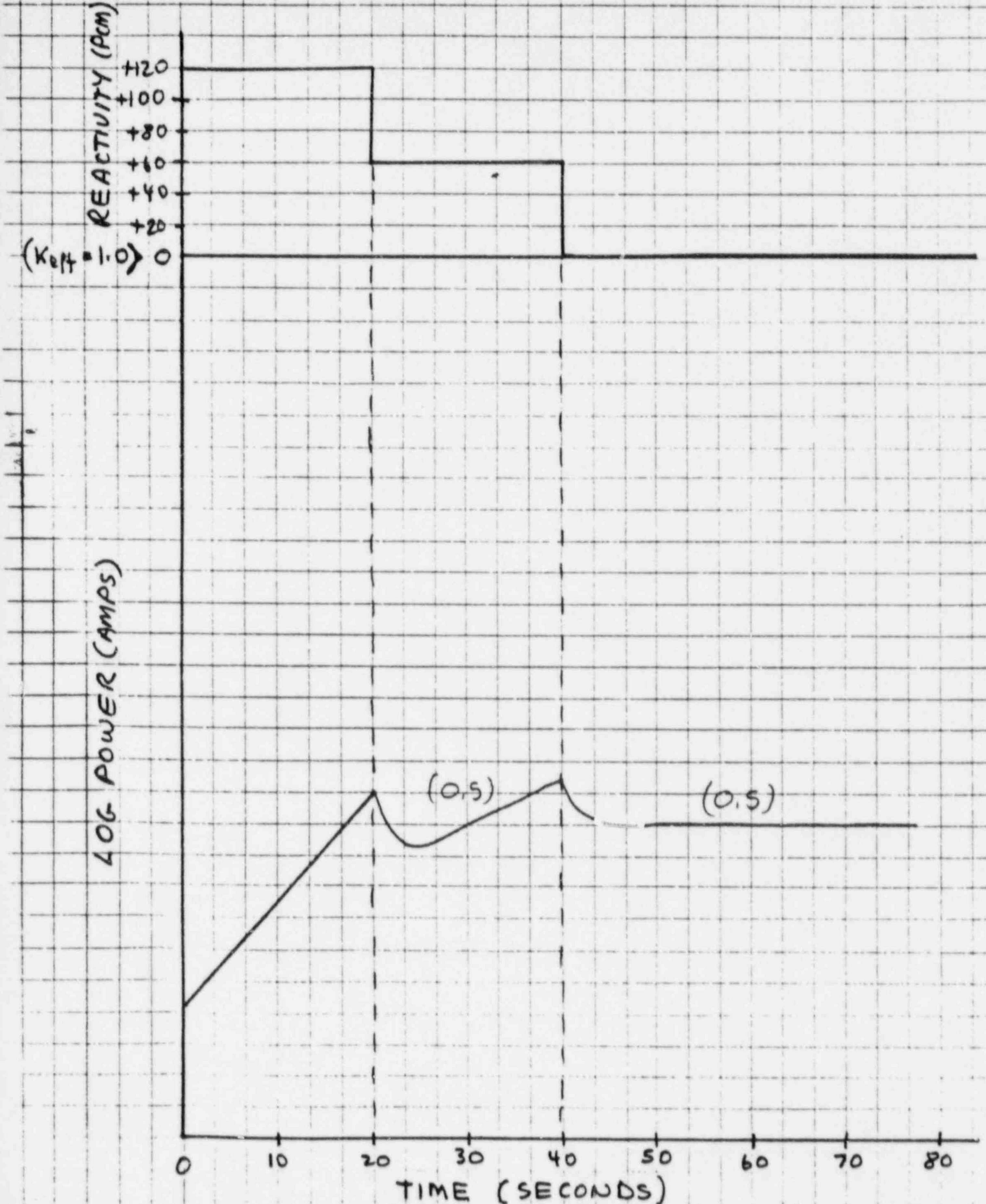


FIGURE 5-6 (KEY)

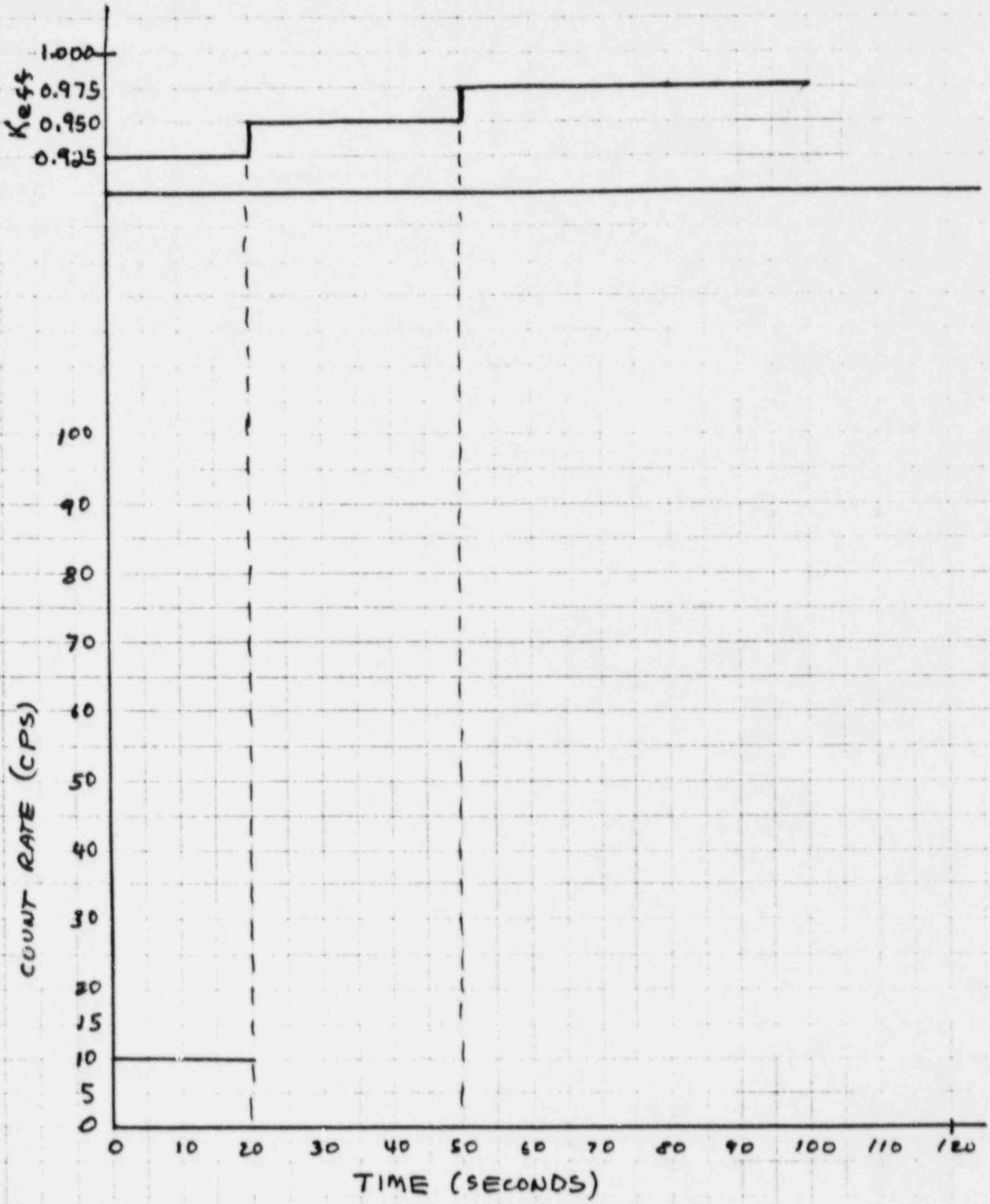

Keff
1.000
0.975
0.950
0.925
COUNT RATE (CPS)
100
90
80
70
60
50
40
30
20
15
10
5
0
0
10
20
30
40
50
60
70
80
90
100
110
120
TIME (SECONDS)

FIGURE 5-7

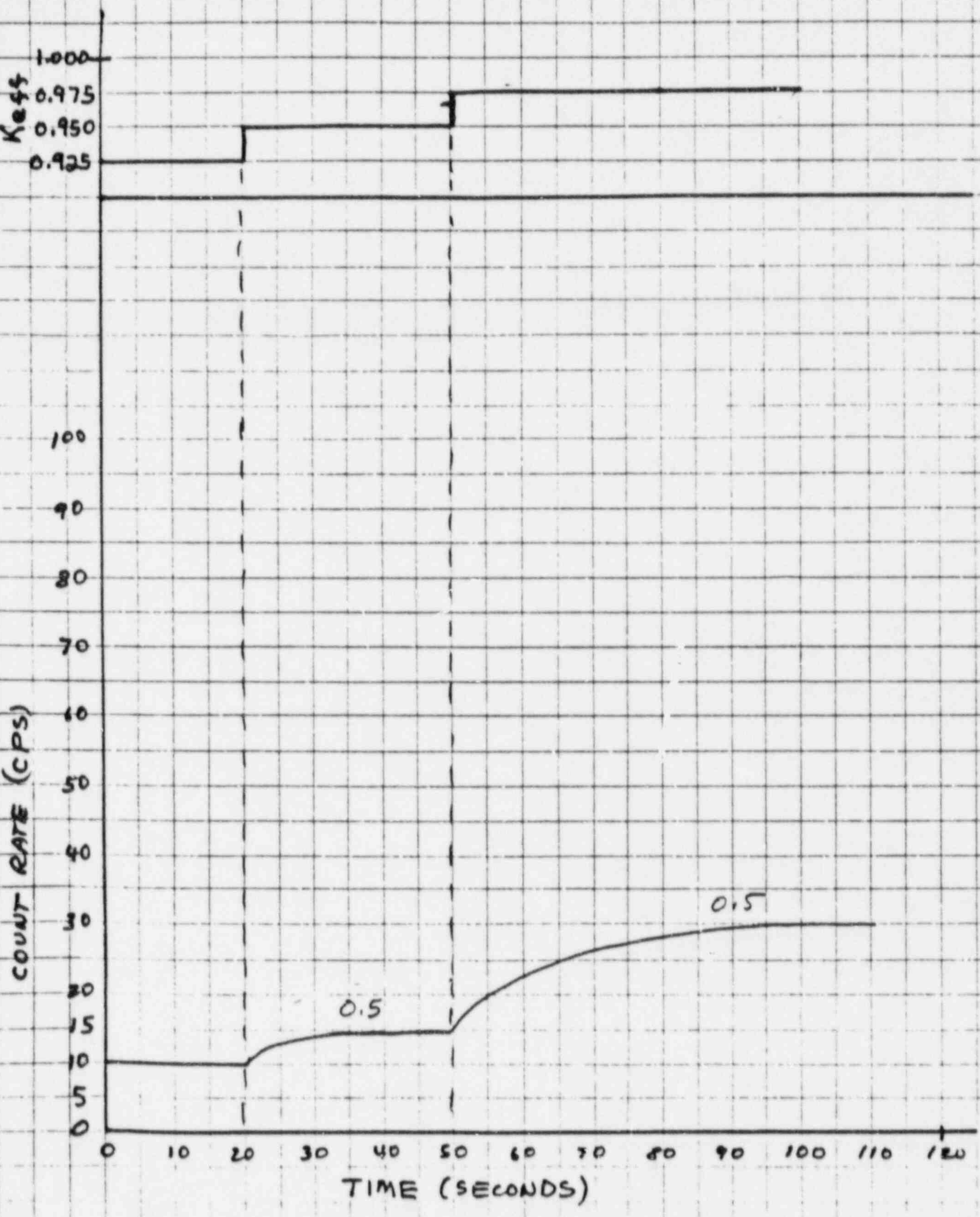


FIGURE 5-7 (KEY)

*QUESTION
5-23 (0.5)
MULTIPLE CHOICE - SELECT THE BEST ANSWER

Unit 1 has been operating at 50% power for six months. Power is then increased to 100%. Equilibrum xenon will:

(a) increase by more than 50%.
(b) increase by 50%.
(c) increase by less than 50%
(d) stay the same.

*ANSWER
(c)
*REFERENCE
Reactor Core Control for Large PWRs, Chapter 4
*KW

*QUESTION
5-24 (0.5)
MULTIPLE CHOICE - SELECT THE BEST ANSWER

Unit 1 has been operating at 50% power for six months. Power is then increased to 100%. Equilibrum samarium will:

(a) increase by more than 50%.
(b) increase by 50%.
(c) increase by less than 50%
(d) stay the same.

*ANSWER
(d)
*REFERENCE
Reactor Core Control for Large PWRs, Chapter 4 (4-31)
*KW

*QUESTION
5-25 (0.75)
MULTIPLE CHOICE - SELECT THE BEST ANSWER

Xenon burn-out will cause the fastest reactivity change when:

(a) power is increased rapidly after a long shutdown.
(b) power is increased rapidly after a short shutdown.
(c) power is increased slowly after a long shutdown.
(d) power is increased slowly after a short shutdown.
*ANSWER
(b)
*REFERENCE
Reactor Core Control for Large PWRs, Chapter 4
*KW

*QUESTION
5-26 (1.5)

Diablo Canyon Unit 2 is initially operating at beginning of life, 2 GWD/MTU, 70% power, 180 steps on control bank D, 1200 ppm boron, Tave is programed normally with the RCS in auto. Use the attached Figures 5-8, 5-9, 5-10, 5-11, 5-12,and 5-13 to answer the following.

With no rod motion what change in boron concentration would be necessary to increase power to 90% over a period of 30 minutes?

*ANSWER
70% to 90% @1200ppm = 850 to 1075 pcm = 225 pcm
-123 ppm/%dp x 0.225 = [-28 +/-3 ppm]
or 225 pcm/10 pcm/ppm = [-22.5 +/-3 ppm]
*REFERENCE
Reactor Core Control for Large PWRs, Chapter 5 and 9
*KW

*QUESTION
5-27 (1.5)

Diablo Canyon Unit 2 is initially operating at beginning of life, 2 GWD/MTU, 70% power, 180 steps on control bank D, 1200 ppm boron, Tave is programed normally with the RCS in auto. Use the attached Figures 5-8, 5-9, 5-10, 5-11, 5-12,and 5-13 to answer the following.

What new rod position would be necessary to decrease power to 50% in 30 minutes?

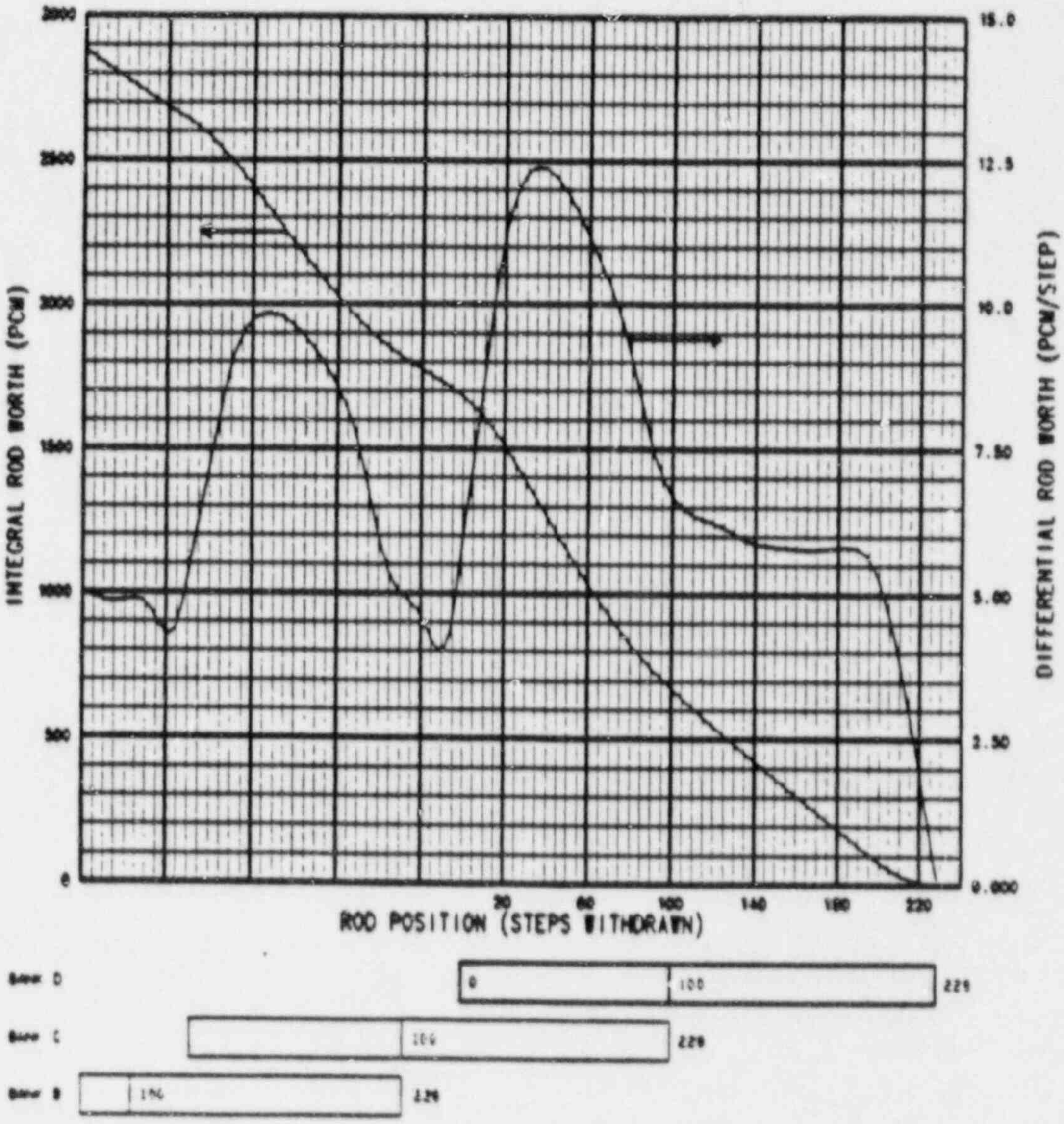
*ANSWER
70% to 50% power is 850 to 615 pcm = -235 pcm
-260 pcm @180 steps to -495 pcm [@137steps +/-5 steps bank D]
*REFERENCE
Reactor Core Control for Large PWRs, Chapter 6 and 9
*KW

DIABLO CANYON POWER PLANT OPERATION DATA

FIGURE 5 - 8

DIFFERENTIAL AND INTEGRAL ROD WORTH VS. STEPS WITHDRAWN, BANKS D, C, B, AND A MOVING WITH 100 STEP OVERLAP, AT BOL, HFP, EQUILIBRIUM XENON

CYCLE 2 FOR BURNUP < 7500 MWD/T



SOURCE: WCAP - 11450, Rev. 0, Figure 6.1

2
UNIT

DIABLO CANYON POWER PLANT OPERATION DATA

TABLE 5-9

HZP INTEGRAL WORTH AS A FUNCTION OF STEPS WITHDRAWN FOR BANKS D AND C WITH 100 STEP OVERLAP

(Cycle 2)

Steps Withdrawn

BANK C	BANK D	0-7500 MWD/T BOL. HZP Predicted Integral Worth	6500-EOL MWD/T Predicted Integral Worth
228	228	-0.0	-0.0
228	220	-10.0	-50.0
228	210	-50.0	-160.0
228	200	-115.0	-320.0
228	190	-190.0	-500.0
228	180	-260.0	-630.0
228	170	-320.0	-760.0
228	160	-380.0	-870.0
228	150	-430.0	-940.0
228	140	-480.0	-1020.0
228	130	-530.0	-1080.0
228	120	-595.0	-1120.0
228	110	-650.0	-1160.0
228	100	-705.0	-1190.0
218	90	-780.0	-1250.0
208	80	-860.0	-1370.0
198	70	-960.0	-1500.0
188	60	-1060.0	-1610.0
178	50	-1170.0	-1730.0
168	40	-1300.0	-1840.0
158	30	-1420.0	-1910.0
148	20	-1515.0	-1990.0
138	10	-1600.0	-2040.0
128	0	-1660.0	-2080.0
118	0	-1705.0	-2100.0
108	0	-1740.0	-2120.0
98 Rod Insertion Limit	0	-1790.0	-2150.0

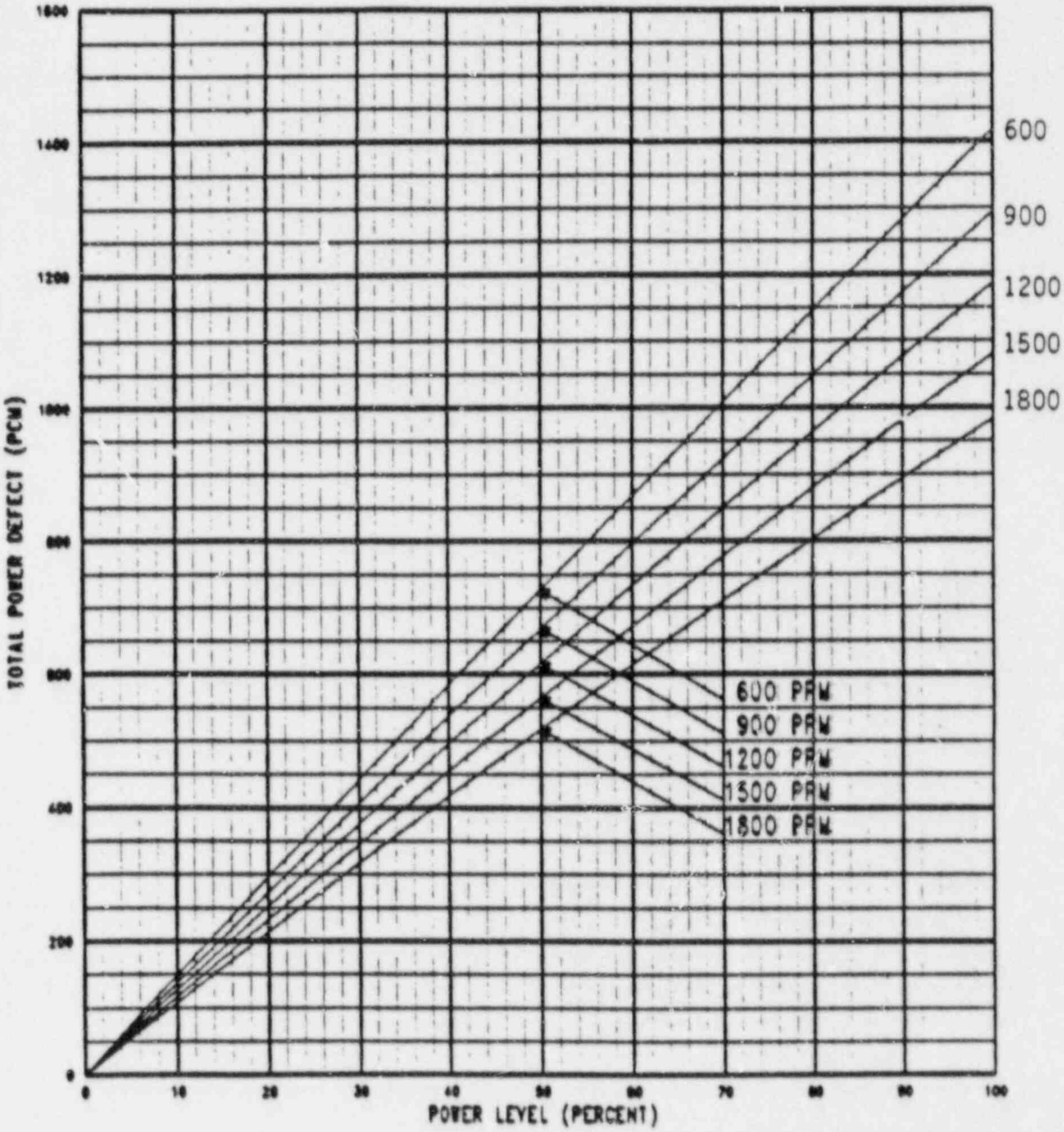
SOURCE: WCAP - 11450 Rev. 0 Figure A.4, Figure A.5.

DIABLO CANYON POWER PLANT OPERATION DATA

FIGURE 5-10

TOTAL POWER DEFECT AS A FUNCTION OF POWER LEVEL AT BOL

CYCLE 2 FOR BURNUP 0-5000 MWD/MTU



SOURCE: WCAP - 11466, Rev. 0, Figure 4.1

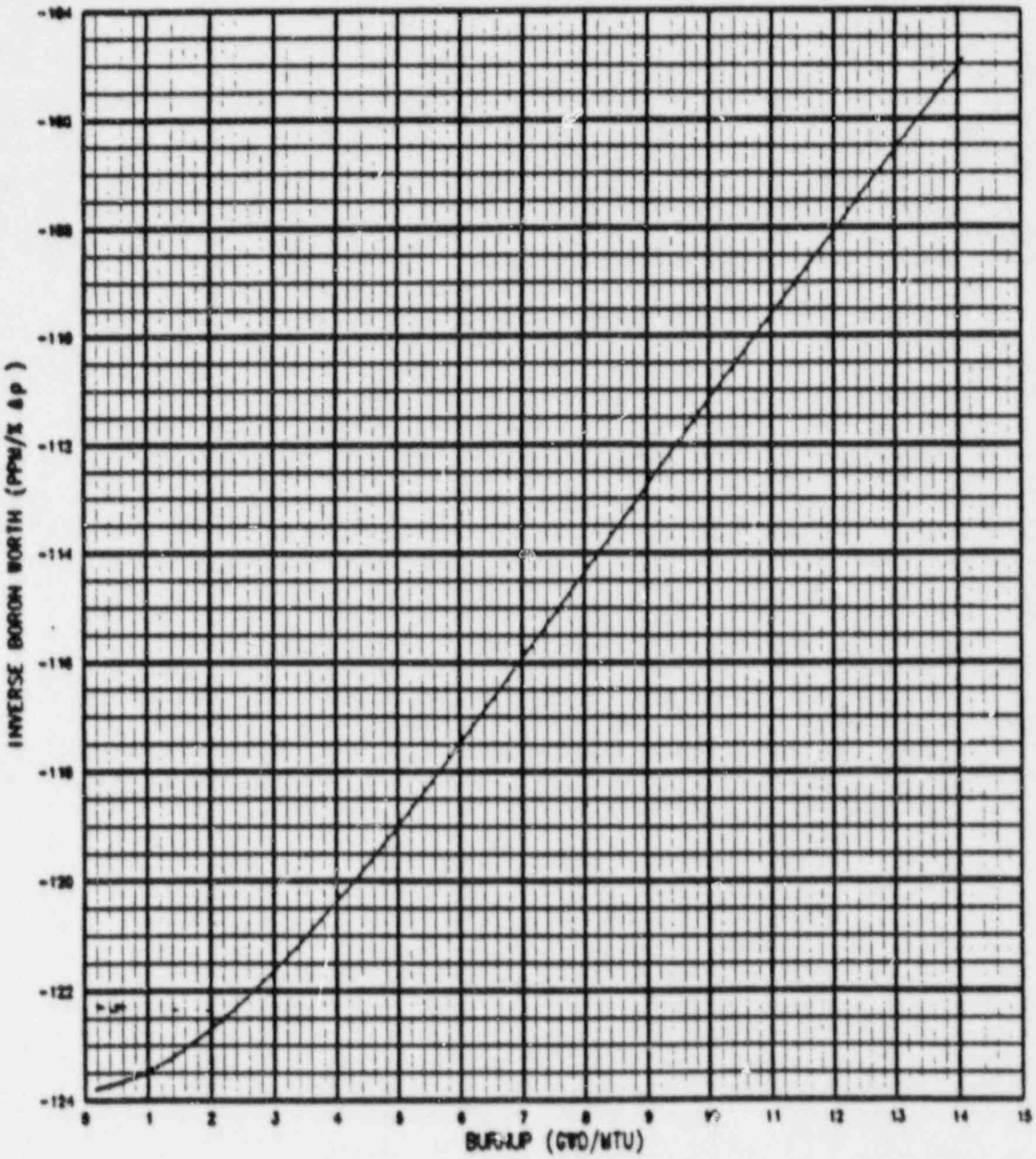
2
UNIT

DIABLO CANYON POWER PLANT OPERATION DATA

FIGURE 5 - 11

INVERSE BORON WORTH AT HFP, ARO, EQUILIBRIUM XENON VS. BURNUP

CYCLE 2



SOURCE: WCAP - 11450, Rev. 0, Figure 5.14

DIABLO CANYON POWER PLANT OPERATION DATA

2 UNIT

FIGURE 5-12

CYCLE 2

GOOD FOR 0-5000 MWD/T

BOL, BORON FREE XENON WORTH (PCM) VS. TIME FOLLOWING PLANT TRIP AFTER STEADY STATE OPERATION

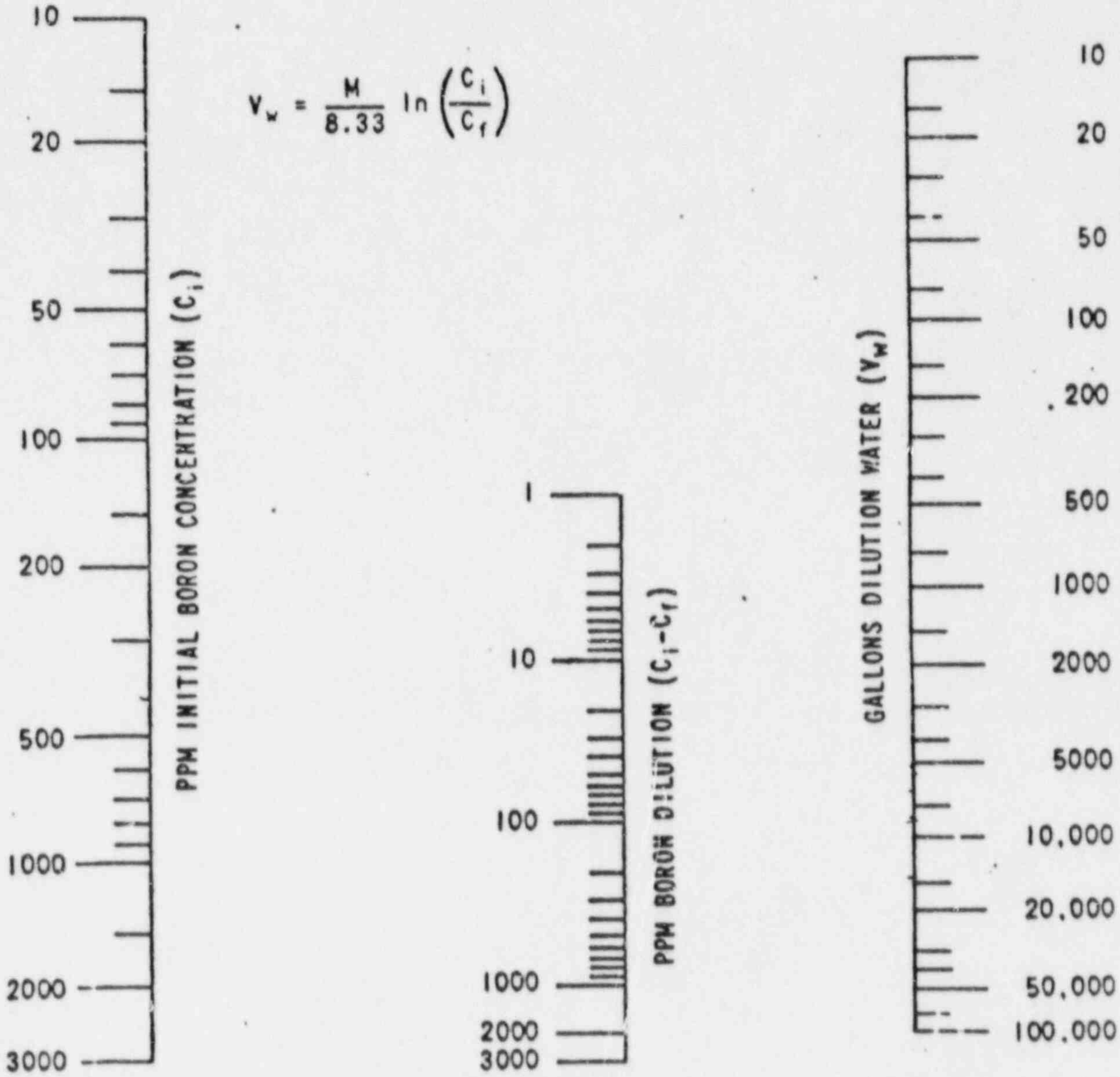
POWER LEVEL (%)	TIME AFTER PLANT TRIP (HOURS) 0	2	4	6	8	10	12	14	16	18	20	25	30	35
100	-3378	-4753	-5584	-6013	-6151	-6082	-5872	-5568	-5208	-4817	-4417	-3451	-2614	-1937
95	-3345	-4667	-5483	-5871	-5998	-5926	-5717	-5418	-5066	-4685	-4294	-3353	-2539	-1881
90	-3313	-4582	-5343	-5729	-5845	-5769	-5562	-5269	-4924	-4552	-4171	-3256	-2464	-1826
85	-3281	-4496	-5222	-5587	-5692	-5613	-5407	-5119	-4782	-4418	-4049	-3158	-2390	-1770
80	-3249	-4411	-5101	-5445	-5539	-5456	-5252	-4970	-4640	-4287	-3926	-3061	-2315	-1714
75	-3197	-4288	-4933	-5250	-5331	-5244	-5043	-4768	-4449	-4106	-3761	-2930	-2215	-1640
70	-3145	-4166	-4756	-5056	-5122	-5031	-4834	-4566	-4258	-3930	-3596	-2799	-2115	-1565
65	-3093	-4044	-4599	-4861	-4914	-4819	-4624	-4365	-4067	-3751	-3431	-2669	-2015	-1490
60	-3040	-3922	-4431	-4666	-4705	-4607	-4415	-4163	-3876	-3573	-3266	-2538	-1915	-1416
55	-2949	-3749	-4205	-4410	-4435	-4334	-4147	-3906	-3634	-3347	-3058	-2374	-1790	-1322
50	-2857	-3575	-3978	-4154	-4165	-4061	-3879	-3649	-3392	-3122	-2850	-2209	-1664	-1229
45	-2766	-3402	-3754	-3898	-3894	-3787	-3612	-3393	-3149	-2896	-2642	-2045	-1539	-1135
40	-2675	-3229	-3528	-3642	-3624	-3514	-3344	-3136	-2907	-2670	-2434	-1880	-1414	-1042
35	-2494	-2966	-3215	-3302	-3275	-3168	-3009	-28[illegible]8	-2609	-2384	-2180	-1682	-1263	-930
30	-2314	-2703	-2902	-2963	-2926	-2822	-2674	-2499	-2311	-2118	-1927	-1484	-1113	-819
25	-2133	-2441	-2589	-2623	-2577	-2478	-2339	-2181	-2013	-1842	-1673	-1285	-962	-707
20	-1953	-2178	-2276	-2283	-2228	-2129	-2003	-1862	-1714	-1565	-1420	-1087	-812	-596
15	-1615	-1770	-1831	-1824	-1771	-1686	-1582	-1467	-1348	-1229	-1113	-850	-634	-484
10	-1277	-1362	-1286	-1365	-1314	-1243	-1161	-1072	-982	-893	-807	-613	-456	-333
5	-638	-681	-693	-682	-657	-622	-580	-536	-491	-446	-403	-307	-228	-167
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

SOURCE: WCAP - 11466, Rev. 0, TABLE 2.1

DIABLO CANYON POWER PLANT OPERATION DATA

BORATION NOMOGRAPHS

Figure 5-13 BORON DILUTION



REFER TO TABLE 1 FOR CORRECTION FACTORS

REVISION 0 DATE 6/3/77

*QUESTION
5-28 (1.0)

Diablo Canyon Unit 2 is initially operating at beginning of life, 2 GWD/MTU, 70% power, 180 steps on control bank D, 1200 ppm boron, Tave is programed normally with the RCS in auto. Use the attached Figures 5-8, 5-9, 5-10, 5-11, 5-12,and 5-13 to answer the following.

With power decreased to 50%, what is the expected change in equilibrum xenon?

*ANSWER
@70% Eq. Xe = -3145 pcm @50% Eq. Xe = -2857 pcm
[Change = +288 +/-10 pcm]
*REFERENCE
Reactor Core Control for Large PWRs, Chapter 4 and 9
*KW

*QUESTION
5-29 (0.5)

Diablo Canyon Unit 2 is initially operating at beginning of life, 2 GWD/MTU, 70% power, 180 steps on control bank D, 1200 ppm boron, Tave is programed normally with the RCS in auto. Use the attached Figures 5-8, 5-9, 5-10, 5-11, 5-12,and 5-13 to answer the following.

How much dilution water is required to decrease boron concentration by 40 ppm?

*ANSWER
See Nomograph
2000 gallons
*REFERENCE
Reactor Core Control for Large PWRs, Chapter 4 and 9
*KW

END OF CATAGORY 5
GO ON TO CATEGORY 6

CATAGORY 6 - PLANT SYSTEMS
DESIGN, CONTROL, AND INSTRUMENTATION

*QUESTION
6-1 (1.5)

The Reactor Trip Breakers are located physically alongside the Reactor Trip Bypass Breakers.

(a) What is the purpose of the bypass breakers? (0.75)

(b) If bypass "A" and bypass "B" breakers were racked in at the same time, what would happen to the reactor trip breakers? (0.75)

*ANSWER
(a) The bypass breakers allow testing the SSPS without tripping the reactor. (0.75)
(b) The reactor trip breakes would trip. (0.75)
*REFERENCE
B-6b, Pg. 23
*KW

*QUESTION
6-2 (1.0)

Operating Procedure A-6I limits VCT pressure to a minimum value prior to starting an RCP and during RCP operation.

(a) What is this minimum pressure? (0.5)

(b) What is the purpose of this minimum pressure? (0.5)

*ANSWER
(a) 15 PSIG (0.5)
(b) This ensures sufficient backpressure on the #1 seal to force adequate flow through the #2 seal to meet its' cooling and lubrication requirements. (0.5)
*REFERENCE
A-6 Pg. 33 and A-6I
*KW

*QUESTION
6-3 (2.0)

The Reactor Vessel Level Indication System has three indicating ranges; Upper Range, Full Range, and Dynamic Range.

(a) When is each range used? (1.0)

(b) What is the indication range in the reactor vessel for each range? (1.0)

*ANSWER
(a) (0.33 each)
Upper - during natural circulation (or when the RCP in the loop with the hot leg connection is not operating)
Full - during natural circulation
Dynamic - when any combination of RCPs are running.
(b) (0.33 each)
Upper - hot leg to top of vessel
Full - bottom to top of vessel
Dynamic - bottom to top of vessel
*REFERENCE
A-2d, Pg. 16 - 17
*KW

*QUESTION
6-4 (2.5)

Low Temperature Overpressure Protection (LTOP) is provided for the reactor coolant system using PORVs 455C and 456.

(a) What is the purpose of LTOP? (0.5)

(b) What are the two plant inputs to the LTOP system? (include setpoints) (1.0)

(c) What two requirements must be met to arm a PORV for LTOP protection? (1.0)

*ANSWER
(a) Low pressure overpressure protection prevents brittle fracture in the RCS. (0.5)
(b) Cold leg temperature 328-330 F (0.5)
Wide range RCS pressure 435-450 PSIG (0.5)
(c) Low setpoint protection cutout switch is in CUT IN and RCS temoerature at or below 328-330 F. (1.0)

*REFERENCE
A-4a, Pg. 49 - 51 & A-1, Pg. 28 - 29
*KW

*QUESTION
6-5 (2.0)

The Unit 1 reactor is operating at 50% power and all systems are operating normally. The pressurizer pressure controller is in AUTO and the PDP is operating. Unknown to the licensed operators, a trainee turns the potentiomenter on the pressurizer hand controller (HC-455K) from 8 turns to 10 turns (ie: to 100%).

(a) How does this action affect the controlling channel setpoint? (0.5)

(b) With no operator action, what will initially happen? (0.5)

(c) With no operator action, what will cause the RCS inventory to decrease? (1.0)

*ANSWER

(a) Setpoint is increased to 2500 PSIG (0.5)

(b) Backup and proportional heaters will go on (0.5)

(c) Increased pressure causes PORVs to open (PZR level falls due to charging inability to keep up) (1.0)

*REFERENCE
A-4a, Pg. 38 - 39
*KW

*QUESTION
6-6 (3.0)

Reactor unit 1 is operating at 100% power and all systems are in automatic and/or normal line up. The loop 1-1 T(cold) fails high.

(a) State four of the seven immediate alarms that would occur? (1.0)

(b) How will the Rod Control System be affected? (0.5)

(c) Why will the steam dump system NOT actuate? (0.5)

(d) How will the operator determine that the T(c) RTD failed high? (1.0)

*ANSWER

(a) (0.25 each for any four)

T(ref) deviation from auctioneered high T(ave)
Delta T deviation
High T(ave) alarm
Overtemperature delta T channel activated
Overpressure delta T channel activated
T(ave) deviation from auctioneered high T(ave)
Protection channel activated

(b) The Control Rod Drive System will drive rods in to counteract the apparent high T(ave). (0.5)

(c) The steam dump system will have a demand, but will not be armed. (0.5)

(d) Compare delta-T and T(ave) indications for each loop. High T(ave) with low delta-T indicates a failed high T(c). (1.0)

*REFERENCE
Lesson Plans A-2c, A-3a, C-2b and AP-5, PK-401 402 403 etc.
*KW

*QUESTION
6-7 (2.0)

The Auxiliary Salt Water System of unit 1 is operating normally with pump 1-1 operating.

(a) What is the position of the following switches to allow auto-start of pump 1-2? (1.0)

Control room control switch

Control room standby selector switch

Hot shutdown pannel switch

(b) With no SI, what two automatic signals will start ASW pump 1-2? (1.0)

*ANSWER
(a) (0.33 each)

Control room control switch - neutral

Control room standby selector switch - Auto

Hot shutdown pannel switch - Control Room or Remote

(b) (0.5 each for any two of the following)

Less than 40 PSIG discharge pressure

Low voltage on the opposite bus.

Bus transfer to startup

Bus transfer to diesel

*REFERENCE
E-5, Pg. 12 - 14
*KW

*QUESTION
6-8 (2.5)

The Reactor Protection System is designed to protect the reactor from specific events by tripping the reactor and the turbine. The bases for the trips are described in the Technical Specifications.

For each of the following reactor trips; what is the event the trip is designed to mitigate? (0.5 each)

(a) Intermediate range hign neutron flux trip.

(b) Reactor trip initiating a turbine trip.

(c) Undervoltage and underfrequency RCP bus trips.

(d) Overpower delta-T trip

(e) Overtemperature delta-T trip

*ANSWER
(0.5 each)

(a) Intermediate range high neutron flux trip.

Core protection during startup (subcritical) from a continuous rod (cluster) withdrawl event

(b) Reactor trip initiating a turbine trip.

Prevents the reactivity insertion that would otherwise result from cooldown and avoids unnecessary Safety Injections.

(c) Undervoltage and underfrequency RCP bus trips.

Core protection against DNB as a result of complete loss of forced coolant flow

(d) Overpower delta-T trip

Provides assurance of fuel integrity, no fuel pellet cracking or melting for over power conditions such as steam line breaks.

(e) Overtemperature delta-T trip

Core protection against DNB for all combinations of pressure, power, temperature, and axial power distribution. (for slow transients)

*REFERENCE
Technical Specifications Bases, pages B 2-3 - B 2-7
*KW

*QUESTION
6-9 (2.0)

The Process Radiation Monitoring System provides both alarms and and automatic operation of some components. For each of the monitors listed below; what automatic action (if any) occurs on a high radiation condition? (0.33 each)

(a) Plant vent Particulate monitor RE-28A&B

(b) Plant vent Iodine monitor RE-24

(c) Component cooling water monitor RE-17A&B

(d) RHR Heat exchanger compartment exhaust monitor RE-13

(e) Condensate demineralizer monitor RE-16

(f) Steam generator blowdown monitor RE-23

*ANSWER
(0.33 each)

(a) Plant vent Particulate monitor - containment ventilation isolation

(b) Plant vent Iodine monitor - alarm only

(c) Component cooling water monitor - Surge tank vent clsoes

(d) RHR Heat exchanger compartment exhaust particulate monitor - alarm only

(e) DELETED - UNIT ONE HAS ALARM ONLY UNIT TWO SHUTS FVC-161 INSTRUMENTATION NOT FULLY FUNCTIONAL AT THIS TIME

(f) Steam generator blowdown monitor - blowdown and sample isolation valves shut and blowdown tank outlet transfers from outfall to EDR (FCV-498 & 399 swap to EDR)

*REFERENCE
G-4, Pg. 28 - 37
*KW

*QUESTION
6-10 (2.5)

Unit 2 is initially at 75% power, with all controls in automatic and/or nornmal. With no operator action, how will each of the following events affect the plant? (Only one item at a time. Describe the plant response and control rod motion until the reactor trips or the unit stabilizes.)

(a) One atmospheric dump valve opens. (1.0)

(b) Turbine load is decreased 5%. (0.75)

(c) One rod drops into the core. (0.75)

*ANSWER

(a) One atmospheric dump valve opens - steam demand increases, T(ave)/T(ref) mismatch occurs, rods move out to increase power at new steam demand. (1.0)

(b) Turbine load is decreased 5% - steam demand decreases, T(ave)/T(ref) missmatch, rods move in to decrease power (or temperature). (0.75)

(c) One rod drops into the core - power decreases, T(h) and T(ave) decrease, T(ave)/T(ref) mismatch, rods move out to re-establish T(ave) (or increase power). (0.75)

*REFERENCE
Lesson Plan A-3a, Pg. 15 - 18 & 30 - 35
*KW

*QUESTION
6-11 (0.5)
MULTIPLE CHOICE - SELECT THE BEST ANSWER

When the RCP seal water return stop valves are shut:

(a) RCP leakoff and excess letdown flow to the reactor coolant drain tank via the excess letdown heat exchanger relief valve.

(b) RCP leakoff and excess letdown flow to the pressurizer relief tank via the excess letdown heat exchanger relief valve.

(c) RCP leakoff and excess letdown flow to the reactor coolant drain tank via the seal leakoff containment relief valve.

(d) RCP leakoff and excess letdown flow to the pressurizer relief tank via the seal leakoff containment relief valve.

*ANSWER
(d)
*REFERENCE
Lesson Plan B-1a, Pg. 44
*KW

*QUESTION
6-12 (0.5)
MULTIPLE CHOICE - SELECT THE BEST ANSWER

From inside containment excess letdown can be diverted to:

(a) The seal water heat exchanger or the reactor coolant drain tank.

(b) The seal water heat exchanger or the pressurizer relief tank.

(c) The volume control tank or the reactor coolant drain tank.

(d) The volume control tank or the pressurizer relief tank.

*ANSWER
(a)
*REFERENCE
B-1b, Pg. 45
*KW

*QUESTION
6-13 (1.0)

How is pump runout protection provided for the auxiliary feedwater pump 1-3?

*ANSWER
The auxiliary feedwater level controlers receive signals from the SGWLC transmitter AND a pressure transmitter in the discharge piping. As the pressure in the discharge piping decreases the signal to the level control valve is biased to close the LCV.

*REFERENCE
D-1, Pg. 20
*KW

*QUESTION
6-14 (1.0)

What are the two automatic start signals for auxiliary feedwater pump 1-1? (include logic)

*ANSWER
Undervoltage on 1 of 2 channels both 12KV buses
Lo-Lo level on 2 of 3 channels in 2 Of 4 steam generators

*REFERENCE
D-1, Pg. 24
*KW

*QUESTION
6-15 (1.0)

What prevents paralleling an instrument AC inverter and a back-up power supply voltage regulator through a vital instrument AC distribution pannel?

*ANSWER
The two supply breakers are mechanically interlocked to prevent both from being closed at one time.
*REFERENCE
J-10, Pg. 9
*KW

END OF CATAGORY 6
GO ON TO CATEGORY

CATAGORY 7
PROCEDURES: NORMAL, ABNORMAL,
EMERGENCY, AND RADIOLOGICAL CONTROL

*QUESTION
7-1 (1.0)
MULTIPLE CHOICE - SELECT THE BEST ANSWER

In the event emergency boration is necessary and the VCT make-up system is unavailable, the prefered method of boration, in order of preference in Abnormal Operating Procedure OP AP-6, Emergency Boration, is:

(a) (1) the manual emergency borate valve (8471), (2) refueling water storage tank, (3) boron injection tank, and (4) emergency boration valve (8104).

(b) (1) emergency boration valve (8104), (2) refueling water storage tank, (3) boron injection tank, and (4) the manual emergency borate valve (8471).

(c) (1) emergency boration valve (8104), (2) the manual emergency borate valve (8471), (3) boron injection tank, and (4) refueling water storage tank.

(d) (1) boron injection tank, (2) refueling water storage tank, (3) emergency boration valve (8104), and (4) the manual emergency borate valve (8471).

*ANSWER

(b)

*REFERENCE
OP AP-6
*KW

*QUESTION
7-2 (2.0)

Based on Abnormal Operating Procedure OP AP-6, Emergency Boration, for each of the situations listed below, when can emergency boration be stopped?
(0.5 each)

(a) Two stuck control rods following a SCRAM

(b) Control rods below rod insertion limit at power

(c) Shutdown margin less than that required by Technical Specifications when shutdown

(d) Criticality achieved inadvertently below the rod insertion limits

*ANSWER

(a) 200 ppm (100 per stuck rod) (0.5)

(b) Borate until rods above RIL (0.5)

(c) Borate until shutdown margin restored (0.5)

(d) 100 ppm (0.5)

*REFERENCE
OP AP-6, Pg. 4
*KW

*QUESTION
7-3 (3.0)

Unit 1 is being heated up from cold shutdown to hot stand-by per Operating Procedure OP L-1, Plant Heatup from Cold Shutdow to Hot Standby. The plant is at 325 PSIG and 100 F.

(a) Based on Technical Specifications, what three plant conditions identify the hot shutdown mode? (1.0)

(b) What three steps (operations) are used in L-1 to establish a steam bubble in the pressurizer? (1.0)

(c) What indications would you look for to verify that a steam bubble is forming in the pressurizer? (1.0)

*ANSWER

(a) $K(eff) < 0.99$, 0% power, and $200\ F < T(ave) < 350\ F$ (1.0)

(b) Energize pressurizer heaters, place PCV-135 in AUTO, and reduce charging (to 35 GPM). (1.0)

(c) Letdown flow is greater than charging flow and pressure is stable or increasing. (1.0)

*REFERENCE
OP L-1
*KW

*QUESTION
7-4 (3.0)

Unit 1 is being heated up from hot shutdown to hot stand-by per Operating Procedure OP L-1, Plant Heatup from Cold Shutdown to Hot Standby. The plant is at 950 PSIG and 400 F.

(a) Based on Operating Procedure OP A-6:I, Reactor Coolant Pumps - Place in Service, what two conditions would require opening the No. 1 seal bypass valve (8142)? (1.0)

(b) What four conditions must be met before opening the No. 1 seal bypass valve? (2.0)

*ANSWER

(a) The pump radial bearing outlet temperature or the No. 1 seal leakoff temperature approach their alarm level. (1.0)

(b) (0.5 each)

RCS pressure is greater than 100 and less than 1000 PSIG

The No. 1 seal leakoff valves (8141a,b,c,d) are all open

No.1 seal leakoff flow is less than 1 GPM

Seal injection to each seal is greater than 6 GPM

*REFERENCE
OP A-6:I, Pg. 2
*KW

*QUESTION
7-5 (2.5)

Unit 2 is being started up per Operating Procedure OP L-2, Hot Standby to Minimum Load. The plant is at 2250 PSIG and 547 F. Refer to Figure 7-1, which shows rod integral worth as a function of steps withdrawn. The ECP is 80 steps on bank D. The Control Operator has just declared the reactor critical at 60 steps on bank C.

(a) What two problems will cause you (as the SRO) to direct that all control bank rods be inserted? (1.0)

(b) Besides inserting all contr banks, what are three of the other four actions required by OP L-2? (1.0)

(c) Whose permission must be obtained prior to continuing the start-up? (0.5)

*ANSWER

(a) Criticality below rod insertion limits and criticality below ECP-120 (1.0)

(b) (0.33 each for any three)

Unblock the high flux at shutdown alarms

Determine the RCS boron concentration by analysis

Recalculate the ECC

Notify plant management

Emergency borate 100 ppm

(c) The Plant Superintendent (0.5)

*REFERENCE
OP L-2, Pg. 9
*KW

2
UNIT

DIABLO CANYON POWER PLANT OPERATION DATA

FIGURE 7 - 1

HZP INTEGRAL WORTH AS A FUNCTION OF STEPS WITHDRAWN FOR BANKS D AND C WITH 100 STEP OVERLAP

(Cycle 2)

Steps Withdrawn

BANK C	BANK D	0-7500 MWD/T BOL. HZP Predicted Integral Worth	6500-EOL MWD/T Predicted Integral Worth
228	228	-0.0	-0.0
228	220	-10.0	-50.0
228	210	-50.0	-160.0
228	200	-115.0	-320.0
228	190	-190.0	-500.0
228	180	-260.0	-630.0
228	170	-320.0	-760.0
228	160	-380.0	-870.0
228	150	-430.0	-940.0
228	140	-480.0	-1020.0
228	130	-530.0	-1080.0
228	120	-595.0	-1120.0
228	110	-650.0	-1160.0
228	100	-705.0	-1190.0
218	90	-780.0	-1250.0
208	80	-860.0	-1370.0
198	70	-960.0	-1500.0
188	60	-1060.0	-1610.0
178	50	-1170.0	-1730.0
168	40	-1300.0	-1840.0
158	30	-1420.0	-1910.0
148	20	-1515.0	-1990.0
138	10	-1600.0	-2040.0
128	0	-1660.0	-2080.0
118	0	-1705.0	-2100.0
108	0	-1740.0	-2120.0
98 Rod Insertion Limit	0	-1790.0	-2150.0

SOURCE: WCAP - 11450 Rev. 0 Figure A.4, Figure A.5.

Date: 06/08/87

*QUESTION
7-6 (2.0)

Valves and other equipment are positioned or regulated by Hagen controllers. Based on Operating Order O-2, Operation of Hagen Controllers, each controller has two power supplies; AUTO and MANUAL.

(a) With a Hagen controller in MANUAL and manual power is lost, how will the controller respond? (0.5)

(b) With a Hagen controller in AUTO and manual power is lost, how will the controller respond? (0.5)

(c) With a Hagen controller in AUTO and manual power is lost, how will the controller respond after manual power is restored? (0.5)

(d) How can you identify a loss of both manual and auto power to the controller? (0.5)

*ANSWER

(a) Controller goes to AUTO-HOLD (0.5)

(b) Controller goes to AUTO-HOLD (0.5)

(c) Controller goes to MANUAL (0.5)

(d) Controller output goes to zero and lights on the controller go out. (0.5)

*REFERENCE
OP O-2, Pg. 2
*KW

*QUESTION
7-7 (2.0)

While starting up Unit 2 the Control Operator selects two nuclear instruments channels to be recorded on recored NR-45. Operating Procedure OP L-2, Hot Standby to Minimum Load, provides guidance as to what channels are to be selected. For each of the following conditions, what channels should the CO select to record on NR-45?

(a) Withdrawing rods for criticality (1.0)

(b) Reactor power stable at 10E-8 AMPS to take data (1.0)

*ANSWER

(a) Select the highest source channel and one intermediate channel. (1.0)

(b) Select one intermediate range and one power range. (1.0)

*REFERENCE
OP L-2, Pg. 6 and 11
*KW

*QUESTION
7-8 (2.0)

Technical Specification Limiting Condition for Operation 3.4.8 establishes the maximum reactor coolant activity limits.

(a) What are the two specific activity limits for the Reactor Coolant System? (1.0)

(b) What are the Technical Specification Bases for these limits? (1.0)

*ANSWER

(a) 1 microcurie/gram dose equivalent I-131 and 100/E microcuries/gram gross activity (1.0)

(b) The site boundary 2 hour dose will not exceed a small fraction of 10CFR100 dose guideline values following a steam generator tube rupture with an assumed previous 1 GPM S/G tube leak. (1.0)

*REFERENCE
T.S. B3/4 4-5 and 3/4 4-25
*KW

*QUESTION
7-9 (0.5)
MULTIPLE CHOICE - SELECT THE BEST ANSWER

Follcwing a control room fire, the control room is being evacuated in accordance with OP A-8, Control Room Inaccessibility. The Unit 2 control operator is responsible for:

(a) Turbine building watch Unit 1

(b) Auxiliary building watch Unit 2

(c) Unit 2 hot shutdown pannel operator

(d) Supervisor of Unit 1 shutdown

*ANSWER

(c)

*REFERENCE
OP A-8
*KW

*QUESTION
7-10 (0.5)
MULTIPLE CHOICE - SELECT THE BEST ANSWER

Following a control room fire, the control room is being evacuated in accordance with OP A-8, Control Room Inaccessibility. The Unit 2 assistant control operator is responsible for:

(a) Turbine building watch Unit 1

(b) Auxiliary building watch Unit 2

(c) Unit 2 hot shutdown pannel operator

(d) Supervisor of Unit 1 shutdown

*ANSWER

(a)

*REFERENCE
OPA-8
*KW

*QUESTION
7-11 (0.5)
MULTIPLE CHOICE - SELECT THE BEST ANSWER

Following a control room fire, the control room is being evacuated in accordance with OP A-8, Control Room Inaccessibility. The Shift Supervisor is responsible for:

(a) Turbine building watch Unit 1

(b) Auxiliary building watch Unit 2

(c) Unit 2 hot shutdown pannel operator

(d) Supervisor of Unit 1 shutdown

*ANSWER
(d)
*REFERENCE
OP A-8
*KW

*QUESTION
7-12 (1.5)

A survey of radiation and contamination levels has been made by Health physics personnel. Figure 7-2 is a map which documents the results of this survey. Figure 7-3 is an extract from 10CFR20 Appendix B, Concentrations in Air and Water Above Natural Background. Answer the following questions based on 10CFR20.

(a) What posting is required for the pump room? (0.5)

(b) What posting is required for the tank room? (0.5)

(c) What posting is required for the valve room? (0.5)

(d) Which area(s) must be locked or access controlled per 10 CFR 20?

*ANSWER

(a) Caution - Radiation Area (0.5)

(b) Caution - High Radiation area (0.5)

(c) Caution - Airborne Radioactivity Area (0.5)

(d) DELETED - POSSIBLE AMBIGUITY

*REFERENCE
10CFR20
*KW

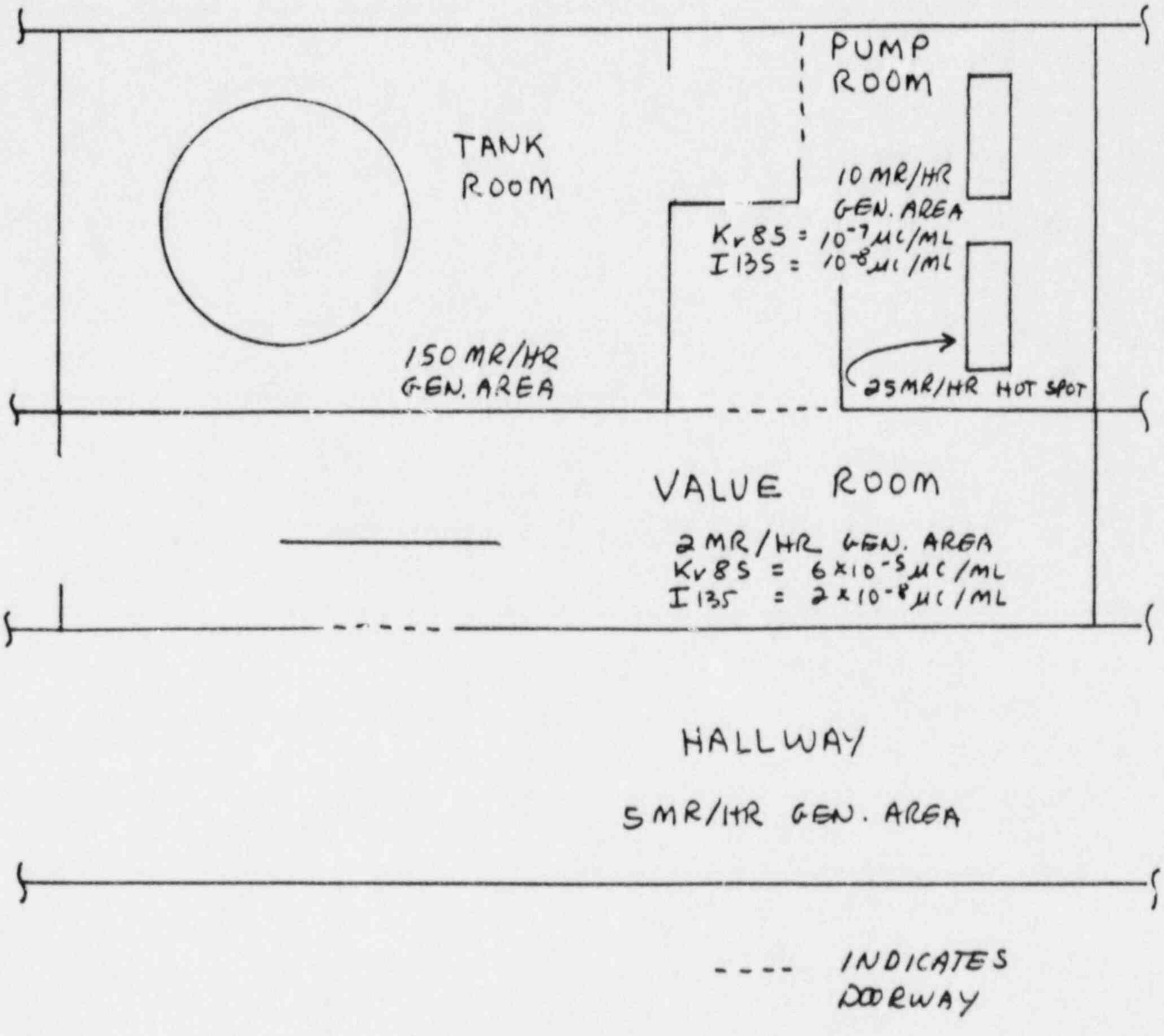

PUMP ROOM
TANK ROOM
10 MR/HR GEN. AREA
Kr85 = 10^-7 µc/ML
I135 = 10^-8 µc/ML
150 MR/HR GEN. AREA
25 MR/HR HOT SPOT
VALVE ROOM
2 MR/HR GEN. AREA
Kr85 = 6x10^-5 µc/ML
I135 = 2x10^-8 µc/ML
HALLWAY
5 MR/HR GEN. AREA
---- INDICATES DOORWAY

FIGURE 7-2

APPENDIX B—CONCENTRATIONS IN AIR AND WATER ABOVE NATURAL BACKGROUND—Continued

[See footnotes at end of Appendix B]

Element (atomic number)	Isotope [1]		Table I Col. 1—Air (μCi/ml)	Table I Col. 2—Water (μCi/ml)	Table II Col. 1—Air (μCi/ml)	Table II Col. 2—Water (μCi/ml)
Iodine (53)	I 125	S	5×10^{-9}	4×10^{-5}	8×10^{-11}	2×10^{-7}
		I	2×10^{-7}	6×10^{-4}	6×10^{-9}	2×10^{-5}
	I 126	S	8×10^{-9}	5×10^{-5}	9×10^{-11}	3×10^{-7}
		I	3×10^{-7}	3×10^{-4}	1×10^{-8}	9×10^{-6}
	I 129	S	2×10^{-9}	1×10^{-5}	2×10^{-11}	6×10^{-8}
		I	7×10^{-8}	6×10^{-3}	2×10^{-9}	2×10^{-4}
	I 131	S	9×10^{-9}	6×10^{-5}	1×10^{-10}	3×10^{-7}
		I	3×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
	I 132	S	2×10^{-7}	2×10^{-3}	3×10^{-9}	8×10^{-6}
		I	9×10^{-7}	5×10^{-3}	3×10^{-8}	2×10^{-4}
	I 133	S	3×10^{-8}	2×10^{-4}	4×10^{-10}	1×10^{-6}
		I	2×10^{-7}	1×10^{-3}	7×10^{-9}	4×10^{-5}
	I 134	S	5×10^{-7}	4×10^{-3}	6×10^{-9}	2×10^{-5}
		I	3×10^{-6}	2×10^{-2}	1×10^{-7}	6×10^{-4}
	I 135	S	1×10^{-7}	7×10^{-4}	1×10^{-9}	4×10^{-6}
		I	4×10^{-7}	2×10^{-3}	1×10^{-8}	7×10^{-5}
Iridium (77)	Ir 190	S	1×10^{-6}	6×10^{-3}	4×10^{-8}	2×10^{-4}
		I	4×10^{-7}	5×10^{-3}	1×10^{-8}	2×10^{-4}
	Ir 192	S	1×10^{-7}	1×10^{-3}	4×10^{-9}	4×10^{-5}
		I	3×10^{-8}	1×10^{-3}	9×10^{-10}	4×10^{-5}
	Ir 194	S	2×10^{-7}	1×10^{-3}	8×10^{-9}	3×10^{-5}
		I	2×10^{-7}	9×10^{-4}	5×10^{-9}	3×10^{-5}
Iron (26)	Fe 55	S	9×10^{-7}	2×10^{-2}	3×10^{-8}	8×10^{-4}
		I	1×10^{-6}	7×10^{-2}	3×10^{-8}	2×10^{-3}
	Fe 59	S	1×10^{-7}	2×10^{-3}	5×10^{-9}	6×10^{-5}
		I	5×10^{-8}	2×10^{-3}	2×10^{-9}	5×10^{-5}
Krypton (36)	Kr 85m	Sub	6×10^{-6}		1×10^{-7}	
	Kr 85	Sub	1×10^{-5}		3×10^{-7}	
	Kr 87	Sub	1×10^{-6}		2×10^{-8}	
	Kr 88	Sub	1×10^{-6}		2×10^{-8}	
Lanthanum (57)	La 140	S	2×10^{-7}	7×10^{-4}	5×10^{-9}	2×10^{-5}
		I	1×10^{-7}	7×10^{-4}	4×10^{-9}	2×10^{-5}
Lead (82)	Pb 203	S	3×10^{-6}	1×10^{-2}	9×10^{-8}	4×10^{-4}
		I	2×10^{-6}	1×10^{-2}	6×10^{-8}	4×10^{-4}
	Pb 210	S	1×10^{-10}	4×10^{-6}	4×10^{-12}	1×10^{-7}
		I	2×10^{-10}	5×10^{-3}	8×10^{-12}	2×10^{-4}
	Pb 212	S	2×10^{-8}	6×10^{-4}	6×10^{-10}	2×10^{-5}
		I	2×10^{-8}	5×10^{-4}	7×10^{-10}	2×10^{-5}
Lutetium (71)	Lu 177	S	6×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
		I	5×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
Manganese (25)	Mn 52	S	2×10^{-7}	1×10^{-3}	7×10^{-9}	3×10^{-5}
		I	1×10^{-7}	9×10^{-4}	5×10^{-9}	3×10^{-5}
	Mn 54	S	4×10^{-7}	4×10^{-3}	1×10^{-8}	1×10^{-4}
		I	4×10^{-8}	3×10^{-3}	1×10^{-9}	1×10^{-4}
	Mn 56	S	8×10^{-7}	4×10^{-3}	3×10^{-8}	1×10^{-4}
		I	5×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
Mercury (80)	Hg 197m	S	7×10^{-7}	6×10^{-3}	3×10^{-8}	2×10^{-4}
		I	8×10^{-7}	5×10^{-3}	3×10^{-8}	2×10^{-4}
	Hg 197	S	1×10^{-6}	9×10^{-3}	4×10^{-8}	3×10^{-4}
		I	3×10^{-6}	1×10^{-2}	9×10^{-8}	5×10^{-4}
	Hg 203	S	7×10^{-8}	5×10^{-4}	2×10^{-9}	2×10^{-5}
		I	1×10^{-7}	3×10^{-3}	4×10^{-9}	1×10^{-4}
Molybdenum (42)	Mo 99	S	7×10^{-7}	5×10^{-3}	3×10^{-8}	2×10^{-4}
		I	2×10^{-7}	1×10^{-3}	7×10^{-9}	4×10^{-5}
Neodymium (60)	Nd 144	S	8×10^{-11}	2×10^{-3}	3×10^{-12}	7×10^{-5}
		I	3×10^{-10}	2×10^{-3}	1×10^{-11}	8×10^{-5}
	Nd 147	S	4×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
		I	2×10^{-7}	2×10^{-3}	8×10^{-9}	6×10^{-5}
	Nd 149	S	2×10^{-6}	8×10^{-3}	6×10^{-8}	3×10^{-4}
		I	1×10^{-6}	8×10^{-3}	5×10^{-8}	3×10^{-4}
Neptunium (93)	Np 237	S	4×10^{-12}	9×10^{-5}	1×10^{-13}	3×10^{-6}
		I	1×10^{-10}	9×10^{-4}	4×10^{-12}	3×10^{-5}
	Np 239	S	8×10^{-7}	4×10^{-3}	3×10^{-8}	1×10^{-4}
		I	7×10^{-7}	4×10^{-3}	2×10^{-8}	1×10^{-4}
Nickel (28)	Ni 59	S	5×10^{-7}	6×10^{-3}	2×10^{-8}	2×10^{-4}

FIGURE 7-3

*QUESTION
7-13 (2.0)

Following a reactor trip and safety injection, Emergency Procedure E-0, Reactor Trip or Safety Injection and the associated Emergency Operating Procedures have been implemented.

(a) At what two times are the Critical Safety Function Status Trees required to be monitored? (1.0)

(b) What are the two reactor coolant pump trip criteria per the "foldout page"? (1.0)

*ANSWER
(a) When directed by E-0, and after transition out of E-0. (1.0)
(b) Trip all RCPS within 5 minutes of a Phase B actuation, and trip all RCPs when either one CCP or one SI pump is running and WR RCS pressure is less than 1275 PSIG. (1.0)
*REFERENCE
EP E-0, Pg. 13 & 19
*KW

*QUESTION
7-14 (2.0)

Following a reactor trip and safety injection, Emergency Procedure E-0, ..actor Trip or Safety Injection and the associated Emergency Operating Procedures have been implemented. Subsequently, E-1.1, SI Termination, is entered.

(a) What are the two SI re-initiation criteria? (1.0)

(b) What are the three adverse contaimnment criteria? (1.0)

*ANSWER
(a) RCS subcooling less than 20 F or pressurizer level cannot be maintained above 4%[20]% (1.0)
(b) Containment pressure above 3 PSIG
Greater than 10E5 R/Hr dose rate
Greater than 10E6 R dose (1.0)
*REFERENCE
EP E-1.1, Foldout
*KW

END OF CATEGORY 7
GO ON TO CATEGORY 8

CATAGORY 8
ADMINISTRATIVE PROCEDURES
PRECAUTIONS AND LIMITATIONS

*QUESTION
8-1 (0.0)
MULTIPLE CHOICE - SELECT THE BEST ANSWER

Operating procedures AP-3, Minor Steam Generator Tube Failure, and AP-3A, Steam Generator Tube Leak, both describe actions to be taken when steam generator leakage is discovered. Regarding the actions to be taken when implementing these procedures:

(a) AP-3 requires reactor shutdown while AP-3A does not require shutdown.

(b) Both AP-3 and AP-3A require shutdown, but with different time requirements.

(c) Neither AP-3 nor AP-3A require that the reactor be shutdown.

(d) AP-3 does not require reactor shutdown while AP-3A requires reactor shutdown.

*ANSWER

DELETED - REFERENCES NO LONGER VALID

*REFERENCE
OP AP-3 and AP-3A, Pg. 1
*KW

*QUESTION
8-2 (3.0)

Technical Specification Limiting Condition for Operation 3.4.6.2 states the limits for Reactor Coolant System leakage. After returning from a vacation you are informed of the following RCS leakages. The unit is being shutdown and is in mode 2 at 2250 PSIG.

- 0.8 GPM through RCS pressure isolation valves (past disc(S))
- 3.1 GPM through a valve stem packing
- 5.0 GPM through a pressurizer relief
- 0.3 GPM tube leaks in steam generator 1-3 (for last 48 hours)
- 0.9 GPM tube leaks in steam generator 1-1 (for last 24 hours)
- 0.1 GPM RCS leakage through a socket weld on the pressurizer
- 0.8 GPM unidentified leakage
- 9.1 GPM RCP 1-1 seal injection flow
- 11.1 GPM RCP 1-2 seal injection flow
- 15.7 GPM RCP 1-3 seal injection flow
- 9.2 GPM RCP 1-4 seal injection flow

What leakage(s) exceed Technical Specification LCO limits? (Include the leakage specification for each out of LCO condition)

*ANSWER

(1) Greater than 40 GPM controlled leakage (45.1 GPM) (0.60)

(2) No pressure boundary leakage allowed (0.1 GPM) (0.60)

(3) Greater than 1 GPM through all steam generators (1.2 GPM) (0.60)

(4) Greater than 500 GPD through one steam generator (0.9 GPM) (0.60)

(5) Greater than 10 GPM identified leakage (10.1 GPM) (0.60)

*REFERENCE
T.S. 3/4 4-19 & Definitions
*KW

*QUESTION
8-3 (1.5)

Administrative Procedure NPAP C-101, Requirements to Remain in the Confines of the Control Room, describes the control room areas to be occupied by the Control Operator (CO) and Senior Control Operator (SRO). Assume Unit 1 at 70% power and Unit 2 shutdown (mode 5). Use the attached Figure 8-1 to draw in the boundaries as requested below.

(a) What are the Unit 1 CO's NORMAL boundaries? (0.5)

(b) What are the Unit 1 CO's EMERGENCY boundaries? (0.5)

(c) What are the SRO's boundaries? (0.5)

*ANSWER

See attached drawings

*REFERENCE
NPAP C101 Figures 1 and 2
*KW

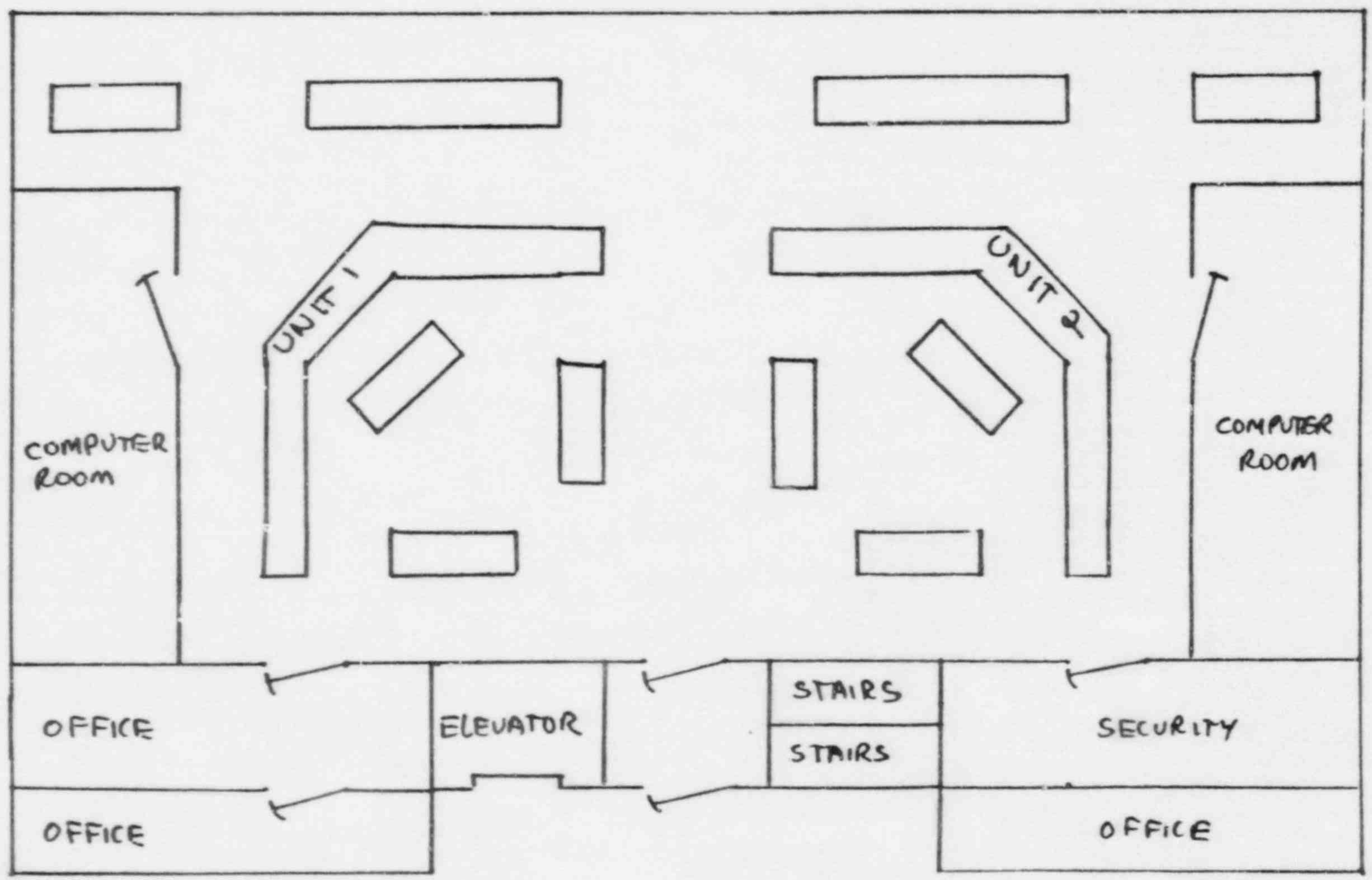

UNIT 1
UNIT 2
COMPUTER ROOM
COMPUTER ROOM
OFFICE
OFFICE
ELEVATOR
STAIRS
STAIRS
SECURITY
OFFICE

FIGURE 8-1

PACIFIC GAS AND ELECTRIC COMPANY
DEPARTMENT OF NUCLEAR PLANT OPERATIONS
DIABLO CANYON POWER PLANT UNIT NOS. 1 AND 2
SUPPLEMENT 1 TO NUCLEAR PLANT ADMINISTRATIVE PROCEDURE C-101

TITLE: CONFINES OF CONTROL ROOM AT DIABLO CANYON

SCOPE

This procedure identifies the boundaries of the Control Room at Diablo Canyon.

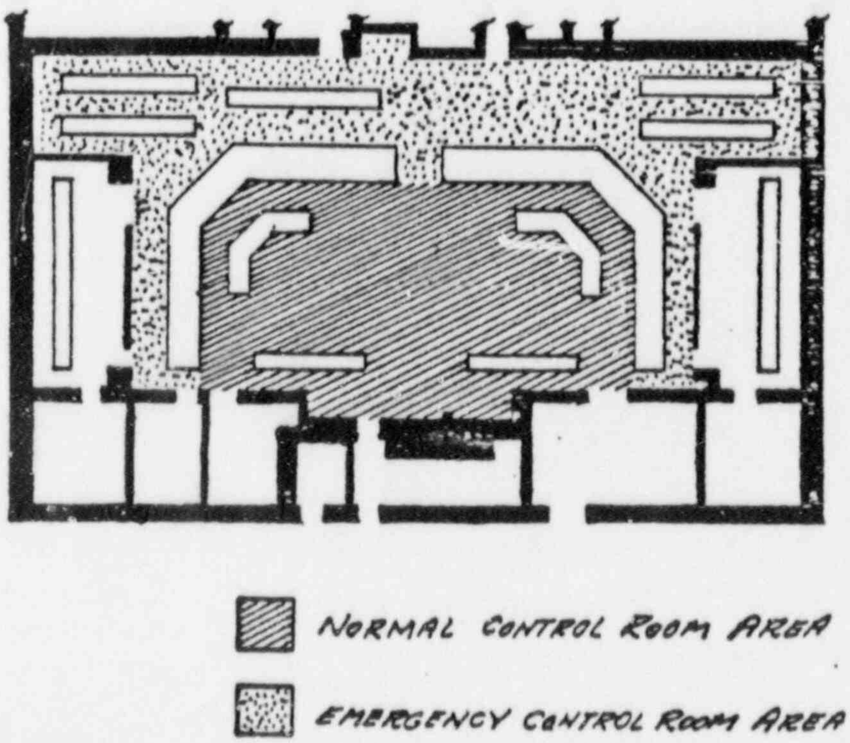
PROCEDURE

1. The normal boundaries of the control room for the Control Operator (operator at the controls) shall be as shown on Figure 1.

2. The emergency boundaries of the control room for the Control Operator shall be as shown on Figure 1.

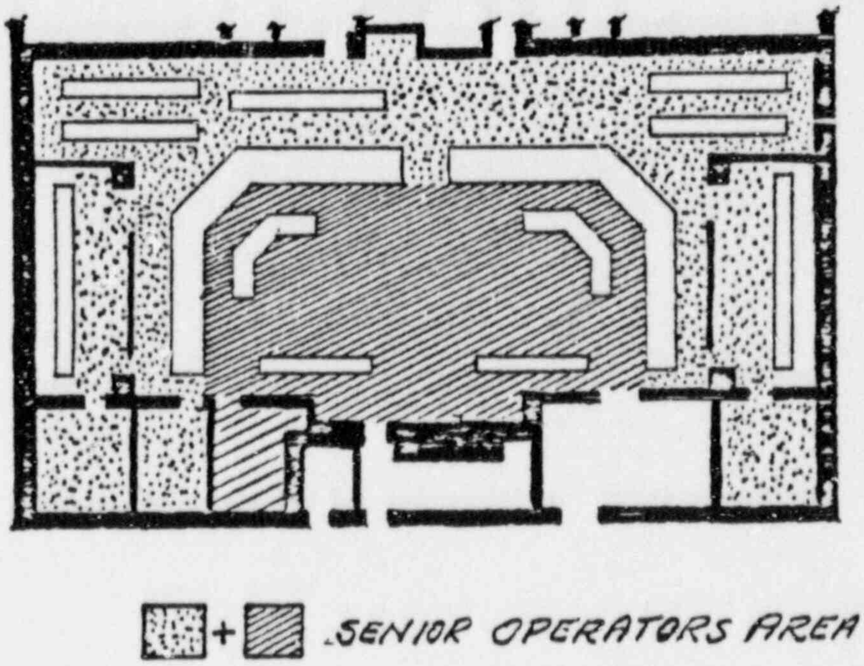
3. The boundaries of the control room for the senior licensed operator shall include areas 1 and 2 above, the Shift Foreman's office and other appropriate adjacent areas. This area is shown on Figure 2.

FIGURE 1



PAGE 1 OF 2	REVISION 2	DATE 3/28/80
APPROVAL R.D. Ramsay (signature) PLANT SUPERINTENDENT	5/6/80 DATE	

FIGURE 2



*QUESTION
B-4 (3.0)

While heating up in preparation for startup (mode 4), Electrical Maintenance has just found that diesel-generator 1-3 requires electrical maintenance. The Electrical Foreman has just submitted a Request for Clearance for your immediate approval. Answer the following based on Administrative Procedures NPAP C-7, Tagging Requirements, C-7S1, Plant Tagging Requirements, and C-150, Instruction for Manual Electrical Switiching.

(a) What is the hierarchy of Tags, from the most powerful to the least? (five required) (0.5)

(b) With the generator power leads to be disconnected, what two tags should be hung on the generator output breaker? (1.0)

(c) What tag should be used for a grounding switch? (0.5)

(d) In an emergency, if diesel generator 1-3 were urgently required, whose permission is required to remove the highest priority tags? (2 people) (1.0)

*ANSWER

(a) (0.1 each)

Maintenance red tag

Man on line tag

Caution tag

Information tag

Action request tag

(b) Maintenance and MOL tags (1.0)

(c) Caution tag (0.5)

(d) The shift Foreman with the concurrence of the requestor or his supervisor. (1.0)

*REFERENCE
NPAP C-7, AP C-7S1, and C-150
*KW

*QUESTION
8-5 (2.0)

When disabling the safety injection pumps to comply with Technical Specification requirements in mode 4 an Administrative Tag Out is used. Based on AP C-6S1, Clearance Request/Job Assignment, what are four of the five rules governing Administrative Tag Outs?

*ANSWER

(0.5 each for any four of the following)

No work can be done

No work order is required

No MOL tags can be used

All tags will be caution tags

No red (or maintenance) tags may be used

*REFERENCE
AP C-6S1
*KW

*QUESTION
8-6 (3.0)

Procedure AP C-6S4, Control of Equipment Required by The Plant Technical Specifications, implements methods for control and tracking of equipment required to be operable by the Technical Specifications.

(a) When is the Unit Shift Foreman required to review all outstanding Technical Specification Equipment Operability Status Sheets? (four out of five required) (2.0)

(b) Who is responsible for the Technical Specification Equipment Operability Status for equipment common to both units? (0.5)

(c) When would both a Train A and Train B Technical Specification Equipment Operability Status Sheet be filled out for one piece of equipment? (0.5)

*ANSWER

(a) (0.5 for any four of the following)

At the beginning of each shift

Prior to removing TS equipment from service required by current mode

Immediatly after declaining any TS required equipment inoperable

Prior to any planned unit mode changes

As soon as possible after a unit Rx trip or forced outage

(b) The Unit 1 Shift Foreman (0.5)

(c) When the equipment is actuated by both trains. (0.5)

*REFERENCE
AP C-6S4
*KW

*QUESTION
8-7 (2.5)

While operating at 100% power, safety injection pump 2-1 has been removed from service on a clearance due to a large pump seal leak. An independent verification in accordance with NPAP C-104, Independent Verification of Operating Activities, and AP C-104S1, Independent Verification of Operating Activities, is in progress.

(a) How much time is allowed to complete the independent verification after removing the SI pump from service? (0.5)

(b) What situation (other that a plant emergency) would allow the Shift Foreman to waive part of the clearance verification? (1.0)

(c) In what situation would it be appropriate for the independent verifier to accompany the individual actually removing equipment from service? (1.0)

*ANSWER

(a) 4 hours or as soon as possible (0.5)

(b) Independent verification may be waived -

(1.0 for either of the following)

if it involves entry into a high radiation area that would not otherwise be made

or if a component has been cleared on a previous clearance which was independently verified.

(c) The clearance person should accompany the verifier when incorrect operation could result in a reactor trip of ESF actuation. (1.0)

*REFERENCE
NPAP C-104 and AP C-104S1
*KW

*QUESTION
8-8 (1.0)

Following repairs to a SI pump it is being returned to service and it is necessary install valve seals in accordance with AP C-9S1, Suppliment 1 to Nuclear Plant Administrative Procedure Sealed Valve.

(a) Prior to installation of a valve seal, how does the operator verify a CLOSED valve? (0.5)

(b) Prior to installation of a valve seal, how does the operator verify an OPEN valve? (0.5)

*ANSWER

(a) Attempt to move the handwheel in the close direction. If the valve is in the correct position no motion will occur. (0.5)

(b) Attempt to move the handwheel in the close direction only enough to verify valve movement. Return the valve to full open. (0.5)

*REFERENCE
AP C-9S1
*KW

*QUESTION
8-9 (2.0)

Due to suspected fuel problems, both reactors have been shutdown for inspection of fuel elements. Unit 1 is in mode 5 and unit 2 is in mode 6 with fuel being removed from the core for underwater examination.

Based on the Minimum Shift Crew Composition required by Technical Specification 6.2.2, what is the minimum shift crew composition? (Include licensed personnel, non-licensed operation personnel, plant staff required to be on site, and their locations if restricted. Do not include Fire Brigade)

*ANSWER

(0.25 for each of the following)

SRO Shift Foreman

SRO Directly supervising fuel movements in Unit 2

RO Control Operator in Unit 1 control room

RO Control Operator in Unit 2 control room

NL Auxiliary Operator for Unit 1

NL Auxiliary Operator for Unit 2

NL Auxiliary Operator

NL Health Physics Technician

*REFERENCE
TS 6.2.2
*KW

*QUESTION
8-10 (1.0)

During abnormal or emergency conditions the primary function of the Shift Foreman is command and control. NPAP A-102, General Authorities and Responsibilities of the Shift Foreman, describes situations when other personnel can assumne the control room command and control function. To answer the following questions assume that it is 2:00 AM and only the minimum shift crew is on site.

(a) If the Shift Foreman is incapacitated and there is no other concurrent emergency, who may assume the control room command and control function? (0.5)

(b) If the Shift Foreman is incapacitated and there is another emergency situation, who should assume the control room command and control function? (0.5)

*ANSWER

(a) A Senior Control Operator (0.5)
(b) The Shift Technical Advisor/Shift Engineer (0.5)

*REFERENCE
NPAP A-102
*KW

*QUESTION
8-11 (2.0)

Using the Emergency Plan clasifications used in EP G-1, Accident Classification and Emergency Plan Activation, (pages 1 through 10 are attached) what are the correct classifications for each of the following events? (0.5 each)

(a) Tsunami causes a 5 minute shutdown of both ASW pumps.
(b) A LOCA with RCS activity over 300 uCi/cc and leaking containment hatch.
(c) Loss of the annunciator system during steady state operation.
(d) An ATWS event occurs without apparent core damage.

*ANSWER

(a) Alert
(b) General Emergency
(c) Alert
(d) Alert

*REFERENCE
EP G-1 pages 25 and 33, FR-S1, Appendix Z
*KW

3.0.3 When a Limiting Condition for Operation is not met, except as provided in the associated ACTION requirements, within 1 hour action shall be initiated to place the unit in a MODE in which the specification does not apply by placing it, as applicable, in:

a. At least HOT STANDBY within the next 6 hours,
b. At least HOT SHUTDOWN within the following 6 hours, and
c. At least COLD SHUTDOWN within the subsequent 24 hours.

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

This specification is not applicable in MODE 5 or 6.

FIGURE 8-2

Pacific Gas and Electric Company

DEPARTMENT OF NUCLEAR PLANT OPERATIONS

DIABLO CANYON POWER PLANT UNIT NO(S) 1 AND 2

TITLE EMERGENCY PROCEDURE
ACCIDENT CLASSIFICATION AND EMERGENCY
PLAN ACTIVATION

IMPORTANT TO SAFETY

APPROVED [redacted]
PLANT MANAGER DATE

SCOPE

This procedure describes the guidelines for Accident Classification and responsibilities for Activation of the Emergency Plan. Implementation of this procedure constitutes declaration of an emergency condition. This procedure and revisions thereto require PSRC review.

GENERAL

This procedure provides guidance on activating the emergency plan and classifying an accident. The steps required by this procedure are in addition to the steps required to maintain or restore the plant to a safe condition.

Prompt notification of offsite authorities should be given within about 15 minutes for the Unusual Event class and sooner (consistent with the need for other emergency actions) for other classes. The time is measured from the time which the Shift Foreman recognizes that events have occurred which make declaration of an emergency class appropriate.

This procedure is organized as follows:

ACTIVATION OF EMERGENCY PLAN

The initial steps to be taken for each of the established accident classifications are listed below under:

1. Notification of an Unusual Event
2. Alert
3. Site Area Emergency
4. General Emergency

Figure 1 may be used for guidance in assignment of shift personnel to activate the Emergency Organization and implement the Emergency Plan.

ACCIDENT CLASSIFICATION

Table 1 provides guidance and criteria for determining if an event meets the emergency action levels requiring declaration of one of the four accident classifications. The left column lists events, as provided in the reference NRC criteria for emergency classification, the right column provides conditions which are sufficient for declaration of that emergency condition at Diablo Canyon. Other indications could also appropriately indicate certain of the emergency conditions, depending on the situation. Normally the classification guidance contained in Appendix Z of the appropriate E, ECA, FR, R, or M series emergency procedures will be used to determine the initial classification. In the event none of the E, ECA, FR, R or M series procedures is appropriate to the immediate situation, Table 1 and judgement should be used for the initial classification (and future events as necessary).

NOTE: If multiple emergency situations are occurring simultaneously such that the probability of a release of radioactive materials is increased over what it would be for the single occurrence, classify the emergency one level higher than it would otherwise have been, based on the most severe single occurrence.

Table 2 summarizes the emergency classification guidance in the E, ECA, FR, R, and M series procedures.

In addition, procedures included in the emergency procedures which meet the NRC requirements for immediate notification (10 CFR 50.72) but do not meet the criteria for implementing the emergency plan are included in Table 3 for reference. Refer to Administrative Procedure C-11 "Non-Routine Notification and Reporting to the Nuclear Regulatory Commission (NRC) and Other Government Agencies" and Supplements to AP C-11 for appropriate reporting for these events.

PROCEDURE

1. NOTIFICATION OF UNUSUAL EVENT

   a. Description

      Unusual events, generally characterize off-normal plant conditions that are in process or have occurred which indicate a potential degradation of the level of safety of the plant if proper action is not taken or if circumstances beyond the control of the operating staff render the situation more serious from a safety standpoint. No releases of radioactive material requiring offsite response or monitoring are expected for this classification unless further degradation of the level of safety of the plant occurs.

b. Actions

1) Assign on-shift personnel to perform the functions required for implementation of the Emergency Plan. Assignments may vary at the discretion of the interim Site Emergency Coordinator, however, a typical organization and assignments are given in Figure 1. Duties and responsibilities are listed in EP G-2, "Establishment of the Onsite Emergency Organization."

a) If organizational requirements are given in the appropriate E, ECA, FR, R, or M Procedure, they should be followed.

b) The minimum functions which must be assigned are:

(1) Operational control of the plant by on-shift personnel (Emergency Operations Coordinator).

(2) Notification of offsite organizations and off-shift staff (Emergency Liaison Coordinator).

2) Notify off-shift plant staff of the emergency situation per EP G-2 "Establishment of the Onsite Emergency Organization."

3) Promptly notify and inform the county, state, NRC and on-call Recovery Manager of the nature of the Unusual Event situation per EP G-3, "Notification of Offsite Organizations."

4) Escalate to a more severe class, if appropriate.

OR

5) Close out with a verbal summary of corrective actions or termination of the event to offsite authorities. (The nature of the event will determine when this should be done).

6) Retain all notification records and other documentation of the event for use in preparation of a written summary of the event within 24 hours of closeout (or on the next normal working day).

2. ALERT

a. Description

Events are in progress, or have occurred, which involve an actual or potential substantial degradation of the level of safety of the plant. Any releases are expected to be limited to small fractions of the EPA Protective Action Guideline exposure levels. It is the lowest level of classification where emergency near-site or offsite response may be anticipated. For most Alert events, the plant would be brought to a safe condition, and radioactive releases, if any, would be minimal.

b. Actions

1) Assign on-shift personnel to perform the functions required for implementation of the Emergency Plan. Assignments may vary at the discretion of the interim Site Emergency Coordinator, however, a typical organization and assignments are given in Figure 1. Duties and responsibilities are listed in EP G-2, "Establishment of the Onsite Emergency Organization."

a) If organizational requirements are given in the appropriate E, ECA, FR, M, or R procedure, they should be followed.

b) The minimum functions which must be assigned are:

(1) Operational control of the plant (Emergency Operations Coordinator).

(2) Notification of offsite organizations and off-shift staff (Emergency Liaison Coordinator).

(3) Evaluation of plant conditions and radiological assessment (Emergency Evaluations and Recovery Coordinator).

2) Sound the site emergency signal (if appropriate) and initiate an all-call on group call 400 and 411, using the Health Physics local radio, to inform plant personnel of the emergency and to initiate site assembly and accountability per EP G-4 "Personnel Assembly and Accountability". The site emergency signal should be followed-up with an announcement over the plant wide paging system.

<u>NOTE</u>: The nature of an emergency may make site assembly unneccessary, impractical or hazardous to personnel, for example a breech in security at the Security Building. In such cases the Shift Foreman may decide not to sound the site emergency signal.

3) Notify off-shift plant staff of the emergency situation and their assignments in the long-term emergency organization per EP G-2, "Establishment of the Onsite Emergency Organization."

4) Promptly notify and inform the county, state, NRC, and on-call Recovery Manager of the Alert status and their anticipated response per EP G-3, "Notification of Offsite Organizations."

5) Initiate onsite monitoring and associated communications per EP RB-7, "Emergency Onsite Radiological Monitoring Program," if a release in excess of 100X Technical Specification Limits is occurring or anticipated. (See EP R-2, "Release of Airborne Radioactive Material").

6) Determine the need for evacuating nonessential site personnel per EP G-5, "Evacuation of Nonessential Site Personnel". (See EP R-2).

7) Provide periodic (approximately every 30 minutes) plant status updates per EP G-3.

8) Escalate to a more severe class, if appropriate.

OR

9) Closeout or recommend reduction in emergency class by verbal communication to offsite authorities.

10) Retain all notification records and other documentation of the event for use in preparation of a written summary of the event within 24 hours of closeout (or the next normal working day).

3. SITE AREA EMERGENCY

a. Description

Events are in process or have occurred which involve actual or likely major failures of plant functions needed for protection of the public. The Site Area Emergency classification reflects conditions where there is a clear potential for significant releases of radioactive material, such releases are likely, or they are occurring, but in all cases a core meltdown situation is not indicated based on current information. Any releases are not expected to exceed EPA Protective Action Guideline Exposure levels except near the site boundary.

b. Actions

1) Assign on-shift personnel to perform the functions required for implementation of the Emergency Plan. Assignments may vary at the discretion of the interim Site Emergency Coordinator; however, a typical organization and assignments are give in Figure 1. Duties and responsibilities are listed in EP G-2, "Establishment of the Onsite Emergency Organization."

a) If organizational requirements are given in the appropriate E, ECA, FR, M, or R procedure, they should be followed.

b) The minimum functions which must be assigned are:

(1) Operational control of the plant (Emergency Operations Coordinator).

(2) Notification of offsite organizations and off-shift staff (Emergency Liaison Coordinator).

(3) Evaluation of plant conditions and radiological assessment (Emergency Evaluations and Recovery Coordinator).

2) Sound the site emergency signal (if appropriate) and initiate an all-call on group call 400 and 411, using the Health Physics local radio, to inform plant personnel of the emergency and to initiate site assembly and accountability per EP G-4 "Personnel Assembly and Accountability". The site emergency signal should be followed-up with an announcement over the plant wide paging system.

<u>NOTE</u>: The nature of an emergency may make site assembly unneccessary, impractical or hazardous to personnel, for example a breech in security at the Security Building. In such cases the Shift Foreman may decide not to sound the site emergency signal.

3) Notify off-shift plant staff of the emergency situation and their assignments in the long-term emergency organization per EP G-2, "Establishment of the Onsite Emergency Organization."

4) Promptly inform the county, state, NRC and on-call Recovery Manager of the site area emergency situation, per EP G-3 "Notification of Offsite Organizations."

5) Determine the need for evacuating non-essential site personnel per EP G-5 "Evacuation of Non-essential Site Personnel."

6) Initiate on-site and off-site monitoring per EP RB-7, "Emergency On-site Radiological Monitoring Program," and EP RB-8, "Emergency Off-site Radiological Monitoring Program."

7) Provide periodic (approximately every 30 minutes) plant status updates per EP G-3, "Notification of Offsite Authorities."

8) Escalate to General Emergency class, if appropriate.

OR

9) Closeout or recommend reduction in emergency class by verbal communication to offsite authorities.

10) Retain all notification records and other documentation of the event for use in preparation of a written summary of the event within 24 hours of closeout.

4. GENERAL EMERGENCY

a. Description

The General Emergency action level reflects accident situations involving actual or imminent substantial core degradation or melting with the potential for loss of containment integrity. Releases can be reasonably expected to exceed EPA Protective Action Guideline exposure levels offsite for more than the immediate site area.

c. Actions

1) Assign on-shift personnel to perform the functions required for implementation of the Emergency Plan. Assignments may vary at the discretion of the interim Site Emergency Coordinator; however, a typical organization and assignments are given in Figure 1. Duties and responsibilities are listed in EP G-2, "Establishment of the Onsite Emergency Organization."

a) If organizational requirements are given in the appropriate E, ECA, FR, M, or R procedure, they should be followed.

b) The minimum functions which must be assigned are:

(1) Operational control of the plant (Emergency Operations Coordinator).

(2) Notification of offsite organizations and off-shift staff (Emergency Liaison Coordinator).

(3) Evaluation of plant conditions and radiological assessment (Emergency Evaluations and Recovery Coordinator).

(4) Evacuation of nonessential site personnel (Site Evacuation Coordinator). (See EP G-5)

2) Sound the site emergency signal and initiate an all-call on group call 400 and 411, using the Health Physics local radio, to inform plant personnel of the emergency and to initiate site assembly and accountability per EP G-4 "Personnel Assembly and Accountability". The site emergency signal should be followed-up with an announcement over the plant wide paging system.

3) Notify off-shift plant staff of the emergency situation and their assignments in the long-term emergency organization per EP G-2, "Activation and Notification of Onsite Emergency Organization."

4) Promptly notify and inform the county authorities of the emergency situation, its classification and their anticipated response per EP G-3, "Notification of Off-Site Organizations," Recommend evacuation out to the LPZ and alerting of the general public in the Basic Emergency Planning Zone to County Authorities.

Recommend sheltering in affected sectors of the Basic Emergency Planning Zone where a release is imminent or actually occurring, and further from the plant, if a dose of >500 mR (whole body) is projected at that distance.

5) Promptly inform the state, NRC and on-call Recovery Manager per EP G-3, "Notification of Offsite Organizations."

6) Order evacuation of nonessential site personnel per EP G-5, "Evacuation of Nonessential Site Personnel," on completion of assembly and accountability.

7) Dispatch onsite and offsite monitoring teams, per EP RB-7 and EP RB-8.

8) Provide periodic (approximately every 30 minutes) plant status updates per EP G-3, "Notification of Offsite Authorities."

9) Closeout or recommend reduction of emergency class when appropriate by briefing of offsite authorities.

10) Retain all notification records and other documentation of the event for use in preparation of a written summary of the event within 24 hours of closeout.

TABLES

1. "Emergency Action Levels"

2. "Emergency Operating Procedures - Accident Classifications"

3. "Emergency Operating Procedures - NRC Immediate Notification"

4. Technical Specifications Applicable to Unusual Event Condition No. 9.

FIGURES

1. "Typical On-Shift Emergency Organization and Assignments"

SUPPORTING PROCEDURES

EP G-2 "Establishment of the Onsite Emergency Organization"

EP G-3 "Notification of Offsite Organizations"

EP G-4 "Personnel Assembly and Accountability"

EP G-5 "Evacuation of Nonessential Site Personnel"

EP R-2 "Release of Airborne Radioactive Material"

*QUESTION
8-12 (1.0)

The Code of Federal Regulations, 10CFR55, defines the general provisions for Operators' licenses. Due to the needs of PG&E you have been working off-shift for 10 weeks of the calendar quarter.

What on shift activity is necessary to maintain your license in an active status? (per quarter)

*ANSWER

One must perform the functions of a SRO on a minimum of seven 8-hour or five 12-hour shifts per calendar quarter.

*REFERENCE
10CFR55.53
*KW

*QUESTION
8-13 (1.0)

Refer to Figure 8-2, which is a copy of the Technical Specifications containing Limiting Condition for Operation 3.0.3.

(a) What are the bases for LCO 3.0.3? (1.0)

(b) For which of the following does 3.0.3 apply? (0.0)

Charging pump 2-1 and RHR pump 2-1 inoperable
Charging pump 2-1 and 2-2 inoperable
RHR pump 2-1 and RHR pump 2-2 inoperable
Accumulator 2-2 and 2-4 inoperable

*ANSWER

(a) The specification delineates the measures tc be taken for those circumstances not found in the action statements and whose occurance would violate the intent of the specification. (1.0)

(b) DELETED - DIABLO CANYON DIVISIONS, CHANNELS, AND EQUIPMENT NUMBERING ARE NOT THE SAME SEE DWG 445651

*REFERENCE
TS 3.0.3 and Bases
*KW

END OF CATEGORY 8
END OF EXAMINATION