U.S. NUCLEAR REGULATORY COMMISSION

REGION III

Report No. 50-305/OL-87-01

Docket No. 50-305 License No. DPR-43

Licensee: Wisconsin Public Service Corporation
Post Office Box 19002
Green Bay, WI 54307-9002

Facility Name: Kewaunee

Examination Administered At: Kewaunee Nuclear Power Plant

Examination Conducted: Week of February 16, 1987

Examiners: T. D. Reidinger — Date 3/19/87

P. R. Sunderland — Date 3/19/87

D. J. Damon — Date 3/19/87

F. W. Victor — Date 3/19/87

Approved By: T. M. Burdick — Date 3/19/87
Operation Licensing Section

Examination Summary

Examination administered on week of February 16, 1987 (Report No. 50-305/OL-87-01)
Examinations were administered to four senior operator and two operator candidates.
Results: Two senior operator candidates failed the examination.

REPORT DETAILS

1. Examiners

T. D. Reidinger, NRC Region III
P. R. Sunderland, NRC Region III
D. J. Damon, NRC Region III
F. W. Victor, Sonalysts Inc.

2. Examination Review Meeting

A copy of the examinations and answer keys was given to the facility personnel for review at the conclusion of the written examination. Facility personnel mailed their comments to the Chief Examiner after their review. Their comments and resolution of these comments are Attachment 1 to this report.

3. Exit Meeting

On February 20, 1987, at the conclusion of the replacement examinations, the examiners met with members of the plant staff to discuss findings made during the course of the examinations. The following personnel attended the exit meeting:

C. Steinhardt, Facility Plant Manager
D. Braun, Facility Superintendent, Plant Operations
K. Evers, Facility Assistant Manager, Plant Operations
F. Stanaszak, Facility Training Supervisor
R. Zube, Facility Simulator Supervisor
J. Brown, Facility Training Instructor
D. Kwaitkowski, Westinghouse Site Services Manager
R. Nelson, NRC Senior Resident Inspector
T. Reidinger, NRC Examiner
P. Sunderland, NRC Examiner
D. Damon, NRC Examiner
J. Lennartz, NRC Examiner

The following areas were discussed:

a. Generic weakness exhibited by the candidates included:

(1) Candidates failed to consistently use abnormal procedures to confirm the correctness of actions taken after a casualty.

(2) Communications should be improved, with the SRO providing a more visible leadership role.

b. Generic strengths noted included:

(1) Use of normal procedures was very good.

(2) Candidates were well versed in administrative requirements.

c. The following concerns were discussed by the examiners. It is requested that the utility provide a written response addressing both of these concerns.

(1) There is a need for a specific procedure that addresses bistables to be tripped following an instrument failure that provides formal verification that the proper bistables are tripped. Currently, the bistables to be tripped are in separate surveillance procedures. It was suggested that an interim procedure could be a partial surveillance procedure sign-off that includes the proper bistables.

(2) Malfunctions on the simulator that do not work need to be identified and corrected. A specific malfunction that did not work for this set of scenarios was TU01 - Turbine Vibration. The utility generated list of malfunctions that do not work is Attachment 2.

ATTACHMENT 1

Exam Comments and Resolutions

Reactor Operator Exam

QUESTION: 1.06

Facility Comment:

Clad creep is predominant in fresh core, however Kewaunee trains that in subsequent loads buildup of PU-240 is the overriding effect.

Resolution:

Comment not accepted. The KNPP Operator Training Manual is unclear as to what the most dominant factor is and the facility reference chart was not provided as a reference to the NRC. The buildup of PU-240 is accepted as a correct answer.

QUESTION: 1.07

Facility Comment:

Operators at KNPP are trained to use the Accumulated Integral Rod Worth Tables vice the individual bank integral rod worth curves which were given on this exam. This is due to the inaccuracies of utilizing a curve which only reflects the "individual" bank with all other banks out of the core and the inherent inaccuracies in reading a curve vice reading a table. With this in mind, a larger tolerance should be allowed on the final answer.

Resolution:

The NRC recognizes the training methods utilized by training staff.

QUESTION: 2.01

Facility Comment:

Valves may also be given by nomenclature and not number. "FCV" numbers are not used by operators.

Resolution:

The NRC recognizes that "FCV" numbers are not used by operators.

QUESTION: 2.02

Facility Comment:

Question does not specifically solicit answers given in key. Alternate answers could be given which would be sufficient for full credit given the question's wording.

i.e., a.1 Hydrogen is added to control oxygen content in the RCS.

a.4 Nitrogen is added as a cover/fill gas to the CVCS holdup tanks.

NOTE: On a.2. It is true that Hydrazine scavenges dissolved oxygen at low temperatures; however, the "why" hydrazine is added is because hydrogen won't scavenge oxygen at plant conditions where flux is minimal. (i.e., no recombination will take place).

b. The examinee may include the general steps involved in adding chemicals via the chemical mixing tank which are contained in procedure N-CVC-35C. KNPP does not require nor encourage rote memorization of normal procedures, but the major steps and goals are emphasized. We have included the detailed procedure as a reference guide for grading purposes.

Resolution:

Comment a.1 not accepted. Facility comment just rewords the answer key.

Comment a.4 not accepted. Facility reference is about Gas Decay Tanks which are not part of the CVCS, nor does the referenced vent line to the CVCS holdup tanks include any purpose. Drawing XK100-37-P does show the N_2 cover gas for the holdup tanks so the answer key is modified to include this answer.

Comment b not accepted. The question is not soliciting a procedure to be memorized. The candidate should know the flowpath and flow control is as requested.

QUESTION: 2.04

Facility Comment:

2.04.d Charging pumps are not cooled by CCW. Alternate answers - cooled by air or pistons cooled by oil bath which is cooled by air.

Resolution:

Comment not accepted. Facility references only prove that CCW does not cool the charging pumps (XK100-19, 20). Facility reference XK100-35 is not related to the question, however, XK100-36 and M-604 show air cooling of the pumps. Answer has been modified to accepted air cooled.

QUESTION: 2.07

Facility Comment:

Wording of question is not consistent with KNPP terminology. The "NORMAL" power source is not the same as the "preferred" power source as implied by question wording and structure. Nor is the "STANDBY" power source the same as the "alternate" power source. (See Reference Drawing E233.) This confusing wording may lead to soliciting only that two sources are required to be shown.

NOTE: Answer key sketch in error on battery. See reference.

Resolution:

Comment not accepted. Wording of question is consistent with KNPP terminology. Drawing references the stated terms, standby, normal, preferred and alternate. Full credit will be given for any combination which provides at least two methods of powering Instrument Bus No. IV from MCC 1-52C 480 VAC bus.

QUESTION: 2.08

Facility Comment:

2.08.a Provides cooling water for the turbine drive bearing cooler is applicable to only the Turbine Drive Aux Feed pump.

Alternate answer(s) could be -

- Provide for condensate conservation by recirculation path back to CSTS.

- Provide for surveillance testing.

Resolution:

Comment not accepted. The recirculation system does not limit answers to both types of Auxiliary Feed Pumps. Also conservation of condensate is not accepted from the reference material as the material was supporting Answer a.1 at the time.

QUESTION: 2.10

Facility Comment

Operators are trained to "list" Stop Lockouts as shown on reference. Especially when setpoints are not required.

Acceptable (full credit) answers should be:

1. Overspeed
2. Low Jacket Water Pressure
3. Start Failure
4. Low Oil Pressure

Resolution:

Comment not accepted. Setpoints in parenthesis were not required for full credit as stated in the question. However, for full credit, the candidate is required to state that the diesel speed sensing switch is activated.

QUESTION: 2.11

Facility Comment:

KNPP utilizes helium filled balloons and air. Smoke is not used.

Resolution:

Comment is not accepted. Reference SP 23-096 which was not provided appears to conflict with SD 23 which was provided.

QUESTION: 2.12

Facility Comment

The question could confuse examinee due to "interlock" - implies a condition which prevents an occurrence. The question would be better worded as "Describe what events occur with a MSIV closure".

Resolution:

Comment is not accepted. The term interlock comes directly from the reference material.

QUESTION: 3.01

Facility Comment:

Part C of the question could solicit additional answers. Such as:

- Turbine Trip
- MDAFW pumps start

Depending on plant conditions assumed, the answer could also include:

- Turbine runback initiated

Resolution:

Comment not accepted. To start a Motor Driven Auxiliary Feed Pump, both Main Feed Pumps must trip per the facility reference. The question specifically states only the Main Feedwater and Condensate Systems should be considered.

QUESTION: 3.02

Facility Comment:

A more detailed answer could have been listed to Part B depending on candidates perception of what depth was necessary to answer this question.

See referenced lesson plan.

Resolution:

Comment not accepted. Answer is consistent with reference and point value.

QUESTION: 3.04

Facility Comment:

Answer should include:

8. Both Reactor Coolant Pump Breakers open.

Resolution:

Comment accepted. Answer modified to include, 8. Both Reactor Coolant Pump Breakers open.

QUESTION: 3.05

Facility Comment:

Answer item #4 should be split and therefore allowed as two separate answers. This is consistent with items 2 and 3 being allowed as two separate answers.

Resolution:

Comment noted.

QUESTION: 3.09

Facility Comment:

Part B of this question is wide open to a vast set of variables. When the first automatic start attempt is unsuccessful - why was it unsuccessful? Was it because the starting air pressure didn't reach 85 psi, didn't the pinion gears engage, or maybe the primary pair of starters malfunctioned? Depending on all of these various possibilities and/or combinations of these, the examinee could have answered anywhere from two to seven additional starts. The more important fact is that if the fifteen second timer times-out, an engine start failure occurs.

Resolution:

Comment not accepted. The question did not state any assumptions or prior conditions. However, if the candidates stated any assumptions, then their answers will be addressed accordingly.

QUESTION: 3.11

Facility Comment:

Answer key error on a.1 - should read $\geq$ 23.5" Hg vacuum.

Additionally, answer may include the setpoint for bypass interlock of 10" Hg vacuum.

Resolution:

Comment noted. An answer of $\geq$ 23.5" Hg vacuum receives full credit.

QUESTION: 3.13

Facility Comment:

Answers solicited may go beyond answer key to the items specifically being affected by relays.

Example:

- 86/MTB1A and 86/MTB1B cause G-1, 3450, 3451 trip and lockout.

NOTE: The Emergency Diesel Generator start is from a Turbine Trip signal - not direct from 86/T1A or T1B (SD No. 43 in error).

Resolution:

Comment not accepted. The question specifically asks about lockout relays 86/T1A and 86/T1B, not 86/MTB1A and 86/MTB1B. The NRC acknowledges the error in KNPP SP43. The error is expected to be corrected by the utility prior to the next scheduled examination.

QUESTION: 4.02

Facility Comment:

Part A is wide open to a vast number of different scenarios.

Example:

- blocked filters
- closed isolation valves

Even the given answer could be in error if the assumption was that inlet pressure was low thereby not causing a delta-p to operate the bypass valve.

Resolution:

Comment not accepted. The cause is consistent with the stated reference. If the candidates made certain assumptions then consideration will be given to those assumptions and will be graded accordingly.

QUESTION: 4.05

Facility Comment:

All blowdown valves and sample valves close. R-19A and B have not been installed yet. KNPP has R-19 for both "A" and "B" steam generators.

Resolution:

Comment accepted. Part A of the answer has been modified to state "all S.G. blowdown valves shut and all S.G. sample valves shut."

QUESTION: 4.11

Facility Comment:

Additional action on pipe break could include:

- Establish alternate decay heat removal with the steam generator or if the RCS is depressurized, with Step 4.5.

Resolution:

Comment accepted. Answer has been modified to include additional action, "Establish alternate decay heat removal with the steam generator or if the RCS is depressurized."

Senior Reactor Operator Exam

QUESTION: 5.04

Facility Comment:

Wording of possible choices is very confusing which could lead to examinee selecting of the wrong item. Item "D" given as the definition is, in fact, not defined in KNPP Technical Specifications in this manner.

Resolution:

Comment accepted. The question is deleted.

QUESTION: 5.08

Facility Comment:

Similar wording should be acceptable. Question could solicit more "operationally-oriented" advantages than design and/or theory type advantages.

Resolution:

Comment not accepted. No operationally - oriented advantages provided by the utility. No other references were provided.

QUESTION: 5.09

Facility Comment:

The quoted reference utilized pertains only in a general sense to this question. The answers which may be solicited could vary considerably depending on assumptions made by examinee.

Resolution:

Comment not accepted. If assumptions are stated by the candidate, the answer is evaluated according to the assumption if the assumption is deemed valid. Utility did not provide any references or assumptions that will support the comment.

QUESTION: 5.10

Facility Comment:

a. A more detailed definition of AFD may be given that is still acceptable?

$$AFD = (P_T - P_B) \times 100 \text{ percent}$$

$$\text{where } P_T = \frac{I_T}{I_T 100 \text{ percent}}$$

$$P_B = \frac{I_B}{I_B 100 \text{ percent}}$$

c. A more complete answer may be given, which includes information not in exam key.

"At full power, the water leaving the reactor (T_H) is much hotter than the water entering the reactor (T_C). The hotter T_H (as power increases) causes the flux to be suppressed in the top of the core (more negative MTC at higher temperatures) forcing the flux peak to shift downward..."

Resolution:

Comment accepted. Answer key was modified to accept both conditions. However, the question did not solicit a formula derived definition in Part a. Comment from utility in Part c is a generalization of the stated answer key.

QUESTION: 5.11

Facility Comment:

More specific information may be given such as:

"Temperature below RT_{NDT}" vice "Relatively Low Temperature."

Resolution

Comment accepted. Answer key modified to add comment. However, the stated answer is specifically noted in the reference mentioned.

QUESTION: 5.15

Facility Comment

Tolerance on final result should be greater. Allowed tolerance on reading RD 6.2 and RD 8.1 could result in a larger variance on final answer than that given.

Resolution:

Comment not accepted. The allowable tolerances in the answer will be in the the range of 3.18 through 3.36. This is within the .1 allowed by the answer key.

QUESTION: 6.01

Facility Comment:

Examinee could interpret item #1 in right hand column as meaning "either" channel and item #2 as meaning "both" channels are needed to do it. If an examinee did make this interpretation, then the answers would be:

a. 1
b. 1
c. 1
d. 2

Resolution:

Comment accepted. To eliminate any potential confusion from the candidates, Item B will be deleted from the examination.

QUESTION: 6.02

Facility Comment:

b. DG 1A Oil Cooler is cooled by the JACKET WATER COOLING SYSTEM which is in turn cooled by service water.

Resolution:

Comment accepted. Answer key modified to reflect comment. However, the stated reference notes that the service water control valves are provided to the diesel Generator 1A/1B oil coolers (CU 31088/31089). The utility reference was not provided prior to the examination.

QUESTION: 6.03

Facility Comment:

Correction to Question

Slack cable setpoint on manipulator crane is 500lb (vice 450) as per Westinghouse Refueling procedure FP-WPS-R11, Rev 0 (SD No. 53 error).

Resolution:

The NRC acknowledges the utility's recognition of the error in KNPP system description Page 53-16. The utility is requested to provide the correction prior to the next examination.

QUESTION: 6.04

Facility Comment:

An additional answer - "The capacity of the refueling water storage tank is based on the requirement for filling the reactor refueling cavity..." Should be allowed.

Another additional answer - ". . . refueling water storage tank conditions specified are consistent with those assumed in the LOCA analysis." Should also be allowed.

Resolution:

Filling the refueling cavity is an additional operation for a correct answer. However, the utility's additional answer is not accepted because it is not considered to be a basis and is discussed by the first three answers.

QUESTION: 6.09

Facility Comment:

Additional answers should be accepted which are in accordance with items shown on reference drawings E1634 and E1636.

Item c.7. should read ". . . not in PULL-OUT."

Resolution:

Comment not accepted. The utility drawings reflected the stated answer key, no additional answers were discerned per the drawings. Item c.7 typographical error "not in pull-out" was amended.

QUESTION: 7.10

Facility Comment:

Acceptable answer on Part B could be anywhere from 100 psig to 106 psig based on referenced SP.

Resolution:

Comment not accepted. KNPP OP Procedure E-FP-08 does not allow this tolerance range.

QUESTION: 7.11

Facility Comment:

Format of answer key in error.

Should be:

a.1. RCS Subcooling based on core exit TC's < 30°F
2. PZR level cannot be maintained > 2%

b.1. RCS Subcooling changes to < 120°F
2. PZR level changes to > 20%

Resolution:

Comment accepted. The mislabeled answer key was amended noting that the answer key is still correct.

QUESTION: 7.12

Facility Comment:

In Part B - Utilizing procedure N-RC-36A, 3.0 note, as well as the Westinghouse RXCP Instruction Book 5710-83B-1, Pump: Section 6, there is no allowance for the omission of ANY of the initial conditions. Although the answer solicited comes from the cited reference, the question itself (as written) requires the answer "NONE" if one were to use only N-RC-36A.

However, in the emergency procedure FR-C.1 a NOTE preceding Step 17 allows the omission of the initial conditions given the conditions applicable to the procedure.

Resolution

Comment not accepted. The note clearly states what the answer of Part B demands. The NRC notes that the utility recognized the stated answer is correct. The utility did not provide the Westinghouse RX CP instruction Book 5710-83B-1.

QUESTION: 7.14

Facility Comment:

Note calculation error in answer key:

a. Distance 1 = 1 ft (D_1)
Distance 2 = 4 ft (D_2)

Dose 1 = 800 mr/hr (I_1)
Dose 2 = x (I_2)

$I_1D_1^2 = I_2D_2^2$

$(800)\ (1)^2 = (x)\ (4)^2$

$800 = 16x$
$800/16 = x$

50 mr/hr = x (Answer key has 30 mr/hr)

50 mr/hr x 3 = 150 mr (Answer key has 90 mrem)

Resolution

Comment accepted. Answer key was modified to reflect the typographical comment.

QUESTION: 7.16

Facility Comment:

Answer Key Correction

a.3. Screenhouse Header Isolation A is SW 3A/CV 31038 (not 31040).

Resolution:

Comment accepted. Answer key was modified to accept the optional answer of valve number. The valve number was not required for the answer but was considered an option by the candidate.

QUESTION: 8.01

Facility Comment:

Answer is correct PROVIDED:

1. Its corresponding emergency power source is operable; and

2. Its redundant system, train, or component is operable. (No information was given in question related to these two provisions.)

Resolution:

Comment not accepted. The facility comment is exactly the reasoning required to produce a correct answer of False. The answer key and question remain unchanged.

QUESTION: 8.03

Facility Comment:

Answer given in Part A only ensures control of entry, not that the CONTAINMENT SYSTEM INTEGRITY requirement is met. The SP for airlock leakrate test satisfactorily completed or the Containment Integrity Checklist satisfactorily completed would be an applicable administrative means of insuring CONTAINMENT SYSTEM INTEGRITY requirements is met.

Resolution:

Comment not accepted. The facility comment does not have any relationship to the answer being solicited.

QUESTION: 8.04

Facility Comment:

KNPP does not require nor desire the rote memorization of all possible reportables given on the Night Orders tables. We have the tables in Night Orders to preclude reliance on memory. We train our people to use this ready reference vice relying on memory.

Resolution:

Comment not accepted. The SRO should know requirements that have actions due within one hour. The NRC supports the utility's philosophy on not requiring rote memorization of possible reportable instances but one hour requirements should be the exception.

QUESTION: 8.06

Facility Comment:

Changes per ACD 1.8 Rev A

Independent verification may be accomplished by:

1. A qualified individual operating independently, physically verifying that a component has been placed in a specified configuration, or

2. The performance of an independent functional test without compromising plant safety that unambiguously verifies the component is in a specified configuration.

Resolution:

Comment accepted. The NRC notes that the utility did not provide an updated ACD prior to the examination.

QUESTION: 8.11

Facility Comment:

The question in Part A solicits "the" major difference and the answer key contains two differences. The "repetitive nature" vs. "non-repetitive jobs" is the major difference.

For information only - Part B refers to a RADIATION HAZARD AREA. KNPP definition of RADIATION HAZARD AREA is "any area where the probability exists of encountering general area radiation fields of 10 R/hr or greater."

Resolution:

Comment not accepted. The reference clearly states that the answer key is correct and was actually extracted verbatim from the reference.

QUESTION: 8.12

Facility Comment:

Answer in Part B is in error. The RWST does not fit into the 72 hour LCO.

Within one (1) hour per KNPP Technical Specifications guidance letter dated August 15, 1984.

NOTE: Additional reference of TS 3.3-2 for RWST level should be added to answer key references.

Resolution:

Comments not accepted. TS 3.2-2 was the only reference available prior to the examination. This specifically states that the answer key is correct as stated. The mentioned KNPP technical guidance letter was not provided prior to the examination, however, the one hour answer will be accepted.

QUESTION: 8.13

Facility Comment:

Part B may solicit much more than what is contained in key. Answers solicited may include items contained in referenced Technical Specifications which are applicable to a power increase from 35% up to 100%. Answer key is only one item.

Resolution:

Comment noted. The utility did not provide any additional items to be considered. The candidate is required to at least state the requirement for AFD to increase power to above 50%. Any additional requirements prior to exceeding 90% power is considered an option for the candidate.

QUESTION: 8.15

Facility Comment:

Part B may only solicit "maintain RCS integrity."

Resolution:

Comment accepted. Answer key adds comment as alternate full credit answer.

QUESTION: 8.17

Facility Comment:

a. SHOULD BE

"Restrict maximum core power level two percent for every one percent of indicated power tilt ratio exceeding 1.0."

Therefore MAXIMUM power is reduce by 10%.

Power limit is 90%.

Resolution:

Comment (a) is accepted. Answer key is changed from 85% to 90%.

ATTACHMENT 2

Malfunctions that need to be corrected:

ED06	-	Loss of 125 VDC Bus
ED07	-	Loss of 118 VAC
ED08	-	Loss of 4160V
ED09	-	Loss of 480V
ED11	-	345 KV Breaker Reclosure
EG09	-	Generator Output Breaker Fails to Open Following Turbine Trip
FW02	-	Condensate System Recirculation Valve Fails Open
FW07	-	Feedwater Pump Recirculation Valve Fails Open
TC05	-	Turbine Control System Cycling
TU01	-	Turbine Blade Damage

MASTER COPY

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

FACILITY: KEWAUNEE

REACTOR TYPE: PWR-WEC2

DATE ADMINISTERED: 87/02/17

EXAMINER: SUNDERLAND, P.

CANDIDATE: _____

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
24.00	24.3Z	_____	_____	5.	THEORY OF NUCLEAR POWER PLANT OPERATION, FLUIDS, AND THERMODYNAMICS
24.50	24.8Z	_____	_____	6.	PLANT SYSTEMS DESIGN, CONTROL, AND INSTRUMENTATION
25.00	25.38	_____	_____	7.	PROCEDURES - NORMAL, ABNORMAL, EMERGENCY AND RADIOLOGICAL CONTROL
25.00	25.38	_____	_____	8.	ADMINISTRATIVE PROCEDURES, CONDITIONS, AND LIMITATIONS
98.50		_____ Final Grade	_____%		Totals

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

_____
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 on one side of the paper, and write "Last Page" on the last answer sheet.

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

10. Skip at least three lines between each answer.

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

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

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

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

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

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

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

18. When you complete your examination, you shall:

a. Assemble your examination as follows:

(1) Exam questions on top.

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

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

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

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

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

EQUATION SHEET

$f = ma$

$v = s/t$

Cycle efficiency = (Net work out)/(Energy in)

$w = mg$

$s = V_o t + 1/2\ at^2$

$E = mc^2$

$KE = 1/2\ mv^2$

$a = (V_f - V_o)/t$

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

$PE = mgh$

$V_f = V_o + at$

$w = \theta/t$

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

$W = v\ \Delta P$

$A = \dfrac{\pi D^2}{4}$

$t_{1/2}^{eff} = \dfrac{[(t_{1/2})(t_b)]}{[(t_{1/2}) + (t_b)]}$

$\Delta E = 931\ \Delta m$

$\dot{m} = V_{av} A \rho$

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

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

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

$Pwr = W_f \Delta h$

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

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

$TVL = 1.3/\mu$

$HVL = -0.693/\mu$

$P = P_o 10^{sur(t)}$

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

$SUR = 26.06/T$

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

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

$SUR = 26\rho/\ell^* + (\beta - \rho)T$

$CR_1(1 - K_{eff1}) = CR_2(1 - K_{eff2})$

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

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

$T = \ell/(\rho - \beta)$

$M = (1 - K_{effo})/(1 - K_{eff1})$

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

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

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

$\ell^* = 10^{-4}$ seconds

$\bar{\lambda} = 0.1$ seconds^{-1}

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

$I_1 d_1 = I_2 d_2$

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

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

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

$\Sigma = \sigma N$

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

Water Parameters

1 gal. = 8.345 lbm.
1 gal. = 3.78 liters
1 ft^3 = 7.48 gal.
Density = 62.4 lbm/ft^3
Density = 1 gm/cm^3
Heat of vaporization = 970 Btu/lbm
Heat of fusion = 144 Btu/lbm
1 Atm = 14.7 psi = 29.9 in. Hg.
1 ft. H_2O = 0.4335 lbf/in.

Miscellaneous Conversions

1 curie = 3.7×10^{10} dps
1 kg = 2.21 lbm
1 hp = 2.54×10^3 Btu/hr
1 mw = 3.41×10^6 Btu/hr
1 in = 2.54 cm
°F = 9/5°C + 32
°C = 5/9 (°F-32)
1 BTU = 778 ft-lbf

QUESTION 5.01 (1.00)

As moderator temperature increases, control rod worth for the controlling bank _____ (INCREASES, DECREASES, or REMAINS THE SAME)

QUESTION 5.02 (1.00)

During a reactor startup, the first reactivity addition caused the count rate to increase from 20 to 40 cps. The second reactivity addition caused the count rate to increase from 40 to 80 cps. Which of the following answers is correct? (There is only one correct answer)

a. The first reactivity addition was larger.
b. The second reactivity addition was larger.
c. The first and second reactivity additions were equal.
d. There is not enough data given to determine the relationship of reactivity values.

QUESTION 5.03 (2.00)

a. List the three largest contributors to total power defect in order of increasing magnitude at BOL. (1.5)
b. The total power defect at a given power level becomes _____ MORE NEGATIVE, LESS NEGATIVE, or REMAINS THE SAME) from BOL to EOL. (Fill in the blank) (0.5)

QUESTION 5.04 (1.50)

Kewaunee is operating at 50% power (steady state) with all systems in manual. If no operator action is taken, what effect (INCREASE, DECREASE, OR REMAINS THE SAME) will a 10 degree-F increase in circulating water temperature have on the following: (consider each separately)

a. Ciculating Water Pump Available NPSH? (0.5)

b. Condenser Vacuum? (0.5)

c. Condensate Temperature? (0.5)

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

QUESTION 5.05 (1.00)

The difference between the total pressure and the saturation pressure at a given point in a centrifugal pump is known as _____. (Multiple Choice)

a. Minimum Required Net Positive Suction Head
b. Available Net Positive Suction Head
c. Total System Head
d. Head Loss

QUESTION 5.06 (1.00)

Fill in the Blanks

a. The t(1/2)(half-life) of I-135 is _____ (LONGER, SHORTER, THE SAME) than (as) that for Xe-135.

b. The fractional change of the effective multiplication factor from critical is known as _____. (0.5)

QUESTION 5.07 (1.50)

List two significant advantages that counter-flow heat exchangers have over parallel-flow heat exchangers. (1.5)

QUESTION 5.08 (1.50)

If natural circulation has been interupted (not due to excessive steam flow), predict if the following indications INCREASE, DECREASE, or REMAIN THE SAME.

a. Steam Generator Level

b. Steam Pressure (assume constant decay heat rate)

c. Core Exit Thermocouple Temperature

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

QUESTION 5.09 (2.50)

a. Define axial flux difference. (0.5)
b. If delta-I is out of the programmed band to the left;
   1. Is more power being produced in the upper or lower half of the core? (0.5)
   2. What manual action should the operator, short of changing power, take to restore delta-I to the target band with rods in automatic? (0.5)
c. Why does delta-I become more negative as power increases? (1.0)

QUESTION 5.10 (1.00)

List two conditions necessary for brittle fracture of a carbon steel pressure vessel to occur.

QUESTION 5.11 (2.50)

For the centrifugal pump whose operating point is illustrated on Figure 1, perform the following:
a. Illustrate on Figure 1(a) the new operating point if the pump discharge is throttled open. (0.75)
b. Explain why changes in flow rate (if any) occur. (0.5)
c. Illustrate on Figure 1(b) the new operating point if a second pump is started in parallel to the first. (0.75)
d. Explain why changes in head loss (if any) occur. (0.5)

QUESTION 5.12 (1.00)

How do the following steam parameters change (INCREASE, DECREASE, or REMAIN THE SAME) between the inlet and outlet of a real (not ideal) turbine?
a. Enthalpy
b. Quality

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

QUESTION 5.13 (2.00)

Answer the following concerning xenon:

a. List two methods of xenon removal. (0.5)

b. Describe how and why xenon reactivity varies after a 25% power increase to 100% power (equilibrium conditions). (1.0)

c. At 100% power, the reactor trips due to a mistake by an I&C technician. Criticality is planned 6 hours after the trip. If the startup is delayed for 2 hours, how and why, is the Estimated Critical Position affected? (0.5)

QUESTION 5.14 (2.50)

Assuming the following conditions:

Assume power is 100 %
Boron concentration is 600 ppm
The reactor is at MOL, 5500 MWD/MTU
Automatic Rod Control
Initial temperature mismatch is 0

Use the curves provided to calculate how much boron must be added to initiate outward rod motion. (Your answer should be in ppm, and you must include all work and assumptions)

QUESTION 5.15 (2.00)

For the following parameters, how do they trend over core life from BOL to EOL (INCREASES, DECREASES, REMAINS THE SAME)? (Consider each separately)

a. Moderator temperature coefficient (0.5)

b. Excess reactivity (0.5)

c. Beta bar - eff (0.5)

d. Rod insertion limits (0.5)

QUESTION 6.01 (1.50)

Match the control functions with the number of controllers for VCT level control (0.5 each)

______	a.	Modulate three-way valve (LD-27) at 56% level	1. Only one channel (LIT-112 or 141)
______	b.	Reset of LD-27 at 70% level (decreasing)	2. Both LIT-112 and LIT-141
______	c.	Close VCT isolation valves at 5% level	

QUESTION 6.02 (1.00)

List the cooling medium for the following heat loads.

a. Seal Water Heat Exchanger
b. Diesel Generator 1A Oil Cooler
c. Waste Evaporator
d. Turbine Gland Steam Condenser

QUESTION 6.03 (1.00)

Multiple Choice

In refueling, when the gripper tube is supported on a fuel assembly and the weight indicator senses a reduction in the suspended weight to less than 450 lb., the _____ indicating lamp lights.

a. Gripper Engaged
b. Gripper Disengaged
c. Tube Down
d. Slack Cable

QUESTION 6.04 (1.50)

List three bases for the capacity of the refueling water storage tank per KNPP System Description 33.

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

QUESTION 6.05 (2.00)

Fill in the blanks:

a. Prior to head replacement, the reactor refueling cavity is drained by pumping water from the RCS hot leg to the RWST with the _____ pumps. (0.5)

b. The All Volatile Treatment system maintains proper water chemistry in the the secondary system through the use of the chemical _____. (0.5)

c. Stress corrosion cracking of austenitic stainless steel components in a post-LOCA environment is prevented by injection of _____ by the _____ system. (0.5 each)

QUESTION 6.06 (2.25)

For the following valves, describe the interlock(s) and bases of each interlock:

a. SI test line isolation valves to the RWST (SI-208,209) (.75)

b. SI pump recirc isolation valves (RHR-300A,B)(2 interlocks) (1.50)

QUESTION 6.07 (1.00)

In July of 1981, at the Kewaunee Plant, low temperature on a section of piping between the BA tanks and the SI pumps was observed. This low temperature was caused by removal of a piece of insulation from the boric acid heat tracing circuits to permit maintenance on the heat tracing circuits.

a. What would the temperature of this fluid be for a low temperature alarm? (0.5)

b. Why should the temperature be maintained above the alarm setpoint? (0.5)

QUESTION 6.08 (1.00)

What is the basis for the maximum pressurizer spray flowrate?

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

QUESTION 6.09 (3.00)

Answer the following concerning a blackout:
a. What three conditions are needed to generate the blackout signal? (1.2)
b. List two events that occur on a safeguards power bus as a result of initiation of a blackout signal. (0.8)
c. List five conditions which must be met for breaker 1-509 to close, connecting D-G 1-A to bus 1-5 during a blackout. (1.0)

QUESTION 6.10 (1.50)

When the Emergency Diesel Generator is started,

a. At what point is the field flashed? (0.5)
b. What two actions take place to cause the field to be flashed? (1.0)

QUESTION 6.11 (2.25)

Describe the flowpath of fluid through the Moisture Separators. Your answer should include the source, final destination, and components in the following flowpaths for both steams and condensates.

a. Heating steam (1.00)

b. Reheated steam (1.25)

QUESTION 6.12 (1.00)

If auctioneered T-avg was high due to a failed temperature instrument, how is pressurizer level affected?

QUESTION 6.13 (2.00)

Answer the following concerning the Overtemperature delta-T function:

a. What is the purpose of the OT delta-T trip? (0.5)
b. What control action(s) are provided by the OT delta-T function? (1.0)
c. Under what conditions do the(se) control action(s) occur? (0.5)

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

QUESTION 6.14 (2.00)

Fill in the blanks for the following Full Length Rod Control questions:

a. Staggered stepping of the groups within banks is controlled by the _____.

b. The conversion of the power mismatch signal to a temperature error is accomplished by the _____.

c. Loss of any one of two (+) 24 vdc power supplies causes a _____ alarm.

d. The speed of a shutdown bank is set at _____ steps per minute.

QUESTION 6.15 (1.50)

Answer the following questions concerning the EHC system:

a. What is used for a load reference in the following modes:
   1. IMP IN (0.5)
   2. IMP OUT (0.5)

b. How are valve stroke times affected by pressing the CV FAST pushbutton? (0.5)

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

QUESTION 7.01 (1.00)

At Kewaunee, what two conditions constitute an adverse containment?

QUESTION 7.02 (.50)

Procedure A-NI-48 (Abnormal Nuclear Instrumentation) directs the use of the meters on the front of the NIS drawers to calculate quadrant power tilt when investigating a PR UPPER OR LOWER HI FLUX DEVIATION alarm.
(True or False)

QUESTION 7.03 (1.00)

Fill in the blanks concerning diesel generator operation:

a. Diesel engine temperature should be maintained at approximately _____ degrees-F when not operating per procedure N-DGM-10. (0.5)

b. The two hour electrical load limitation on a diesel generator is _____ KW. (0.5)

QUESTION 7.04 (1.50)

After a reactor trip, when may the shift supervisor authorize a restart per N-ESF-5 (Three conditions)

QUESTION 7.05 (1.00)

If Secondary Integrity Criteria are not met (E-1 QRF), then procedure E-2 (Faulted Steam Generator Isolation) should be implemented. What are these two criteria?

QUESTION 7.06 (2.00)

If criticality is not attained at the ECP plus 400 pcm, what does the 'Reactor Startup' procedure (N-CRD-49B) require the operator to do? (Include all options)

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

QUESTION 7.07 (2.00)

Concerning 'Emergency Boration' (E-CVC-35):
a. When do you Emergency Borate? (1.0) (list four conditions)
b. What immediate actions are required? (1.0) (list four actions)

QUESTION 7.08 (1.50)

An RCS leak occurs inside containment. List five containment parameters that have indication or alarms that would alert the operator that the leak was in containment.

QUESTION 7.09 (2.00)

For the following four procedures, under what conditions in the immediate actions must you trip the reactor?
a. Continuous Rod Insertion (E-CRD-49A)
b. Continuous Rod Withdrawal (E-CRD-49B)
c. Dropped Rod (E-CRD-49C)
d. Loss of Instrument Air (E-AS-01)

QUESTION 7.10 (1.50)

In procedure E-FP-08 (Fire), symptoms include control room annunciators for Fire Pump 1A and/or 1B running.

a. What two conditions cause a FIRE PUMP 1A RUNNING alarm? (1.0)

b. What condition causes a FIRE PUMP 1B RUNNING alarm? (0.5)

QUESTION 7.11 (1.50)

While in procedure E-0 (Reactor Trip or Safety Injection), there are certain conditions for which SI must be actuated per the E-0 QRF.

a. List two conditions that require Safety Injection actuation. (1.0)

b. How do these conditions change with adverse containment? (0.5)

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

QUESTION 7.12 (2.00)

a. State the initial conditions that must be met for starting a RCP for the following parameters per N-RC-36A: (1.5)
   1. #1 Seal delta-P.
   2. CCW supply temperature.
   3. VCT pressure.

b. Under what conditions may the above initial conditions be omitted? (0.5)

QUESTION 7.13 (1.00)

What procedure(s) specifically recommend(s) that the CSF status trees should not be implemented but be monitored for information only?

QUESTION 7.14 (2.50)

After working in an area for 3 hours, a worker discovers that his pocket dosimeter is off scale and leaves the area. A survey is taken that reveals a hot area of 800 mr/hr. at 1 ft. from the hot spot. The workers activities were primarily 4 feet from the hot spot.

a. Determine the exposure that the worker received. (1.5)

b. If the worker's previous quarterly exposure was 826 mr, what KNPP and/or 10 CFR 20 exposure limits, if any, were exceeded? (1.0)

QUESTION 7.15 (2.50)

Include all possible operator actions required in procedure FR-S.1 (Response to Nuclear Power Generation/ATWS) under the following conditions? (Each condition is considered separately.)

a. Reactor has failed to trip. (1.25)

b. Turbine has failed to trip. (1.25)

QUESTION 7.16 (1.50)

Kewaunee has experienced a low pressure in Service Water header 1A.

a. What automatic actions occur when pressure reaches 72 psig (decreasing)? (1.0)

b. Why does the operator hold the service water pump switch in the ON position for five seconds to start additional service water pumps. (0.5)

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

QUESTION 8.01 (.50)

True or False
If the normal power source for an RHR pump is inoperable, then Technical Specifications requires that the RHR pump must be considered inoperable.

QUESTION 8.02 (1.50)

Fill in the blanks
a. One diesel generator may be inoperable for a period not exceeding _____ days provided the other diesel generator is tested _____ to ensure operability... (0.5 each)
b. Oxygen concentration must be maintained below _____ ppm during steady state operation. (0.5)

QUESTION 8.03 (1.00)

In the definition of CONTAINMNENT SYSTEM INTEGRITY, at least one door in both the personnel and the emergency airlocks is properly closed. List one administrative and one design means of insuring that this requirement is met. (0.5 each)

QUESTION 8.04 (1.00)

Per KNPP Standing Night Orders, state the time limits for NRC notification required under the following conditions:

a. The initiation of any nuclear plant shutdown required by Technical Specifications. (0.5)

b. An event during operation that is not covered by Kewaunee operating or emergency procedures. (0.5)

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

QUESTION 8.05 (1.00)

Multiple Choice

To protect non-ESF equipment or to warn of unusual or dangerous conditions, a _____ tag is used.

a. Caution
b. Hold
c. Out of Service
d. Danger

QUESTION 8.06 (1.50)

List two acceptable methods of performing an INDEPENDENT VERIFICATION per ACD 1.8.

QUESTION 8.07 (1.00)

a. What kind of temporary changes may be made to the refueling procedure? (0.4)

b. Who must approve the change? (List THREE) (0.6)

QUESTION 8.08 (2.00)

What does an operable SI/RHR train consist of?

QUESTION 8.09 (2.00)

Answer the following questions concerning Temporary Operating Procedures.

a. Under what conditions may a Temporary Operating Procedure be used? (1.0)
b. Prior to implementation, who may approve a Temporary Operating Procedure? (1.0)

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

QUESTION 8.10 (1.50)

It has just been established that one pressurizer PORV cannot be operated from the control room. What do Technical Specifications require? (Include all options)

QUESTION 8.11 (2.00)

a. What is the major difference between a regular and extended Radiation Work Permit (RWP)? (1.0)

b. List the two situations that require a special RWP. (1.0)

QUESTION 8.12 (1.50)

With the plant at 100% power, an auxiliary operator discovered that the RWST bubbler level indicator was below the amount of water required for Technical Specifications. Later it was determined that FPC-1100 was open, allowing a flowpath between the RWST and the Waste Holdup Tank.

a. How much water do Technical Specifications require there to be in the RWST? (0.5)

b. What actions do Technical Specifications require the SRO to take? (1.0)

QUESTION 8.13 (1.50)

a. For power operation at 70% power, you exceed 1 hour of time outside the target axial flux difference band in the last 9 hours. What actions are required? (1.0)

b. If the reactor is at 35% power and it is planned to go to 100% power, what axial flux difference requirements must be met? (0.5)

QUESTION 8.14 (1.50)

An incident report is required from any supervisor recognizing an incident. ACD 2.16 defines incident situations. List six (6) of these situations. (NOTE: use general versus specific situations in your answer)

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

QUESTION 8.15 (2.50)

Answer the following Safety Limit Questions:

a. What is the maximum limit on reactor coolant system pressure per Safety Limit 2.2? (0.5)

b. What is the basis of this Safety limit? (0.75)

c. How was the limit established? (0.75)

d. After shutdown of the plant for violation of this safety limit, who may authorize resumption of operation? (0.5)

QUESTION 8.16 (1.50)

a. Who is the leader of the fire brigade? (0.5)

b. Who are the other four members of the fire brigade? (1.0)

QUESTION 8.17 (1.50)

The reactor is at 95% power. A Quadrant Power Tilt Ratio (QPTR) is performed and the results show a ratio of 1.05.

a. If the tilt can't be eliminated in 2 hours, what must be done? (Be specific) (0.5)

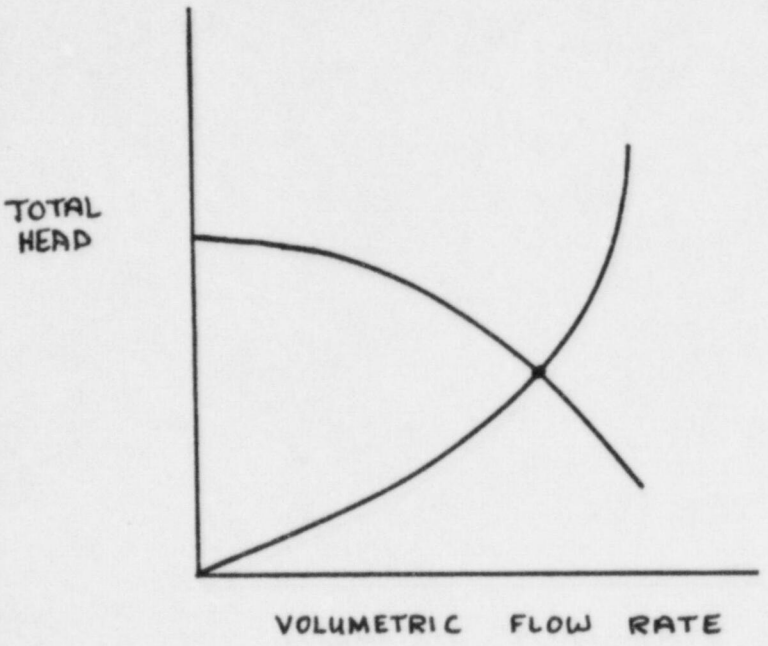
b. If the tilt condition remains for greater than 24 hours, what must be done? (0.5)

c. If the QPTR was 1.10 instead with no rod misalignment, what would the operator be required to do? (0.5)

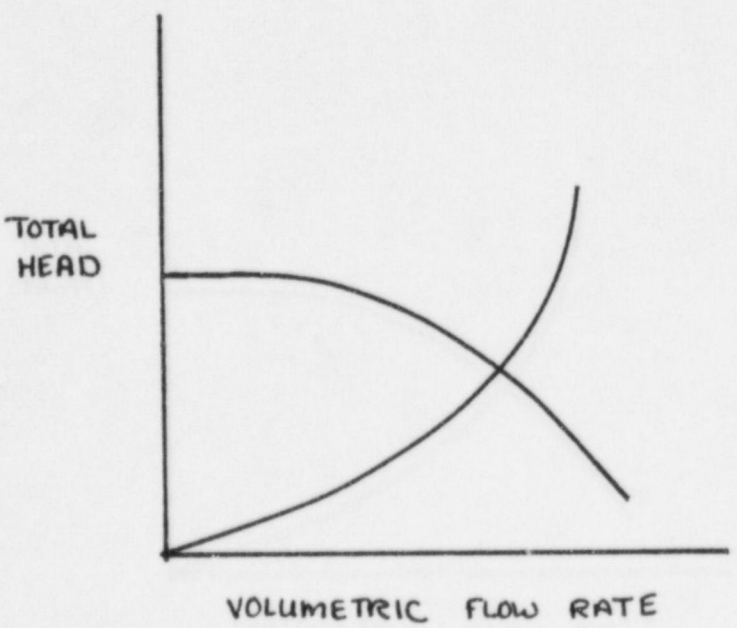
(***** END OF CATEGORY 08 *****)
(********** END OF EXAMINATION **********)

Figure 1
for question 5.11

1a) Discharge valve opened



1b) Start a second pump in parallel

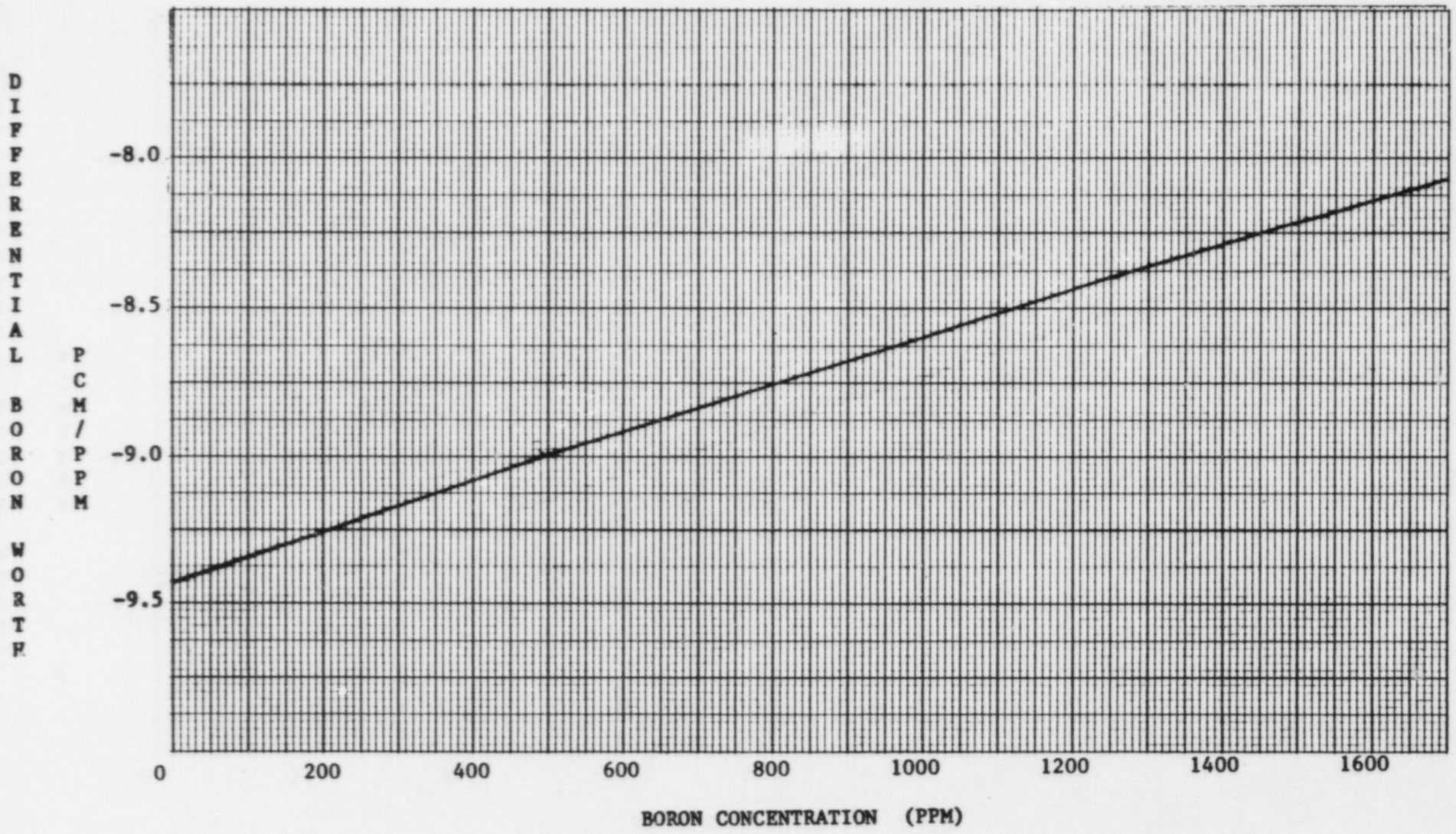


RD. 6.1

REV. JUL 2 1986

DIFFERENTIAL BORON WORTH VS. BORON CONCENTRATION

BOL(0 MWD/MTU) T = 547 F CYCLE 12



RD. 6.1

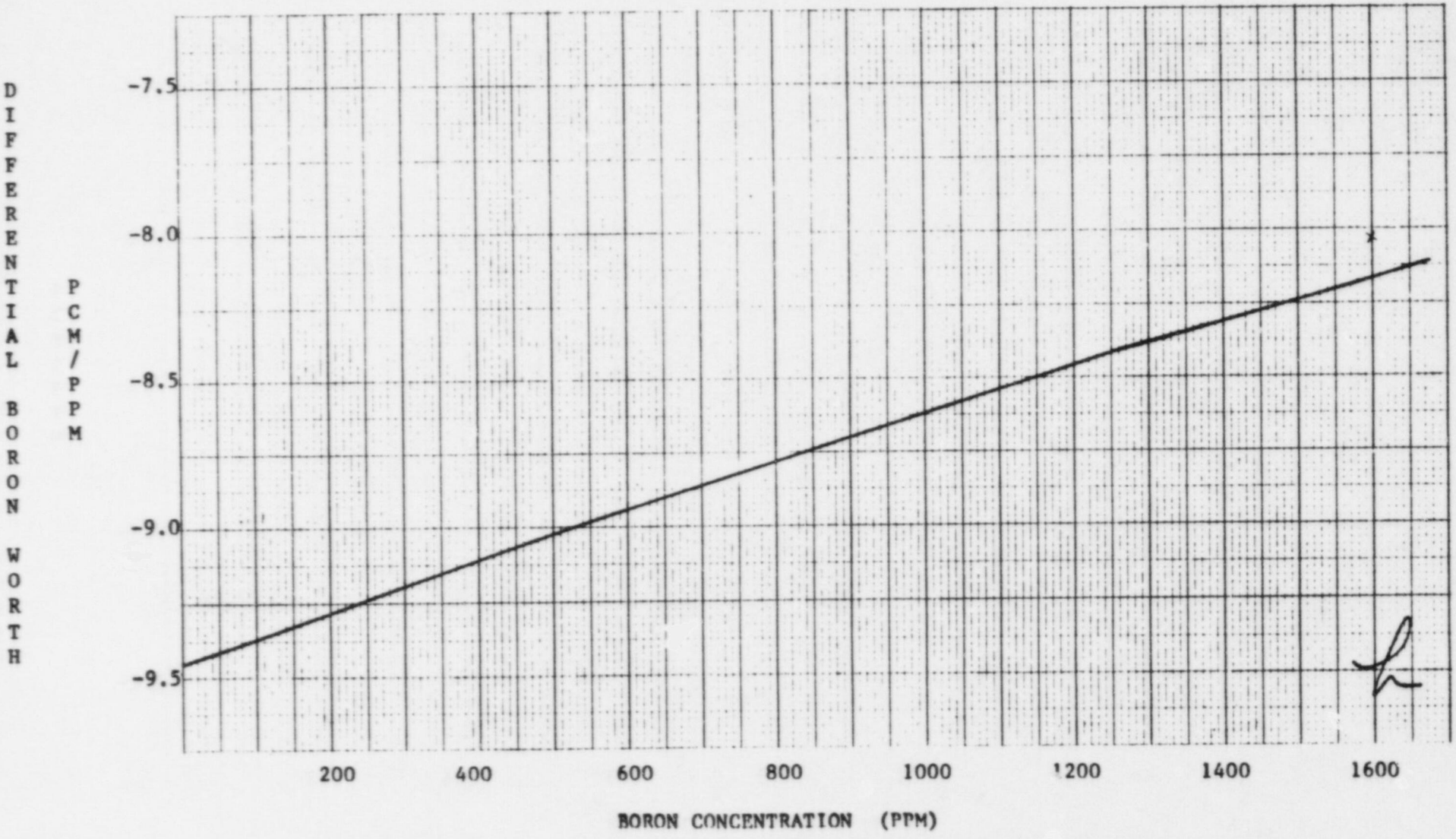
REV. JUL 2 1986

RD. 6.2

REV. APR 1 5 1986

DIFFERENTIAL BORON WORTH VS. BORON CONCENTRATION

MOL (5500 MWD/MTU) T = 547 F CYCLE 12



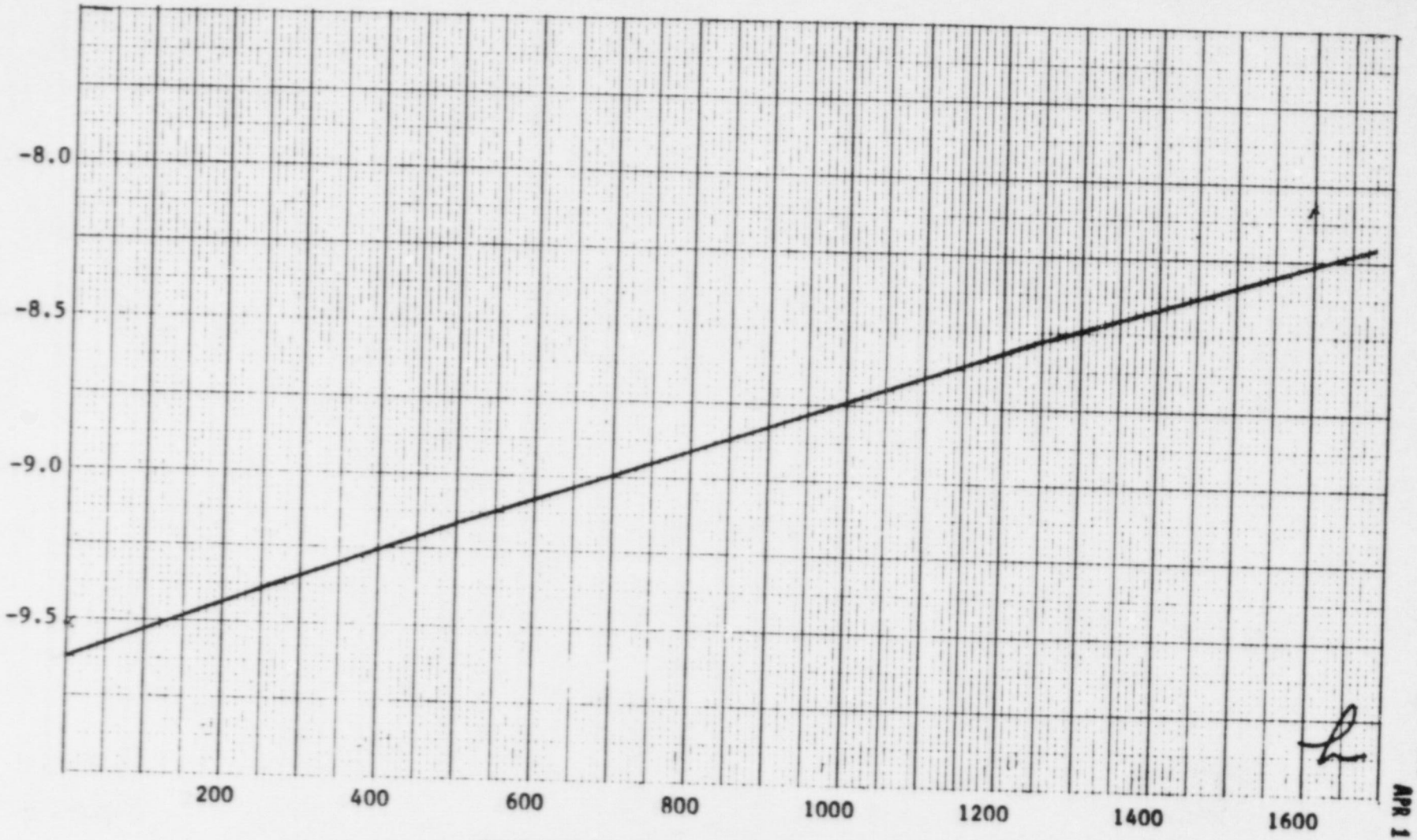
RD. 6.2

REV. APR 1 5 1986

DIFFERENTIAL BORON WORTH VS. BORON CONCENTRATION

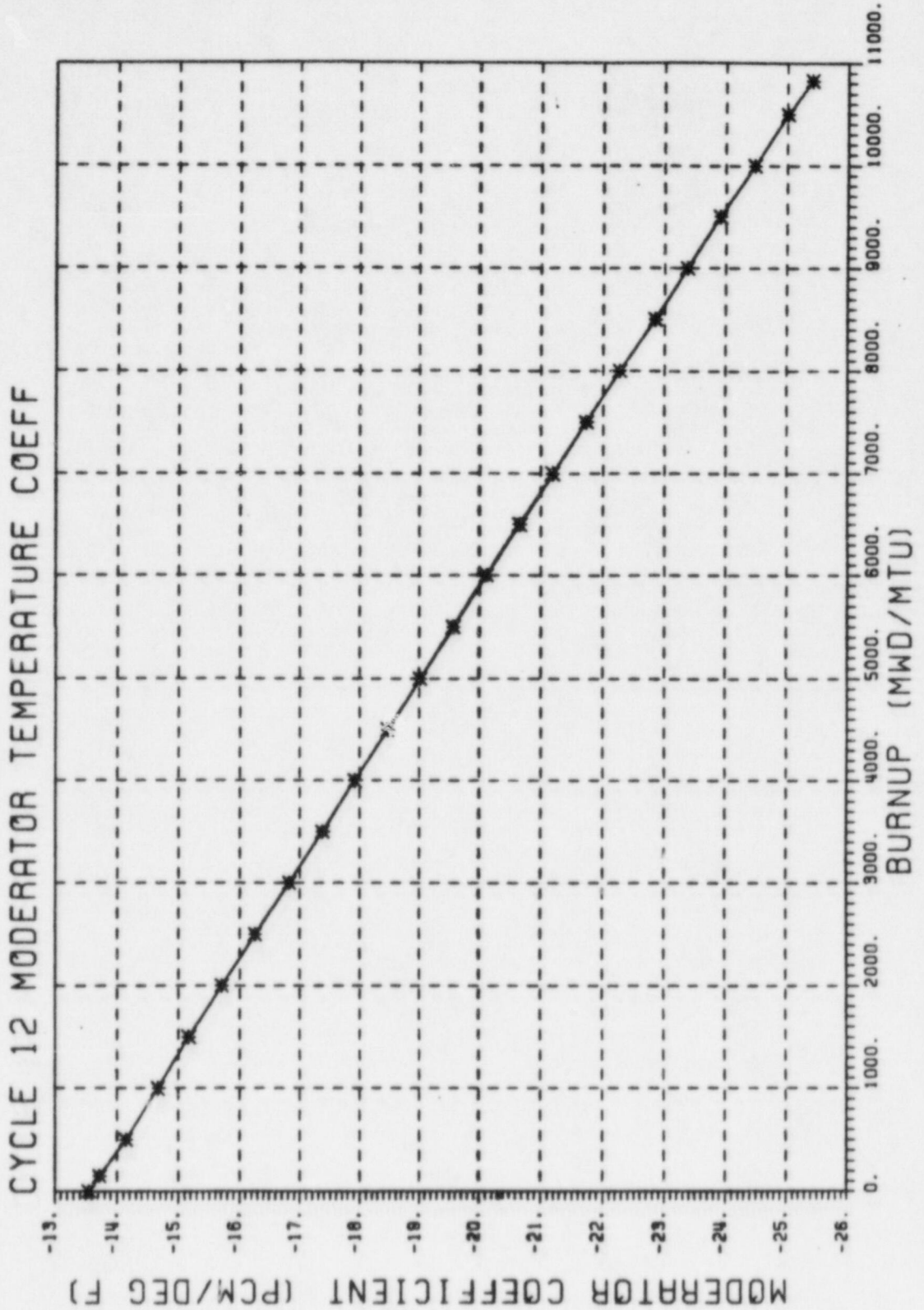
REV. APR 15 1986

EOL (11000 MWD/MTU, T = 547 F CYCLE 12



RD. 6.3

APR 15 1986


CYCLE 12 MODERATOR TEMPERATURE COEFF
MODERATOR COEFFICIENT (PCM/DEG F)
-13.
-14.
-15.
-16.
-17.
-18.
-19.
-20.
-21.
-22.
-23.
-24.
-25.
-26.
0.
1000.
2000.
3000.
4000.
5000.
6000.
7000.
8000.
9000.
10000.
11000.
BURNUP (MWD/MTU)

ANSWERS -- KEWAUNEE -87/02/17-SUNDERLAND, P.

ANSWER 5.01 (1.00)

Increases.

REFERENCE
W Reactor Core Control, P. 6-22

ANSWER 5.02 (1.00)

a.

REFERENCE
W Reactor Core Control, p. 9-10

ANSWER 5.03 (2.00)

a. (0.4 each, 0.3 for correct order)
   1. Void
   2. Moderator temperature coeffient
   3. Doppler power (or fuel temperature) coefficient
b. More negative (0.5)

REFERENCE
W Reactor Core Control, p. 3-42

ANSWER 5.04 (1.50)

(0.5 each)
a. Decreases
b. Decreases
c. Increases

REFERENCE
W Thermo-Hydraulic Principles, p. 10-54, 12-4 through 12-9
W Reactor Core Control, p. 6-29 through 6-31

ANSWERS -- KEWAUNEE -87/02/17-SUNDERLAND, P.

ANSWER 5.05 (1.00)

b.

REFERENCE
W Thermo-Hydraulic Principles, p. 10-54

ANSWER 5.06 (1.00)

(0.5 each)
a. Shorter
b. Reactivity

REFERENCE
W Reactor Core Control, p. 7-35, and 4-11

ANSWER 5.07 (1.50)

(Any 2 of 3 at .75 pts. each)
1. Outlet temperature of cold fluid approaches highest temperature of the hot fluid.
2. More uniform temperature difference between the two fluids produces a more uniform rate of heat transfer.
3. More uniform temperature difference between the two fluids minimizes the thermal stresses throughout the heat exchanger.

REFERENCE
W Thermal-Hydraulic Principles, p. 5-10

ANSWER 5.08 (1.50)

(0.5 each)

a. Increase
b. Decrease
c. Increase

ANSWERS -- KEWAUNEE -87/02/17-SUNDERLAND, P.

REFERENCE
W Thermo-Hydraulic Principles, p. 14-27

ANSWER 5.09 (2.50)

a. Axial flux difference is the difference between the upper and lower detector signals (0.5). (More detailed answers are also acceptable)
b. (0.5 each)
   1. Lower half
   2. Borate
c. T-cold decreases due to more steam demand from the S/Gs. This colder water enters the bottom of the core and produces more power because of the denser moderator (0.5). Therefore, delta-I decreases (0.5) (Also acceptable: T-hot is much higher than T-cold as power increases making the moderator less dense at the top so less power is produced.)

REFERENCE
W Reactor Core Control, p. 8-25 through 8-32

ANSWER 5.10 (1.00)

(any 2 @ 0.5 each)

1. Temperature Below RT-NDT
2. Material Defect or Flaw
3. External Stress on Vessel

REFERENCE
W Thermal-Hydraulic Principles p. 13-60,61

ANSWER 5.11 (2.50)

See Figure 1.

REFERENCE
W Thermo-Hydraulic Principles, pages 10-41 and 10-46

ANSWERS -- KEWAUNEE -87/02/17-SUNDERLAND, P.

ANSWER 5.12 (1.00)

(0.5 each)
a. Decreases
b. Decreases

REFERENCE
W Thermo-Hydraulic Principles, p. 7-102 through 7-110

ANSWER 5.13 (2.00)

a. (0.25 pts. each)
   1. Neutron absorption (burnout)
   2. Decay
b. Xenon reactivity initially decreases (0.25) because of increased burnout. (0.25) Production of Xe and I increases due to a higher fission rate. (0.25) This causes Xe reactivity to increase as these isotopes build up. The result is an equilibrium reached after about 40 hours at a higher xenon concentration. (0.25)
c. Xenon concentration is increasing at a high rate, adding negative reactivity (0.25) so the rods are at a higher position to achieve criticality. (0.25)

REFERENCE
W Reactor Core Control, p. 4-11 through 4-22

ANSWER 5.14 (2.50)

Assume that a 1.5 degree F temperature mismatch causes rod motion. (0.5)
(other assumptions may be accepted)

-19.5 (+/- .3) from RD 6.2 (0.5)
-8.95 (+/- .1) from RD 8.1 (0.5)

$$\text{ppm Boron} = 1.5 \text{ degrees F } (-19.5 \text{ ppm/F}) = \frac{3.27 (+/- .1) \text{ ppm}}{(-8.95 \text{ pcm/ppm})} \quad (1.0)$$

REFERENCE
KNPP Reactor Data Book, RD 6.2, 8.1

ANSWERS -- KEWAUNEE -87/02/17-SUNDERLAND, P.

ANSWER 5.15 (2.00)

(0.5 each)

a. decreases (becomes more negative)
b. decreases
c. decreases
d. remains the same

REFERENCE
KNPP Reactor Data Book, RD 3.3, 4, 8.1, 13.1

ANSWERS -- KEWAUNEE -87/02/17-SUNDERLAND, P.

ANSWER 6.01 (1.50)

a. 1
b. 1
c. 2

REFERENCE
KNPP System Descriptions, p. 35-22

ANSWER 6.02 (1.00)

(0.25 each)
a. CCW
b. Jacket water cooling system
c. CCW
d. Condensate

REFERENCE
System Descriptions, p. 31-1, 31-2. 3-2, 2-10

ANSWER 6.03 (1.00)

d

REFERENCE
KNPP System Descriptions, p. 53-16

ANSWER 6.04 (1.50)

(Any 3 at 0.5 each)
1. A volume sufficient to refill the reactor vessel above the nozzles.
2. Enough borated water to maintain the core in a cold shutdown condition (with all RCCs, except the most reactive, inserted into the core)
3. Provide a sufficient volume of water on the floor to permit the initiation of recirculation.
4. Filling the reactor refueling cavity

REFERENCE
KNPP System Descriptions, p. 33-5

ANSWER 6.05 (2.00)

(0.5 each)
a. RHR
b. Hydrazine
c. NaOH, Internal Containment Spray

REFERENCE
KNPP System Description, p. 34-7, 28-1

ANSWER 6.06 (2.25)

a. Prevents opening sump isolation valves (SI-350A,B and SI-351A,B) when said valves are open (0.5) to prevent inadvertant release of containment vapor to the RWST (0.25)
b. 1. RHR pump discharge instrument prevents said valve from opening (0.5) if pressure is above design pressure of the SI pump suction piping (alternative is to say, to protect the SI piping). (.25)
2. Said valves can not be opened unless SI-5A,B (SI pump suction valves) are shut (0.5) to prevent pumping containment sump water into the RWST with the RHR pumps. (0.25)

REFERENCE
KNPP System Descriptions, p. 33-9

ANSWER 6.07 (1.00)

a. 150 degrees F (0.5)
b. Boron would come out of solution (or insolubility of boric acid) (0.5)

REFERENCE
System Descriptions, p. 35-27
KNPP Technical Specifications, p. 3.2-3

ANSWER 6.08 (1.00)

a. Prevents reaching the operating setpoint of the air operated relief valve (0.5) during a step reduction in power of 10% of full load. (0.5)

ANSWERS -- KEWAUNEE -87/02/17-SUNDERLAND, P.

REFERENCE
System Descriptions, p. 36-7

ANSWER 6.09 (3.00)

a. (0.4 each)
   1. The reserve auxiliary and tertiary auxiliary power sources are not available.
   2. A bus voltage loss signal exists.
   3. All bus power source breakers have been tripped.

b. (0.4 each)
   1. Load shedding
   2. Blackout sequencing

c. (Any five of ten at 0.2 each)
   1. Reserve auxiliary and tertiary power sources unavailable
   2. Breaker 1-509 in operate position
   3. D-G 1-A not locked out
   4. Bus 1-5 voltage loss signal present
   5. All Bus 1-5 power source breakers must be tripped
   6. Breaker 1-509 selector switch in AUTO
   7. Breaker 1-509 control switch not in PULL-OUT
   8. D-G > 95% nominal voltage
   9. D-G > 59 Hz
   10. Bus 1-5 voltage low

REFERENCE
System Descriptions, p. 42:43-45

ANSWER 6.10 (1.50)

a. When the diesel generator reaches 700 rpm (0.5)

b. 1. Remove the short circuit from the field winding (0.5)
   2. Close the station battery contacter (0.5)

REFERENCE
KNPP System Descriptions, p. 42-20

ANSWER 6.11 (2.25)

Reheat - Main Steam HP turbine exhaust (0.25) enters the Moisture Separator where it is dryed and heated (0.25), then sent to the LP turbines (0.25). Condensate is collected and drains directly to the heater drain tank. (0.25).
Heating - Main Steam (0.25) taken from the main steam lines enters the Moisture Separator to heat the HP turbine exhaust steam (0.25). This steam is condensed and drains into a reheater drain tank (RDT) (0.25) The RDT drains to provide heating to feedwater heaters 15 (A&B) (0.25) or bypass to the main condenser (0.25).

REFERENCE
System Description, p. 6-11, M207

ANSWER 6.12 (1.00)

The level program controller limits reference level to 50% so actual level would seek 50%. (1.0)

REFERENCE
KNPP Operator Training Manual, p. IV-7.5 through 7.11

ANSWER 6.13 (2.00)

a. To protect against DNB. (0.5)
b. Turbine Runback (0.5)
Automatic and Manual Rod withdrawal inhibition (0.5)
(-.1 if both automatic and manual not included)
c. 5% below trip setpoint. (0.5)

REFERENCE
KNPP Operator Training Manual, p. IV-11.6.
KNPP Technical Specifications, p. 2.3-5

ANSWER 6.14 (2.00)

(0.5 each)
a. Master Cycler
b. Non-linear gain unit
c. Non-urgent failure
d. 66

ANSWERS -- KEWAUNEE -87/02/17-SUNDERLAND, P.

REFERENCE
KNPP Operator Training Manual, p.IV-3.2, 4, 10, 11

ANSWER 6.15 (1.50)

a. 1. Impulse Pressure
2. Control Valve position
b. Changes the stroke time of the control valves to about 200% per minute.

REFERENCE
KNPP Operator Training Manual, p. III-1.12

ANSWERS -- KEWAUNEE -87/02/17-SUNDERLAND, P.

ANSWER 7.01 (1.00)

(0.5 each)
1. Containment pressure greater than 4 psig
2. Containment radiation greater than IOE5 Rem/hr.

REFERENCE
KNPP Integrated Plant EOP, E-0 QRF

ANSWER 7.02 (.50)

False

REFERENCE
KNPP Operating Procedure A-NI-48, p. 2.

ANSWER 7.03 (1.00)

a. 100 (+/-10)
b. 2950

REFERENCE
KNPP Operating Procedure N-DGM-10

ANSWER 7.04 (1.50)

(0.5 each)
1. All problems resolved.
2. Equipment malfunctions resolved.
3. Cause of the trip positively determined.

REFERENCE
KNPP Operating Procedure N-ESF-55, p. 2

ANSWER 7.05 (1.00)

(0.5 each)
1. If any SG pressure is decreasing in an uncontrolled manner or
2. If any SG has completely depressurized and has not been isolated.

ANSWERS -- KEWAUNEE -87/02/17-SUNDERLAND, P.

REFERENCE
KNPP Emergency Operating Procedures, E-1 QRF

ANSWER 7.06 (2.00)

(0.5 each)
1. Return the rods to the ECP
2. Recalculate the ECP
3. If the ECP shows no errors, place the unit in hot shutdown
4. If errors existed and the new ECP is higher, then continue the startup.

REFERENCE
KNPP Operating Procedure N-CRD-49B, p. 4

ANSWER 7.07 (2.00)

(0.25 each)
a. 1. Two or more control rods NOT fully inserted following a reactor trip.
   2. Rods stepping in below the low-low rod insertion limit.
   3. An uncontrolled cooldown.
   4. Unexplained reactivity increase.
b. 1. Open the emergency boration line valve (CVC-440/MV-32127).
   2. Start both boric acid transfer pumps in fast speed.
   3. Start a second charging pump and manually adjust it to maximum speed.
   4. Open an additional 40 gpm orifice isolation valve.

REFERENCE
KNPP Operating Procedures, E-CVC-35, p. 1-2

ANSWER 7.08 (1.50)

(0.3 each) (any 5 of 6)
1. Containment vessel high humidity
2. Containment vessel high radiation or vent activity
3. Excessive sump pump operation
4. Containment high pressure
5. Containment temperature increasing
6. Containment or reactor cavity sump level high

ANSWERS -- KEWAUNEE -87/02/17-SUNDERLAND, P.

REFERENCE
KNPP Operating Procedures, A-RC-36D, p. 1

ANSWER 7.09 (2.00)

(0.5 each)
a. If the insertion continues after shifting to manual rod control.
b. If the withdrawal continues after shifting to manual rod control.
c. If more than one rod has dropped.
d. If instrument air pressure can't be maintained above 60 psig.

REFERENCE
KNPP Operating Procedures
a. E-CRD-49A, p. 2
b. E-CRD-49B, p. 2
c. E-CRD-49C, p. 2
d. E-AS-01, p. 1

ANSWER 7.10 (1.50)

a. "Fire Pump 1A Running" means that the fire header pressure is < 110 psig (0.5) or that a deluge valve is opening. (0.5)
b. "Fire Pump 1B Running" means that fire header pressure is < 100 lbs (0.5)

REFERENCE
KNPP Operating Procedure E-FP-08, p. 1

ANSWER 7.11 (1.50)

a. 1. RCS Subcooling based on core exit TC's < 30 F (0.5)
   2. PZR level can't be maintained above 2% (0.5)
b. 1. RCS subcooling changes to less than 120 F (0.25)
   2. PZR level changes to more than 20% (0.25)

REFERENCE
KNPP Emergency Operating Procedures, E-0 QRF

ANSWERS -- KEWAUNEE -87/02/17-SUNDERLAND, P.

ANSWER 7.12 (2.00)

a. (0.5 pts each)
1. 200 psid or greater
2. 105 degrees F or less
3. 15 psig or greater

b. When the pump has been stopped briefly (0.25) and it is known that there have been no changes made in the service systems. (0.25)

REFERENCE
KNPP Operating Procedures, N-RC-36A

ANSWER 7.13 (1.00)

ECA-0.0, Loss of All AC Power

REFERENCE
KNPP Emergency Procedures, ECA-0.0, p. 2

ANSWER 7.14 (2.50)

a. Use inverse square law.
(I-1)(D-1E2)/(D-2 E2) = I-2
800 mr/hr (1)/16 = 50 mr/hr (.75)
(30 mr/hr) (3 hrs) = 150 mr (.75)

b. Exceeded KNPP daily limit of 50 mrem/day. (1.0)

REFERENCE
KNPP Radiation Protection Manual, p. 1-1 and 0-51

ANSWERS -- KEWAUNEE -87/02/17-SUNDERLAND, P.

ANSWER 7.15 (2.50)

a. Manually trip the reactor (0.5). If the reactor will not trip, then:
   1. Open the bus 1-33 and 1-43 supply breakers to deenergize the rod drive MG sets. (0.25)
   2. Dispatch operator to locally open reactor trip breakers and Rod Drive MG set supply breakers. (0.25)
   3. When the Reactor Trip breakers and the local MG set supply breakers have been opened, then reenergize Bus 1-22 and Bus 1-43 (0.25).

b. Manually trip the turbine (0.5). If the turbine will not trip, then manually run back the turbine (0.25), and stop both EH oil pumps. (0.25) If the turbine governor valves cannot be closed, then manually initiate Steamline Isolation (0.25).

REFERENCE
KNPP Emergency Procedures, FR-S.1, p. 2

ANSWER 7.16 (1.50)

a. 1. Starts 1A1 Pump (0.33)
   2. Starts 1A2 Pump (0.33)
   3. Closes Screenhouse Header Isolation A (SW 3A/CV 31038) (0.33)

b. This overrides the bearing seal water low flow permissive. (0.5)

REFERENCE
KNPP Operating Procedure, E-SW-02, p. 1

ANSWERS -- KEWAUNEE -87/02/17-SUNDERLAND, P.

ANSWER 8.01 (.50)

False.

REFERENCE
KNPP Technical Specifications, p. TS 3.7-2

ANSWER 8.02 (1.50)

a. 7, daily (0.5 each)
b. .10 (0.5)

REFERENCE
KNPP Technical Specifications, p. TS 3.1-3, 3.1-14, and 3.7-1.

ANSWER 8.03 (1.00)

(0.5 each)
a. Airlock keys must be obtained from shift supervisor

b. Doors are interlocked so that if one is open, the other door is interlocked closed.

REFERENCE
KNPP Technical Specifications, p. TS 1.1-2a
KNPP Operating Procedures, N-CCI-56, p. 1, 2

ANSWER 8.04 (1.00)

a. 1 hr. (0.5)
b. 1 hr. (0.5)

REFERENCE
KNPP Standing Night Orders, "Guidelines for NRC Immediate Notification"

ANSWER 8.05 (1.00)

d.

ANSWERS -- KEWAUNEE -87/02/17-SUNDERLAND, P.

REFERENCE
KNPP ACD 4.3, p.1

ANSWER 8.06 (1.50)

(0.75 each)
1. An qualified individual (.25) operating independently, physically verifying that a component has been placed(.25) in a specified configuration (.25), or

2. The performance of an independent functional test (0.25) without comprimising plant safety that unambiguously verifies (0.25) the component is in a specified condition (0.25)

REFERENCE
KNPP ACD 1.8, p.2

ANSWER 8.07 (1.00)

a. Changes that clearly do not change the engineering intent of the procedure. (0.4)
b. (0.2 each)
   1. WPS Shift Supervisor
   2. W Refueling Coordinator
   3. A member of the plant management staff

REFERENCE
KNPP Refueling Procedures, p. 22

ANSWER 8.08 (2.00)

1. One operable SI pump (0.4)
2. One operable RHR pump (0.4)
3. One operable RHR heat exchanger (0.4)
4. An operable flow path (0.4) capable of taking suction on a boric acid source (0.2) and after manual transfer, taking suction from the containment sump. (0.2)

REFERENCE
KNPP Technical Specifications, p. TS 3.3-2

ANSWERS -- KEWAUNEE -87/02/17-SUNDERLAND, P.

ANSWER 8.09 (2.00)

a. If an operating procedure is inadequate (0.5), and the general intent of the operating procedure is not changed (0.5).
b. Two members of the plant supervisory staff (0.5), at least one of which holds an SRO license (0.5).

REFERENCE
KNPP ACD 4.2, p. 4

ANSWER 8.10 (1.50)

The PORV must be restored to an operable condition within 1 hour (0.75), or the associated block valve shall be closed (0.5) and be maintained closed by administrative procedures to prevent inadvertent opening (0.25).

REFERENCE
KNPP Technical Specifications, p. TS 3.1-2a

ANSWER 8.11 (2.00)

a. An extended RWP is used for jobs of a repetitive nature (0.5). A regular RWP is for non-repetitive jobs. (0.5)

b. 1. Entry into any area posted as a Radiation Hazard Area. (0.5)
2. Maintenance on any component that has a contact radiation reading of greater than 1R/hr. (0.5)

REFERENCE
KNPP ACD 6.3, p. 1, 2

ANSWER 8.12 (1.50)

a. 272,500 gallons (0.5)
b. If not restored within 1 hour (0.5), he must initiate action in one hour to shut the plant down to Hot Standby. (0.5)

REFERENCE
KNPP Technical Specifications, p. TS 3.3-3
Nuclear Power Experience, Vol., PWR-2, VIII Auxiliary Systems, p. 175

ANSWER 8.13 (1.50)

a. 1. Reduce power below 50%. (0.5)
   2. High neutron flux setpoint reduced to less than or equal to 55% of rated power. (0.5)
b. Axial Flux Difference must not be out of the target band for more than two hours of the previous 24 hours. (0.5)

REFERENCE
KNPP Technical Specifications, p. TS 3.10-4 and 4a

ANSWER 8.14 (1.50)

(Any 6 of 8) (0.25 each)
1. Failure of safety related equipment
2. Theft or loss of licensed material
3. Overexposure and/or excessive levels and concentrations
4. Defect or noncompliance
5. Exceeding a Technical Specification safety limit or LCO
6. Immediate notification
7. Reportable event
8. Security event

REFERENCE
KNPP ACD 2.16, p. 1

ANSWER 8.15 (2.50)

a. 2735 psig
b. Prevents radionuclides contained in the RCS from reaching the atmosphere. (Also acceptable is to maintain RCS integrity)
c. Max transient pressure allowable in the pressure vessel in ASME Codes is 110% of design pressure.
d. NRC

REFERENCE
KNPP Technical Specifications, p. TS 2.2-1

ANSWER 8.16 (1.50)

a. Auxiliary Operator (0.5)

b. 1. Equipment Operator (0.25)
2. Radiation Protection Technologist (0.25)
3. Two Contract Security Personnel (0.25 each)

REFERENCE
KNPP ACD 14.1, p. 4

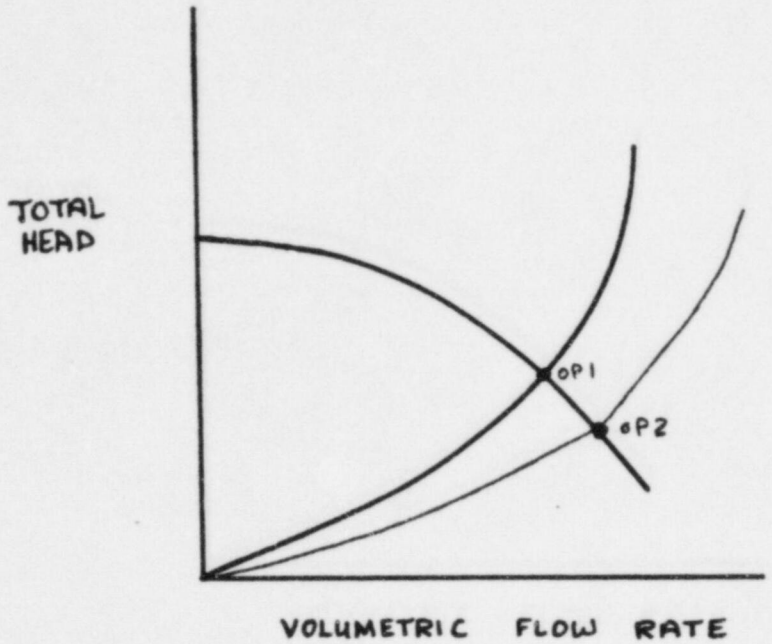
ANSWER 8.17 (1.50)

a. Restrict maximum power level two percent for every one percent tilt ratio over 1.0, so maximum power is reduced by 10% to 90%. (0.5)
b. Reduce power to 50% or lower. (0.5)
c. Reduce reactor power to the No Load Condition (5% power or less) (0.5)

REFERENCE
KNPP Technical Specifications, p. 3.10-5

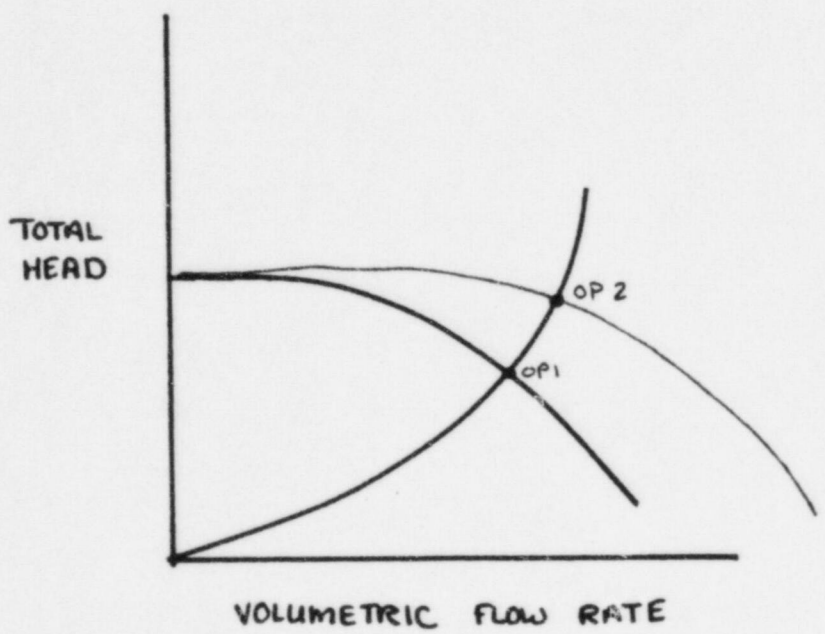
Figure 1
for question 5.11

1 a) Discharge valve opened



System head loss decreases due to the valve opening causing less resistance to flow, therefore, the flowrate increases.

1 b) Start a second pump in parallel



With 2 pumps in parallel, a new characteristic curve is generated, which represents a higher system flowrate. This increases the system head loss

MASTER COPY

U. S. NUCLEAR REGULATORY COMMISSION
REACTOR OPERATOR LICENSE EXAMINATION

FACILITY: KEWAUNEE

REACTOR TYPE: PWR-WEC2

DATE ADMINISTERED: 87/02/17

EXAMINER: VICTOR, F.

CANDIDATE: _____

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	25.00	_____	_____	1. PRINCIPLES OF NUCLEAR POWER PLANT OPERATION, THERMODYNAMICS, HEAT TRANSFER AND FLUID FLOW
25.00	25.00	_____	_____	2. PLANT DESIGN INCLUDING SAFETY AND EMERGENCY SYSTEMS
25.00	25.00	_____	_____	3. INSTRUMENTS AND CONTROLS
25.00	25.00	_____	_____	4. PROCEDURES - NORMAL, ABNORMAL, EMERGENCY AND RADIOLOGICAL CONTROL
100.00		_____ Final Grade	_____ %	Totals

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

_____
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 on one side of the paper, and write "Last Page" on the last answer sheet.

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

10. Skip at least three lines between each answer.

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

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

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

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

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

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

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

18. When you complete your examination, you shall:

a. Assemble your examination as follows:

(1) Exam questions on top.

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

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

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

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

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

QUESTION 1.01 (1.00)

Determine the temperature of the fluid just downstream of a pressurizer PORV which is partially stuck open at normal operating pressure if the back pressure in the pipe just downstream of the PORV is 85 psig. State whether the fluid will be subcooled, saturated or superheated.

QUESTION 1.02 (2.00)

With the plant operating at 85 percent power, control systems in automatic, how will the following changes in plant conditions affect DNBR (Increase, Decrease, or No Change). Consider each case separately.

1. The operator manually withdraws control rods 30 steps without changing turbine load. (0.5)

2. The first group of condenser steam dump valves fail open. (0.5)

3. Raise the setpoint on the pressurizer pressure controller by 30 psig. (0.5)

4. Reactor coolant flow decreases by 10% (no reactor trip). (0.5)

QUESTION 1.03 (2.00)

State the type of device used to measure flow rate in the Reactor Coolant system and describe the principle of operation.

QUESTION 1.04 (2.00)

How does the Available Net Positive Suction Head for a centrifugal pump change (Increase, Decrease or Remain The Same) given the following conditions? EXPLAIN why. Consider each separately.

a. The height difference between the pump and the tank supplying the pump suction is reduced. (1.0)

b. The fluid upstream of the pump is cooled. (1.0)

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

QUESTION 1.05 (2.00)

An estimated critical position (ECP) has been calculated for a reactor startup that is to be performed 6 hours after a trip from a 60 day full power run. How would each of the following events or conditions (independently) affect the actual critical rod position compared to the ECP? In your answer, state whether the actual rod position would be: Higher than ECP, Lower than ECP, or No significant difference.

a. The startup is delayed for approximately two hours (0.5)

b. The steam dump pressure setpoint is increased by 100 psi above the no-load setpoint. (0.5)

c. A new boron sample shows a boron concentration 20 ppm higher than that used in the ECP calculation. (0.5)

d. All Steam Generator levels were raised by 5% just prior to criticality. (0.5)

QUESTION 1.06 (2.00)

Doppler power coefficient changes from beginning of life to end of life because of four factors. List the FOUR factors and state which factor is most dominant? (2.0)

QUESTION 1.07 (1.00)

The reactor is subcritical with D-Bank at 78 steps. It has been determined that 250 pcm are needed to reach criticality and be on an acceptable ramp toward 10E-8 amps. Use the attached curve(s) to determine the required bank position. Assume no change in boron concentration or xenon. Briefly EXPLAIN how you arrived at your answer.

QUESTION 1.08 (1.00)

The reactor is initially at 4 x 10E-9 amps. Positive reactivity is inserted to put the reactor on a constant SUR of 0.25 DPM. Determine how long it takes to reach 1.4 x 10E-8 amps. (Show work)

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

QUESTION 1.09 (1.50)

a. With RCS Tave equal to 290 degrees Fahrenheit, what is the maximum allowable RCS pressure in psig which does not violate the 320 degree Fahrenheit differential temperature limitation between the RCS and the pressurizer? (0.75)

b. What steam generator pressure must be established to ensure a 50 degree Fahrenheit subcooling margin when RCS pressure is 1000 psig? (0.75)

QUESTION 1.10 (1.50)

A reactor plant is operating at 100% power with RCS Tave at 562 F and a steam pressure of 735 psig. What is the new value for Tave to maintain 100% power and a steam pressure of 735 psig with 10% of the steam generator tubes plugged (assume no change in RCS mass flow rate). SHOW ALL WORK, including any applicable formulas.

QUESTION 1.11 (1.50)

Explain HOW and WHY Control Rod Worth is affected by a 15 degree F increase in Tave.

QUESTION 1.12 (2.50)

a. List the THREE most significant reactivity coefficients in order of INCREASING contribution to total power coefficient at BOL. (1.5)

b. How does total power coefficient vary as the core ages? (1.0)

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

QUESTION 1.13 (2.50)

a. State the TWO methods of Xenon production and the TWO methods of removal. (1.0)

b. State the method of Samarium production and removal. (0.5)

c. Compare Xenon and Samarium in regard to their variation in concentration following a power reduction from 100% to 50% and remaining at 50% for two weeks. (1.0)

QUESTION 1.14 (2.50)

a. Define Shutdown Margin (SDM) per Technical Specification. (1.0)

b. State/List THREE reasons for Rod Insertion Limits per Technical Specification. (1.5)

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

QUESTION 2.01 (1.50)

Describe THREE possible flowpaths from the boric acid storage tanks to the charging pumps that could be used for boration. Include major valves and components.

QUESTION 2.02 (1.50)

a. Explain why each of the following substance(s) is added to the Chemical and Volume Control System.
   1. Hydrogen gas
   2. Hydrazine
   3. Lithium hydroxide
   4. Nitrogen gas (1.0)

b. Describe how the contents of the Chemical Mixing Tank are transferred to the RCS system including flow path and how flow rate is controlled? (0.5)

QUESTION 2.03 (2.00)

TRUE or FALSE.

a. When the control switch for Small-capacity Station and Instrument Air Compressor 1A is placed in the "AUTO" mode, the compressor will start and stop as required to maintain 90 psig miminum and 105 psig maximum receiver air pressure. (0.5)

b. Station air supplied to the inside of containment is isolated during Reactor Operations. (0.5)

c. Automatic control valves will isolate the Station Air header when pressure in the Station and Instrument air header decreases to 85 psig. (0.5)

d. Small-capacity Air Compressor 1C is the only small capacity air compressor that can be controlled at the compressors local panel. (0.5)

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

QUESTION 2.04 (2.50)

What system(s) provide normal cooling for the following:
(a) SI pumps seals. (0.5)
(b) Boric acid evaporator. (0.5)
(c) Spent fuel pit heat exchanger. (0.5)
(d) Charging pumps. (0.5)
(e) Pressurizer relief tank. (0.5)

QUESTION 2.05 (1.50)

a. What THREE accidents form the design basis for the Safety Injection System? (0.75)

b. Why are the Safety Injection lines into the reactor vessel normally valved closed? (0.75)

QUESTION 2.06 (1.50)

List THREE signals that will automatically close either an individual or both main steamline isolation valve(s). Specify if an individual valve or both valves close for each signal. (1.5)

QUESTION 2.07 (2.50)

a. Describe the flow paths by which the 118 VAC Instrument Bus No.IV is powered from MCC 1-52C 480 VAC bus. List all major components and include their NORMAL (preferred) and STANDBY (alternate) power sources where they exist. (Sketch acceptable.) (2.0)

b. What PREVENTS energizing Instrument Bus IV from both the normal and stand-by power supplies at the same time? (0.5)

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

QUESTION 2.08 (2.50)

a. List THREE functions of the Auxiliary Feedwater pump(s) recirculation system. (1.5)

b. If the suction for the Auxiliary Feedwater pumps had been shifted to the Service Water System and SW Train A is isolated explain how this casualty would affect the operation of the Auxiliary Feedwater System. (1.0)

QUESTION 2.09 (1.50)

a. List THREE sources capable of supplying water to the suction of the High Head Safety Injection Pumps and state which source is used first on receipt of a Safety Injection signal. (All components function normally.) (1.0)

b. Describe the feature which has been designed into the Safety Injection System to minimize the probability of a ruptured injection line causing a loss-of-coolant accident. (0.5)

QUESTION 2.10 (2.50)

a. One of the pre-start interlocks that will prevent the Emergency Diesel Generator from starting is a STOP LOCKOUT condition. List FOUR conditions that will initiate a STOP LOCKOUT. (Setpoints not required.) (2.0)

TRUE or FALSE

b. When power is lost to ESF bus 1-6 the bus goes into a Power Source Search Mode which will check the Tertiary Auxiliary Transformer first, then the Reserve Auxiliary Transformer and finally the Emergency Diesel Generator 1B as a source of power. (0.5)

QUESTION 2.11 (1.50)

a. Describe how the signal that automatically activates the Containment Spray System is DEVELOPED including setpoints and coincidence. (1.25)

b. How are the spray ring headers inside containment tested to demonstrate that the nozzles are not clogged? (0.25)

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

QUESTION 2.12 (1.00)

Describe the operation of the INTERLOCK associated with a Main Steam Isolation valve closure.

QUESTION 2.13 (1.50)

a. What design feature will minimize the affect of loss of ~~instrument~~ INSTRUMENT air on the operation of the Pressurizer Power Operated Relief Valves (PORVs) (1.0)

b. What is the basis for the design capacity of the Pressurizer Relief Tank rupture disk? (0.5)

QUESTION 2.14 (1.50)

a. List the NORMAL and the EMERGENCY source of makeup water for the Component Cooling Water System. (0.5)

b. List the power source(s) (bus) for the Component Cooling Water pump motors. (1.0)

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

QUESTION 3.01 (2.50)

Answer the following questions regarding the Main Feedwater and Condensate systems:

a. What automatic actions will occur in response to a low feedwater pump suction pressure condition? (0.75)
b. List FOUR permissives that must be satisfied before a Feedwater Pump will start. (1.0)
c. List the automatic actions that occur when a Feedwater Pump trips and state which system component supplies the actuation signal. (0.75)

QUESTION 3.02 (2.00)

a. List FIVE Equipments/Components associated with Rod Control that are RESET by the Control Board Startup Pushbutton. (1.5)
b. Explain how Rod Control Operation is affected by a ROD CONTROL URGENT ALARM at power. (0.5)

QUESTION 3.03 (1.50)

Indicate if the following statements concerning Source Range Instrumentation are TRUE or FALSE:

a. The Source Range audio count rate can be changed by a power of ten, hundred, thousand, or ten thousand. Changing the audio count rate does not affect the count rate for the visual display. (0.5)
b. If the Containment Evacuation Alarm is manually blocked, the High Flux at Shutdown Alarm is not affected. (0.5)
c. The level amplifier provides signal input for the High Flux at Shutdown Alarm and the Visual-Audio Count Rate Channel. (0.5)

QUESTION 3.04 (1.75)

The reactor is critical at 5% rated thermal power during a normal reactor startup. List ALL reactor trips which are DISABLED in this condition.

QUESTION 3.05 (2.00)

The Volume Control Tank (VCT) level instrumentation, in addition to providing Control Room Indication and Alarms, initiates control signals at various levels in the VCT. List FOUR control signals including the levels at which they occur.

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

QUESTION 3.06 (2.50)

List FIVE control interlocks, INCLUDING coincidence, that will stop automatic rod withdrawal.

QUESTION 3.07 (1.00)

Explain how the feedwater THREE ELEMENT CONTROLLER compensates for the affect of "shrink" and "swell".

QUESTION 3.08 (2.50)

The plant is operating at 80 percent power with all systems in automatic when CHANNEL III (controlling) pressurizer pressure channel FAILS HIGH.

a. List all the IMMEDIATE AUTOMATIC actions which occur because of the failure. Alarms are not required. Assume no operator action. (1.5)

b. After completing all required operator actions, the plant is stabilized at the previously existing conditions with an alternate pressurizer pressure channel selected for control and the FAILED INSTRUMENT BISTABLE tripped. At this time, the CHANNEL I Tcold instrument FAILS LOW. List the immediate automatic action(s) which occur(s) as a result of this additional failure. (Assume no operator action.) (1.0)

QUESTION 3.09 (2.00)

a. List the THREE conditions that will cause an AUTOMATIC start of the Emergency Diesel Generator. (Normal system lineup.) (1.5)
b. If the first AUTOMATIC start attempt is unsuccessful, HOW MANY ADDITIONAL starting attempts will be made before the engine start signal is LOCKED OUT? (0.5)

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

QUESTION 3.10 (3.00)

The plant is operating at 50% power with all control systems in automatic. Bank D rods are at 150 steps. Given the following conditions/situations, describe the INITIAL rod motion which occurs. Your answer should contain IN, OUT, or NO MOTION with a brief explanation. Assume no operator action (unless stated) and the reactor does NOT trip. Consider each case separately.

a. B steam generator MSIV inadvertantly closes (turbine load constant).
b. Loop A narrow-range Thot instrument fails high.
c. Loop B narrow-range Tcold instrument fail low.
d. Turbine load is ramped to 20% at 5% per minute

(0.75 for each)

QUESTION 3.11 (1.50)

a. List TWO conditions which satisfy the C-9 permissive circuit for the Condenser Steam Dump System. Include setpoints. (1.0)

b. List the Mode Selector Switch position(s) which provide a full trip open feature for the Steam Dump Valves. (0.5)

QUESTION 3.12 (1.50)

List THREE of the four signals that will automatically start the Control Room Post-Accident Recirculation fans when the control room switch is in AUTO.

QUESTION 3.13 (1.25)

Protective devices associated with the main transformers, main auxiliary transformers, and various power distribution buses, all function to trip lockout relays 86/T1A and 86/T1B. List FIVE safety/protective actions that occur when lockout relays 86/T1A and 86/T1B are tripped.

(***** END OF CATEGORY 03 *****)

QUESTION 4.01 (2.00)

The plant undergoes a turbine trip from 100% power and the RO notes that an automatic trip did not occur nor can the reactor be tripped manually.

a. What procedures are referred to in this situation? (0.5)

b. What is the next operator action per procedure following the failure of a manual reactor trip initiation and WHAT does this action accomplish? (0.5)

QUESTION 4.02 (1.50)

You have indication that instrument air pressure is dropping (not a meter problem) and is at 80 psig but the service air header isolation valve is still open and the backup air compressors have not started.

a. What is the cause of the low instrument air pressure? (0.5)

b. E-AS-01, "Loss of Instrument Air," requires a manual reactor trip if instrument air decreases to what pressure? Why is this action necessary? (1.0)

QUESTION 4.03 (1.50)

Indicate if the following statements are TRUE or FALSE.

a. According to A-MI-87, "Miscellaneous Instrumentation Abnormal Operation", a licensed Reactor Operator may trip reactor protection bistables with permission of the Shift Supervisor, if a qualified I&C man is not immediately available. (0.5)

b. If the Loose Parts Monitoring System (LPMS) confirms the existance of a valid HIGH alarm, operating procedures require that the operator trip the reactor and then evaluate the cause of the alarm. (0.5)

c. According to E-FP-08, "Emergency Operating Procedure-Fire", the Plant Emergency Alarm is not sounded until a Plant Operator (does not have to be licensed) at the scene provides a verbal evaluation or report. (0.5)

(***** CATEGORY 04 CONTINUED ON NEXT PAGE *****)

QUESTION 4.04 (2.50)

The following concern statements listed in N-O-01 "Plant Startup from Cold Shutdown Conditions to Hot Shutdown Conditions".

a. The shutdown banks must be fully withdrawn whenever positive reactivity is being added by Boron or Xenon changes, RCS temperature changes or control bank movement except during 2 conditions. State the TWO conditions. (1.0)

b. Explain why pressurizer pressure is held in the 1800 to 1900 psig range until Steam Generator pressure is >600 psig? (1.5)

QUESTION 4.05 (2.50)

Briefly describe the automatic actions that occur (if any) when the following Radiation Monitoring System channels reach their alarm setpoints:

a. Steam Generator Sample Monitor (R-19A) (1.5)
b. Component Cooling Water System Liquid Monitor (R-17) (0.5)
c. Service Water Monitor (R-20) (0.5)

QUESTION 4.06 (2.50)

State the FOUR Immediate Operator Actions listed in ECA-0.0, "Loss of ALL AC Power". INCLUDE how these actions are verified. NOTE: Sub steps are required.

QUESTION 4.07 (2.00)

State the TWO conditions per step 1 of Operating Procedure E-1 "Loss of Reactor or Secondary Coolant" which would require the operator to stop the RCPs.

(***** CATEGORY 04 CONTINUED ON NEXT PAGE *****)

QUESTION 4.08 (1.50)

List FIVE examples or general statements of the kind of significant operations or actions that the Reactor Operator will enter in the Reactor Log per administrative directives. Omit data filled in on stamped form at the beginning of each day. (1.5)

QUESTION 4.09 (2.50)

a. List TWO of the four heat sinks (different components) listed in Technical Specification which must be operable whenever the average reactor coolant temperature is less than or equal to 350 degrees F but greater than 200 degrees F. (1.0)

b. State the required action(s) according to Technical Specification when ONE of the Pressurizer PORV's becomes inoperable during hot standby and/or operating modes. (1.5)

QUESTION 4.10 (1.50)

According to STANDING NIGHT ORDERS list THREE of the seven parameters or factors that should be considered when determining whether an actual rod misalignment exists or an electrical problem with Individual Rod Position Indication (IRPI) problem exists.

QUESTION 4.11 (2.50)

According to A-RHR-34, "Loss of Residual Heat Removal Cooling", what action will occur when a RHR pipe ruptures in the RHR pump pit. List the AUTOMATIC action(s) and FOUR Operator IMMEDIATE actions.

QUESTION 4.12 (1.50)

List THREE symptoms of inadvertent boron dilution in accordance with A-RC-36F, "Inadvertent Boron Dilution while at Hot or Cold Shutdown".

(***** CATEGORY 04 CONTINUED ON NEXT PAGE *****)

QUESTION 4.13 (1.00)

a. List the THREE people by title or job description who must sign a Regular RWP prior to anyone starting work specified on the permit. (0.75)

b. You are required to periodically check your self reading pocket dosimeter (SRD) while in a RCA. What "reading" would require you leave the area immediately and notify HP personnel, according to KEWAUNEE "Radiation Protection Training Manual". (0.25)

(***** END OF CATEGORY 04 *****)
(********** END OF EXAMINATION **********)

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

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

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

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

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

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

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

$TVL = 1.3/\mu$

$HVL = 0.693/\mu$

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

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

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

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

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

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

$\ell^* = 1 \times 10^{-5}$ 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 = 0.4335 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

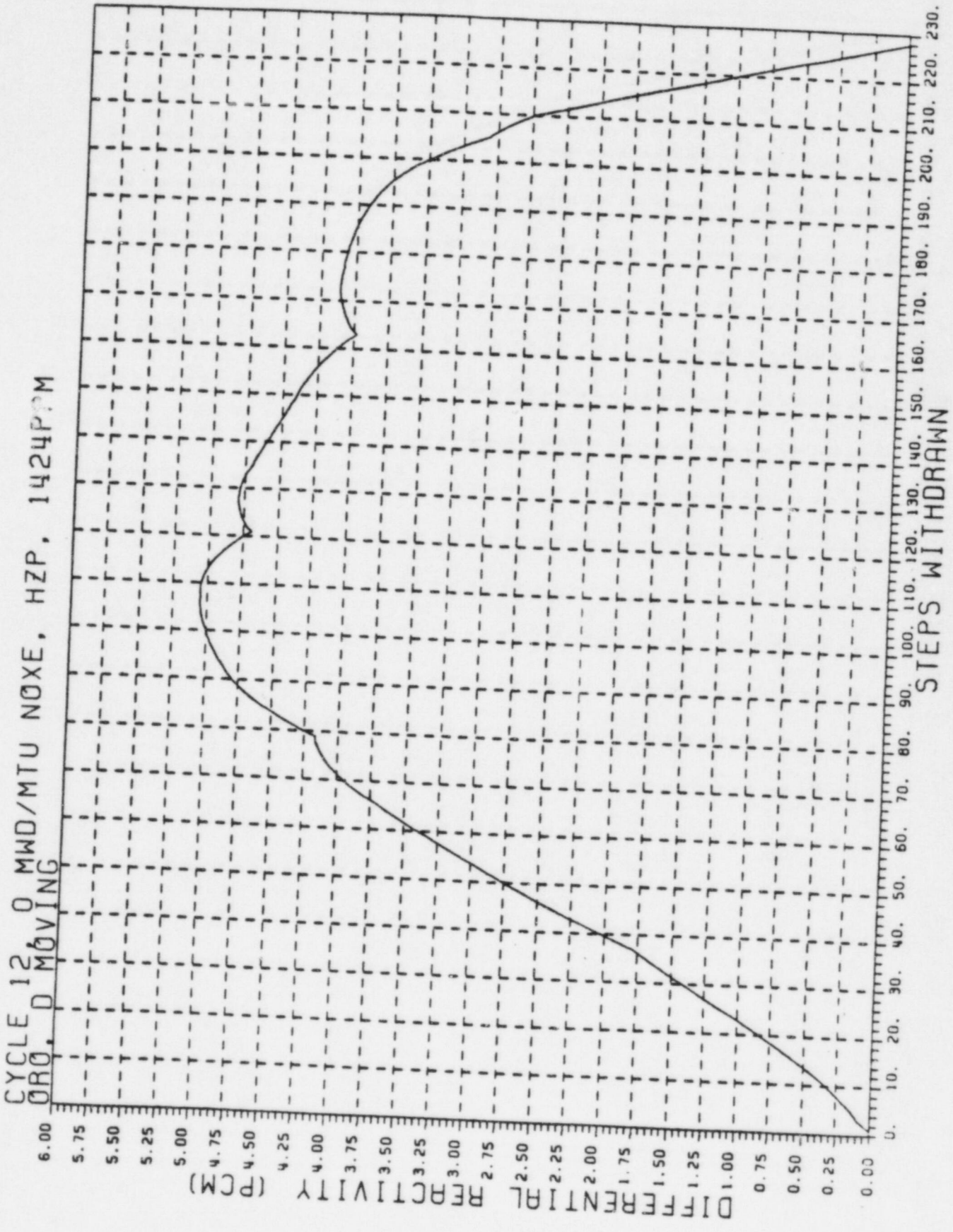
1 Mw = 3.41×10^6 Btu/hr

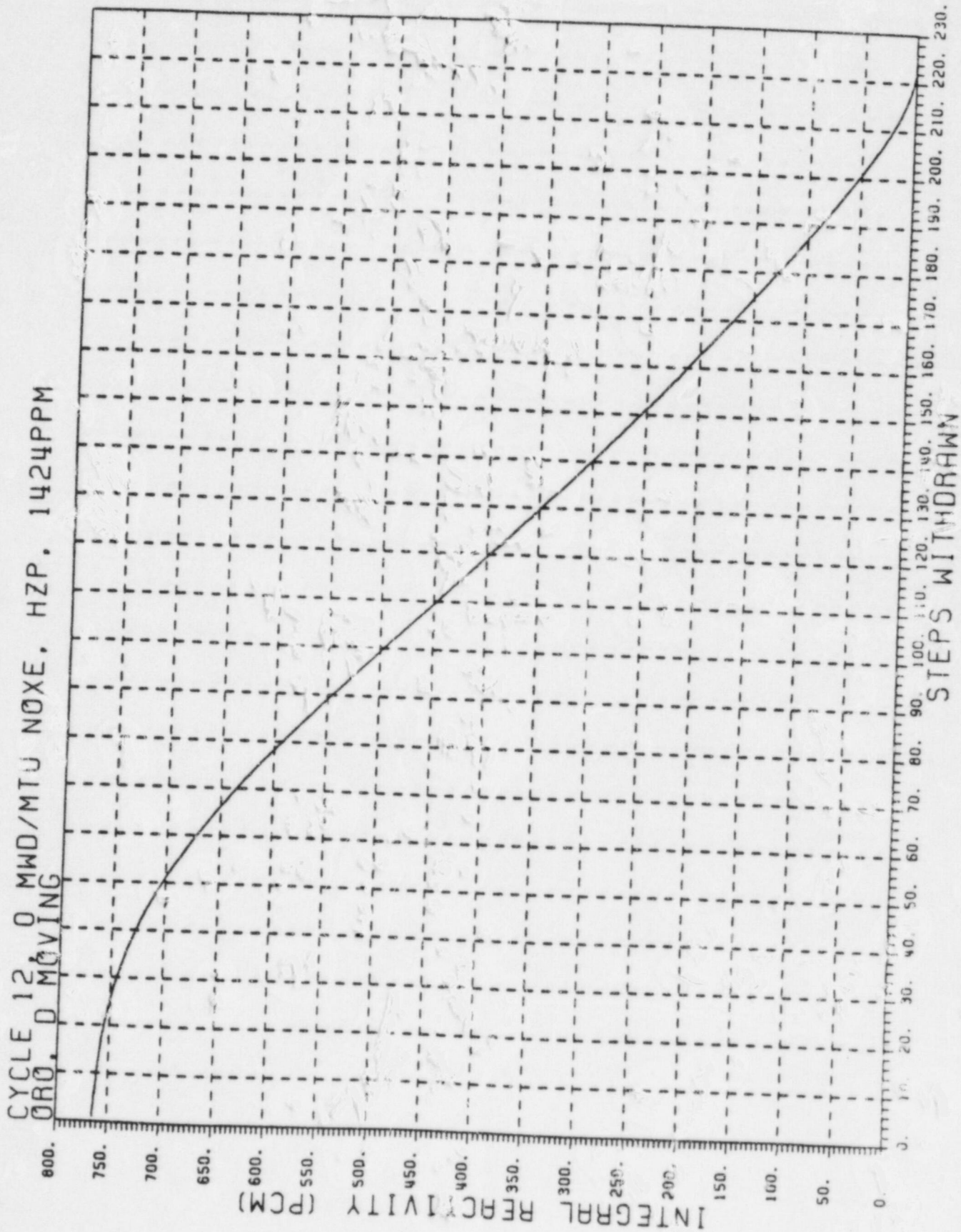
1 Btu = 778 ft-lbf

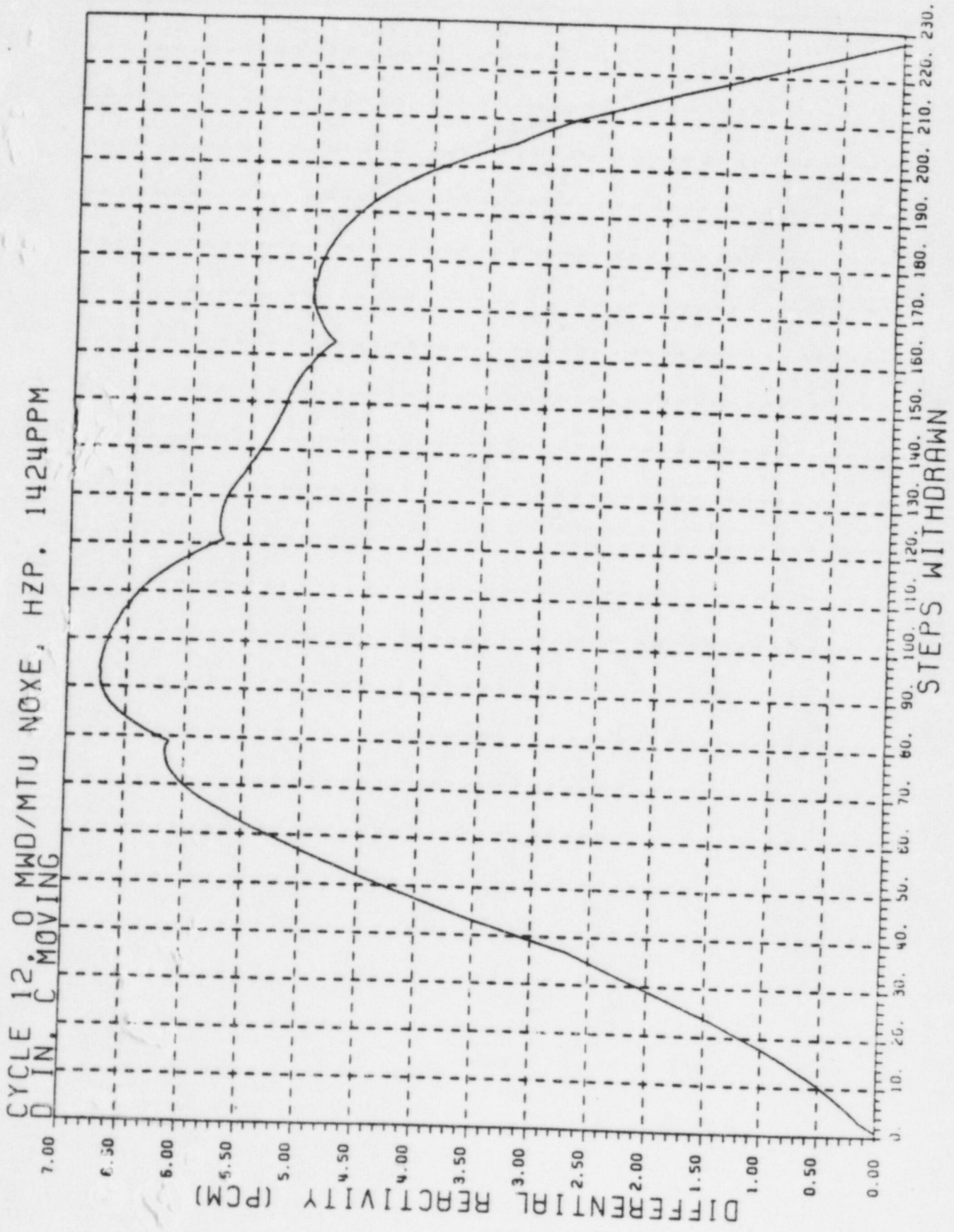
1 inch = 2.54 cm

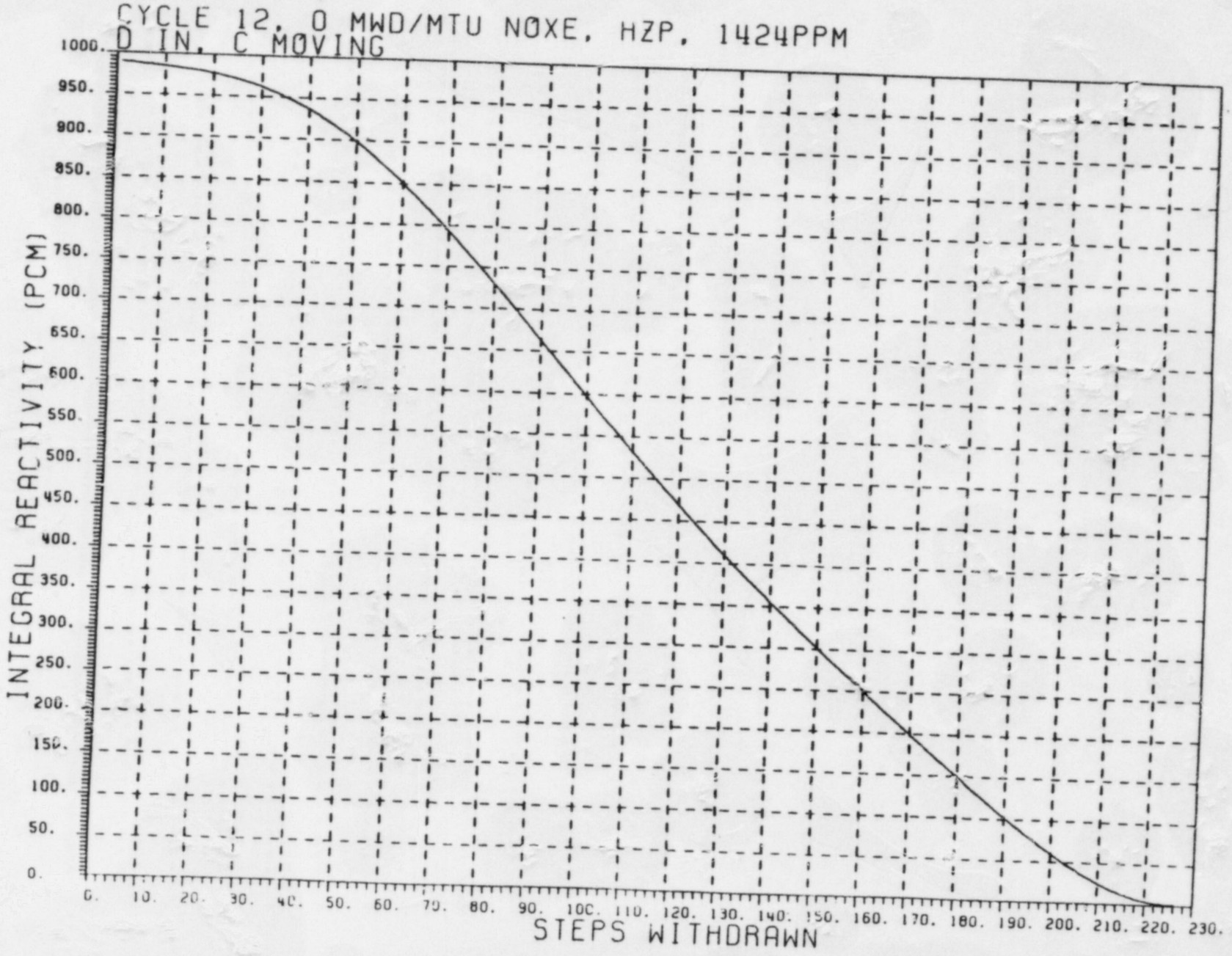
$^oF = 9/5\ ^oC + 32$

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


CYCLE 12, 0 MWD/MTU NOXE, HZP, 142PPM
ORO, D MOVING
DIFFERENTIAL REACTIVITY (PCM)
STEPS WITHDRAWN
6.00
5.75
5.50
5.25
5.00
4.75
4.50
4.25
4.00
3.75
3.50
3.25
3.00
2.75
2.50
2.25
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.00
0. 10. 20. 30. 40. 50. 60. 70. 80. 90. 100. 110. 120. 130. 140. 150. 160. 170. 180. 190. 200. 210. 220. 230.

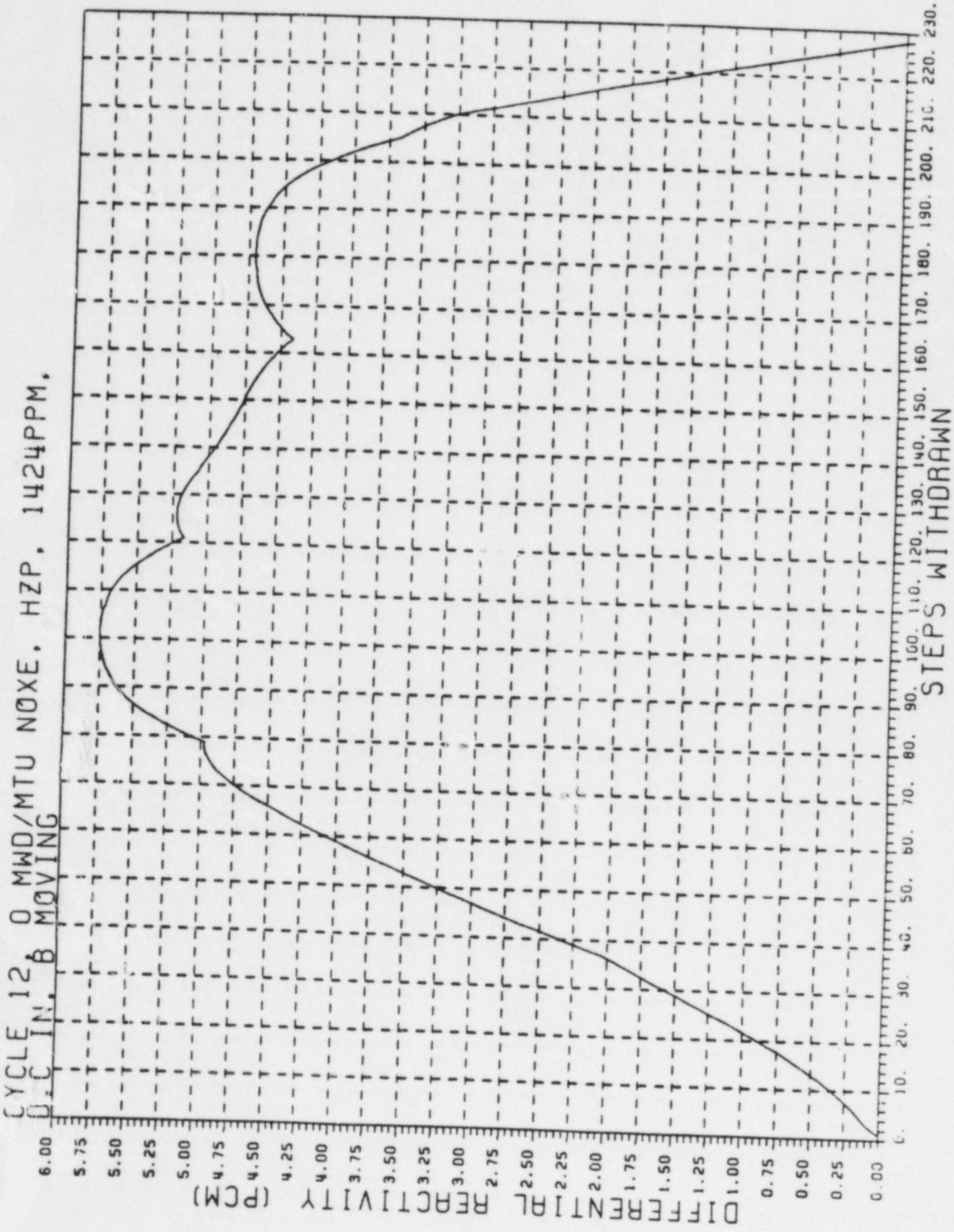

CYCLE 12, 0 MWD/MTU NOXE, HZP, 1424PPM
ORO, D MOVING
INTEGRAL REACTIVITY (PCM)
STEPS WITHDRAWN
800.
750.
700.
650.
600.
550.
500.
450.
400.
350.
300.
250.
200.
150.
100.
50.
0
10.
20.
30.
40.
50.
60.
70.
80.
90.
100.
110.
120.
130.
140.
150.
160.
170.
180.
190.
200.
210.
220.
230.

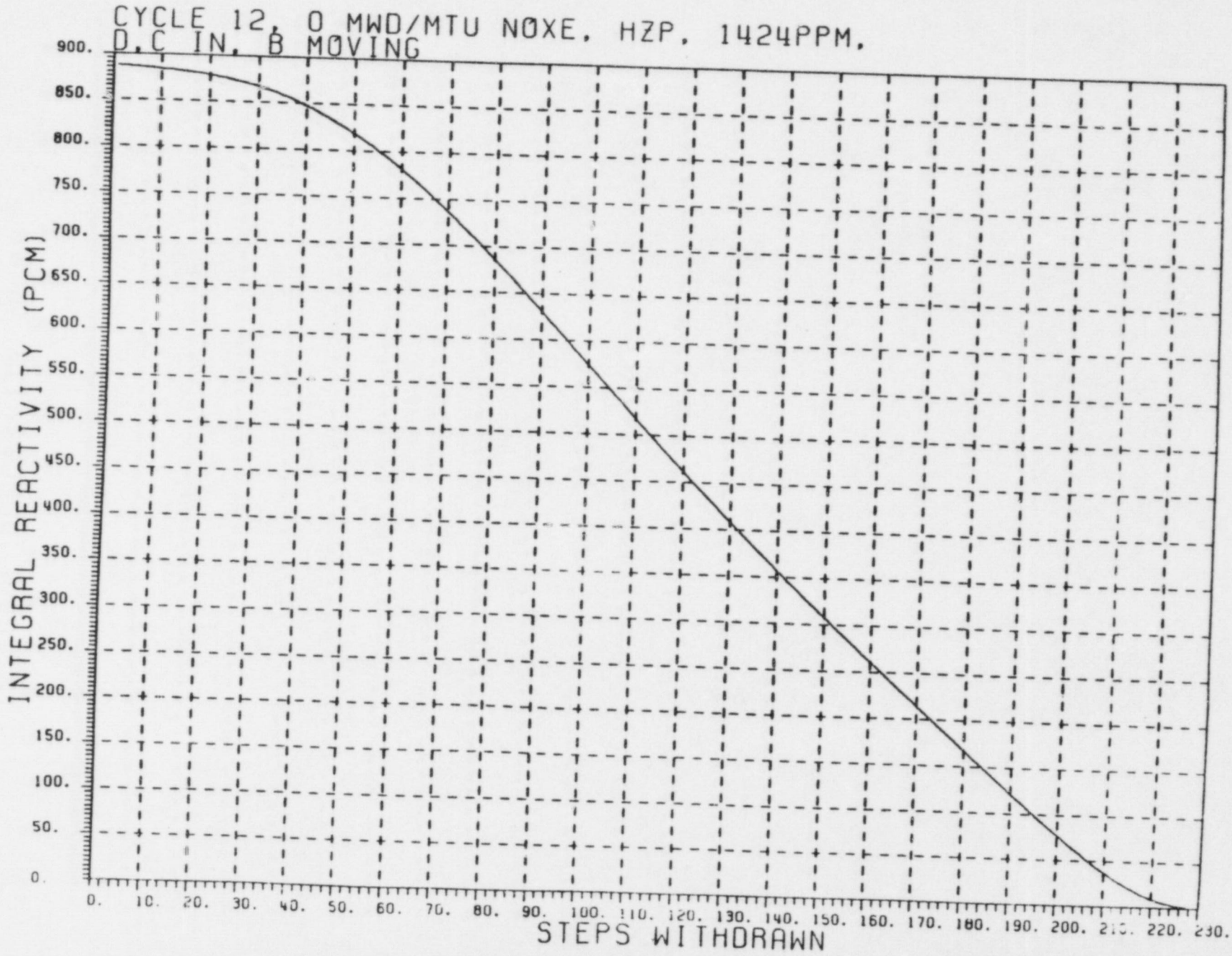

CYCLE 12, 0 MWD/MTU NOXE, HZP. 1424PPM
0 IN, C MOVING
DIFFERENTIAL REACTIVITY (PCM)
7.00
6.50
6.00
5.50
5.00
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
0. 10. 20. 30. 40. 50. 60. 70. 80. 90. 100. 110. 120. 130. 140. 150. 160. 170. 180. 190. 200. 210. 220. 230.
STEPS WITHDRAWN



RD. 5.2.2

REV. APR 15 1985

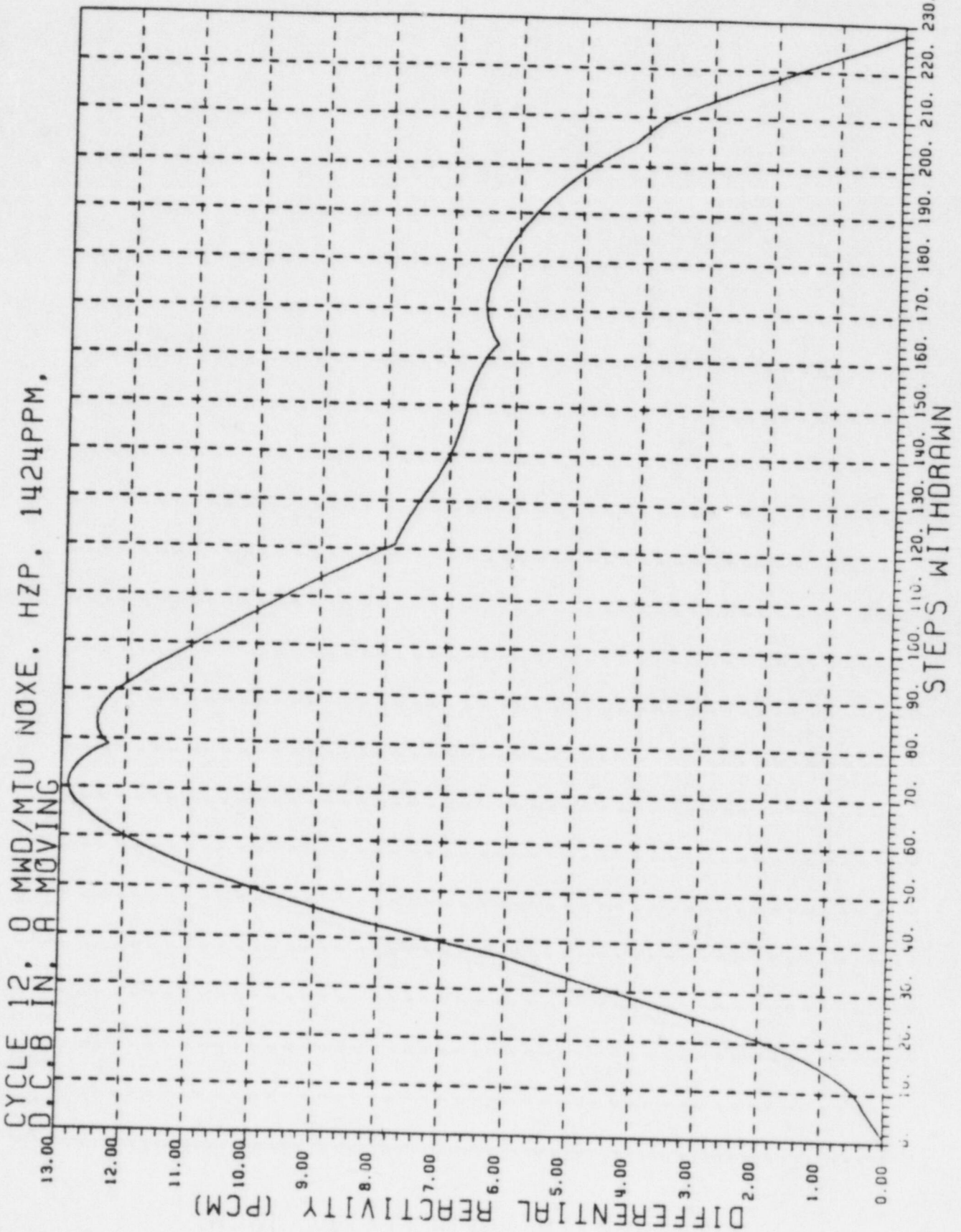

CYCLE 12 0 MWD/MTU NOXE. HZP. 1424PPM.
0.C IN. B MOVING
DIFFERENTIAL REACTIVITY (PCM)
STEPS WITHDRAWN
6.00
5.75
5.50
5.25
5.00
4.75
4.50
4.25
4.00
3.75
3.50
3.25
3.00
2.75
2.50
2.25
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.00
0. 10. 20. 30. 40. 50. 60. 70. 80. 90. 100. 110. 120. 130. 140. 150. 160. 170. 180. 190. 200. 210. 220. 230.

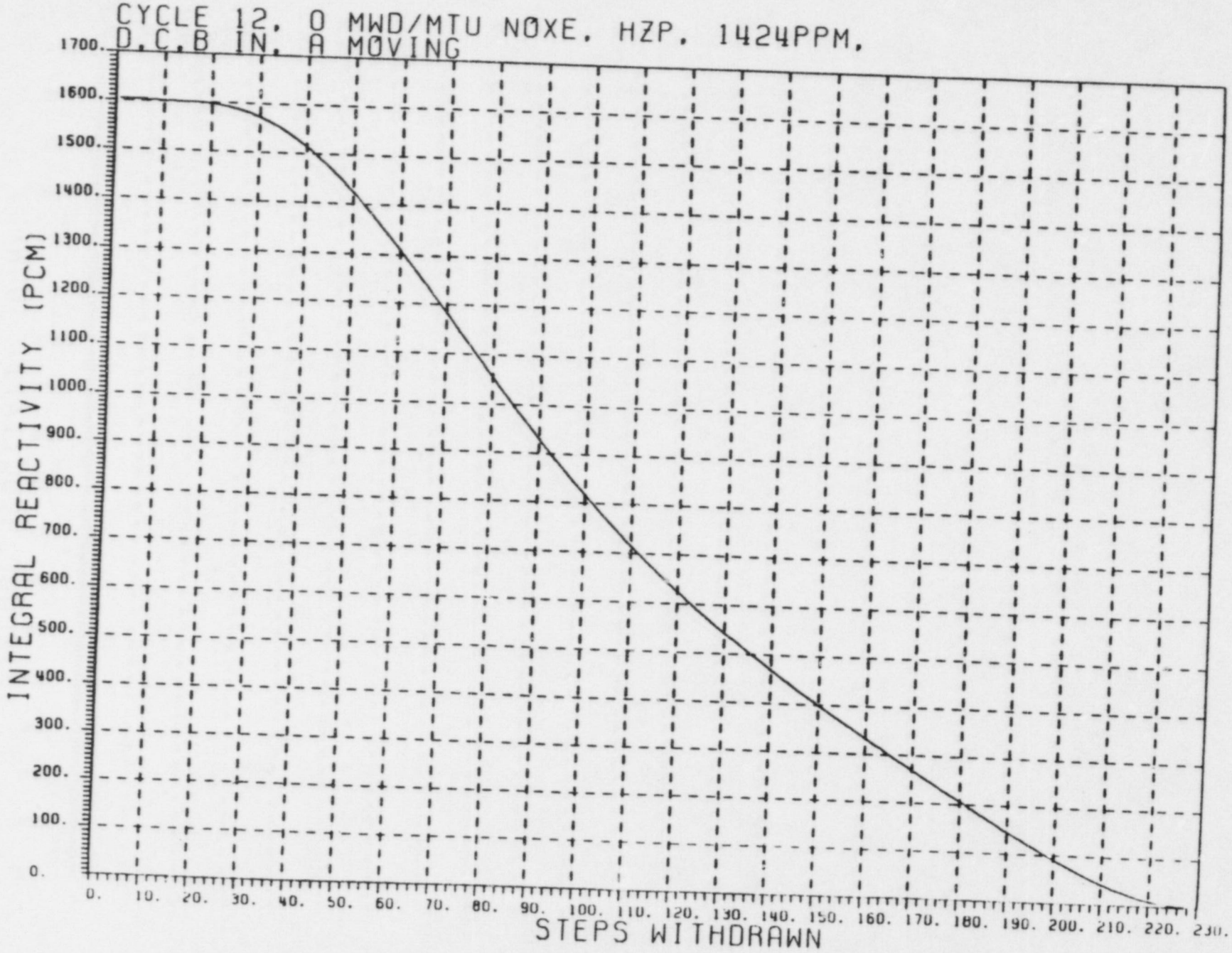


REV. APR 1 5 1986

RD. 5.2.4

REV. APR 1 5 1986





REV. APR 15 1986

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	1065.3	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	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
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
196.0	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	204.39	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	105.907	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

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
620.0	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	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
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	73.5[illegible]	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*

Table 3. Superheated Steam

Abs Press. Lb/Sq In (Sat. Temp)		Sat. Water	Sat. Steam	Temperature – Degrees Fahrenheit 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	809.8	869.4	929.0	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	0.0167	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	180.12	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	0.3121	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	2.2004
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				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	1.8971	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	17.879	19.076	20.207	21.527	22.740	25.153	27.557	29.954	32.348	34.740	37.130	39.518
	h	208.52	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		1.7217	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	20.195	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	418.98	518.98	618.98	718.98	818.98	918.98
	v	0.01727	8.514			8.769	9.474	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	1.987	2.022	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 (302.92)	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	8.972	9.793	10.659	11.522	12.382	13.240	14.097
	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

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 350	400	450	500	550	600	700	800	900	1000	1100	1200	1300	1400
	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
80	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
(312.04)	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
	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
85	v	0.01762	5.167	5.445	5.840	6.273	6.597	6.966	7.330	8.052	8.768	9.480	10.190	10.898	11.604	12.310	13.014
(316.26)	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
	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
90	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
(320.28)	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
	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
95	v	0.01770	4.651	4.845	5.705	5.551	5.889	6.221	6.548	7.196	7.838	8.477	9.113	9.747	10.380	11.012	11.643
(324.13)	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
	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
100	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
(327.82)	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
	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
105	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
(331.37)	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	1745.4
	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
	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
110	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
(334.79)	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	1745.4
	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
	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
115	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
(338.08)	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	1745.3
	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
	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
120	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
(341.27)	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
	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
130	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
(347.33)	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
	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
140	v	0.01803	3.2190		3.4661	3.7143	3.9526	4.1844	4.4119	4.8588	5.2995	5.7364	6.1709	6.6036	7.0349	7.4652	7.8946
(353.04)	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
	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
150	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
(358.43)	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
	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
160	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
(363.55)	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
	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
170	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
(368.42)	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
	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
180	v	0.01827	2.5312		2.6474	2.8508	3.0433	3.2286	3.4093	3.7671	4.1084	4.4508	4.7907	5.1289	5.4657	5.8014	6.1363
(373.08)	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
	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
190	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
(377.53)	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
	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
200	v	0.01839	2.2873		2.3598	2.5480	2.7247	2.8939	3.0583	3.3783	3.6915	4.0008	4.3077	4.6128	4.9165	5.2191	5.5209
(381.80)	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	Temperature – Degrees Fahrenheit 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	3.5178	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	2.0978	2.2462	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	2.4874	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	3.7717	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	1.6317	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	1525.9	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		1.3775	1.4913	1.6002	1.7078	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	1.4966		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
	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
400	v	0.01934	116.10	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
(444.60)	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
	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
420	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
(449.40)	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
	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
440	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
(454.03)	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
	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
460	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
(458.50)	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
	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
480	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
(462.82)	h	444.75	1204.8		1234.1	1269.1	1300.8	1330.5	1358.8	1413.6	1467.3	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
	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
500	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
(467.01)	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
	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
520	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
(471.07)	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
	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
540	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
(475.01)	h	458.71	1204.4		1225.3	1262.5	1295.7	1326.3	1355.3	1410.9	1465.1	1519.1	1573.4	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
	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
560	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
(478.84)	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
	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
580	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
(482.57)	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
	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
600	v	0.02013	0.7697		0.7944	0.8746	0.9456	1.0109	1.0776	1.1892	1.3008	1.4093	1.5160	1.6211	1.7252	1.8284	1.9309
(486.20)	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
	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
650	v	0.02032	0.7084		0.7173	0.7954	0.8634	0.9254	0.9835	1.0979	1.1969	1.2979	1.3969	1.4944	1.5909	1.6864	1.7813
(494.89)	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
	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
700	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
(503.08)	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
	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
750	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
(510.84)	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
	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
800	v	0.02087	0.5690			0.6151	0.6774	0.7373	0.7878	0.8759	0.9631	1.0470	1.1289	1.2093	1.2885	1.3669	1.4446
(518.21)	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
	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
850	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
(525.24)	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	1.7780	1.8094	1.8395
	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
900	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
(531.95)	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	1.5822	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
	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
850	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
(538.39)	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
	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
1000	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
(544.58)	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
	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
1050	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
(550.53)	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
	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
1100	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
(556.28)	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
	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
1150	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
(561.82)	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
	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
1200	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
(567.19)	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	1.7995
	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
1300	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	0.8835
(577.42)	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	1.5027	1.5296	1.5544	1.5773	1.6194	1.6578	1.6937	1.7275	1.7596	1.7902
	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
1400	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
(587.07)	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
	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
1500	v	0.02346	0.2772		0.2820	0.3378	0.3717	0.4049	0.4350	0.4629	0.4894	0.5394	0.5869	0.6327	0.6773	0.7210	0.7639
(596.20)	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
	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
1600	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
(604.87)	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
	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
1700	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
(613.13)	h	636.45	1158.6			1215.3	1270.5	1314.5	1357.9	1388.1	1421.7	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
	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
1800	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
(621.02)	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
	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
1900	v	0.02517	0.2028			0.2374	0.2687	0.3004	0.3275	0.3521	0.3749	0.4171	0.4565	0.4940	0.5303	0.5656	0.6002
(628.56)	h	660.36	1145.6			1185.7	1251.3	1300.2	1341.4	1378.4	1412.9	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
	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
2000	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
(635.80)	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
	Sh					7.74	57.74	107.74	157.74	207.74	257.74	357.74	457.74	557.74	657.74	757.74	857.74
2100	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
(642.76)	h	683.79	1131.5			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
	Sh					5.5	50.55	100.55	150.55	200.55	250.55	350.55	450.55	550.55	650.55	750.55	850.55
2200	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
(649.45)	h	695.46	1122.7			1127.9	1218.0	1276.8	1323.1	1363.3	1400.0	1467.6	1530.9	1591.5	1651.3	1711.9	1772.4
	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
	Sh						44.11	94.11	144.11	194.11	244.11	344.11	444.11	544.11	644.11	744.11	844.11
2300	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
(655.89)	h	707.18	1113.2				1209.3	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	1.3913	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	Temperature – Degrees Fahrenheit 700	750	800	850	900	950	1000	1050	1100	1150	1200	1300	1400	1500
	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
2400	v	0.02790	0.1408	0.1824	0.2164	0.2474	0.2648	0.2850	0.3037	0.3214	0.3382	0.3545	0.3703	0.3856	0.4155	0.4443	0.4724
(662.11)	h	718.95	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
	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
2500	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
(668.11)	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
	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
2600	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
(673.91)	h	744.47	1087.0	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
	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
2700	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
(679.53)	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
	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
2800	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	0.3267	0.3532	0.3785	0.4030
(684.96)	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
	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
2900	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
(690.22)	h	785.13	1039.8	1095.3	1209.6	1274.7	1374.9	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
	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
3000	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
(695.33)	h	801.84	1070.3	1060.5	1197.9	1267.0	1319.0	1361.2	1403.1	1440.2	1475.4	1509.4	1547.4	1574.8	1638.5	1701.4	1763.8
	s	0.9728	1.1619	1.1966	1.3131	1.3697	1.4097	1.4429	1.4717	1.4976	1.5213	1.5434	1.5642	1.5841	1.6214	1.6561	1.6888
	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
3100	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
(700.28)	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
	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
3200	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
(705.08)	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
	Sh																
3300	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
	Sh																
3400	v				0.1179	0.1475	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
	Sh																
3500	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
	Sh																
3600	v				0.0966	0.1796	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
	Sh																
3800	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				1.1888	1.2955	1.3517	1.3928	1.4265	1.4558	1.4821	1.5061	1.5284	1.5495	1.5886	1.6247	1.6584
	Sh																
4000	v				0.0531	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	1401.6	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
	Sh																
4200	v				0.0498	0.0945	0.1183	0.1362	0.1513	0.1647	0.1769	0.1883	0.1991	0.2095	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
	Sh																
4400	v				0.0471	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	1347.0	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*

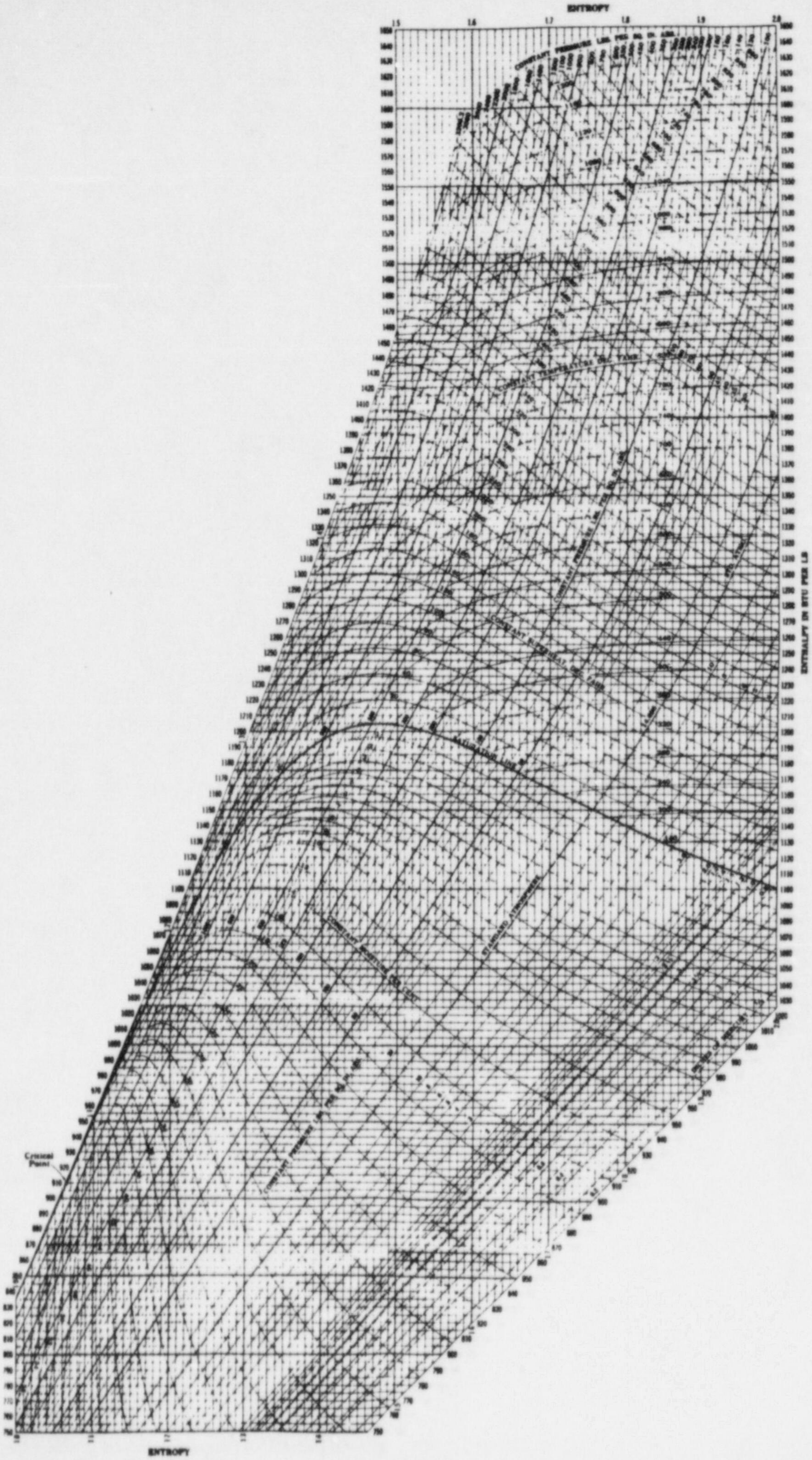
Abs Press. Lb/Sq In. (Sat. Temp)		Sat Water	Sat Steam	Temperature – Degrees Fahrenheit 750	800	850	900	950	1000	1050	1100	1150	1200	1250	1300	1400	1500
4600	Sh																
	v			0.0380	0.0751	0.1005	0.1186	0.1335	0.1465	0.1582	0.1691	0.1792	0.1889	0.1982	0.2071	0.2242	0.2404
	h			883.8	1100.0	1207.3	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	1.5921	1.6272
5000	Sh																
	v			0.0338	0.0591	0.0855	0.1038	0.1185	0.1312	0.1425	0.1529	0.1626	0.1718	0.1806	0.1890	0.2050	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	1.5277	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	0.0778	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	0.0672	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	1101.8	1201.8	1273.6	1331.0	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	1.3658	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	1.5960
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	1413.0	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	1535.3	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	0.0528	0.0603	0.0675	0.0742	0.0804	0.0867	0.0917	0.1019	0.1113
	h			786.4	859.2	938.3	1027.4	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	1362.9	1415.3	1463.4	1508.6	1593.1	1677.8
	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	1.3321	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	1660.6
	s			0.9196	0.9742	1.0292	1.0851	1.1417	1.1945	1.2414	1.2833	1.3209	1.3546	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	0.0309	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	1.2918	1.3264	1.3576	1.3860	1.4363	1.4808
13000	v			0.0236	0.0253	0.0275	0.0302	0.0335	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	1545.7	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	1.2287	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	1213.9	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	0.0369	0.0405	0.0443	0.0479	0.0516	0.0552	0.0624	0.0695
	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	887.7	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


ENTROPY
ENTHALPY IN BTU PER LB
Critical Point
ENTROPY

ANSWERS -- KEWAUNEE -87/02/17-VICTOR, F.

ANSWER 1.01 (1.00)

Temperature is 328 degrees F +/- 1. (0.5)
The fluid will be saturated (wet vapor state since this is a throttling process). (0.5)

REFERENCE
CNTO Thermal-Hydraulics Principles p.10-62 to 10-72
Steam Tables and/or Mollier diagram

ANSWER 1.02 (2.00)

1. DNBR Decreases
2. DNBR Decreases
3. DNBR Increases
4. DNBR Decreases (0.5 each) (2.0)

REFERENCE
CNTO Thermal-Hydraulics Principles p.13-23

ANSWER 1.03 (2.00)

An elbow flow meter is used for this measurement.(0.5) The principle of operation is based on fluid flow around the bend in the elbow which exerts force on the outside of the pipe radius.(0.5) This results in an increase in the pressure at the outside and a decreased pressure at the inside of the radius.(0.5) Flow rate is determined by measuring the pressure differential.(0.5) (The volume flow rate is proportional to the square root of the pressure difference.) (2.0)

REFERENCE
CNTO Thermal-Hydraulic Principles p.11-23, 11-24

ANSWERS -- KEWAUNEE -87/02/17-VICTOR, F.

ANSWER 1.04 (2.00)

a. Decrease. (.25) Available NPSH is a function of static pressure of the fluid. Reducing the vertical distance between the tank and the pump decreases the static pressure.(.75) (1.0)
b. Increase. (.25) Cooling the fluid decreases the saturation pressure of the fluid, which increases available NPSH.(.75) (1.0)
(Similar wording acceptable)

REFERENCE
CNTO Thermal-Hydraulic Principles p. 10-60, 10-61

ANSWER 1.05 (2.00)

a. ACP Higher than ECP.
b. ACP Higher than ECP.
c. ACP Higher than ECP.
d. ACP Lower than ECP. (0.5 each) (2.0)

REFERENCE
CNTO Core Control p.7-25

ANSWER 1.06 (2.00)

1. Gap thermal conductivity
2. Fuel densification
3. Cladding creep
4. Plutonium production (0.4 each)

Cladding creep (fuel clad gap reduction) is the most dominant effect(0.4)
The buildup of Pu-240 is also accepted as a correct answer (2.0)

REFERENCE
Kewaunee Operator TM p. I-6.14

ANSWERS -- KEWAUNEE -87/02/17-VICTOR, F.

ANSWER 1.07 (1.00)

At 78 steps the total pcm in the rods is 600 pcm on the Integral Rod Worth curve.(0.4) Subtracting 250 pcm gives 350 pcm (0.2).At this value, D-bank is about 128 steps plus or minus 4 steps. (0.4) (1.0)

REFERENCE
CNTO Core Control p.6-16 to 6-21; Rx Data Book fig.5.2.1

ANSWER 1.08 (1.00)

130 seconds plus or minus 2 seconds
P = Po10 Exp(sur)t
P/Po = 1.4x10E-8 / 0.4 x 10E-8 = 3.5 (0.5)
log (base 10) 3.5 = (0.25)t, t = 2.18 minutes (0.5)

REFERENCE
Kewaunee Operator TM p.I-5.13

ANSWER 1.09 (1.50)

a. 1647 psig +/- 7 psig
b. 642 psig +/- 7 psig (0.75 each) (1.5)

REFERENCE
Steam Tables

ANSWERS -- KEWAUNEE -87/02/17-VICTOR, F.

ANSWER 1.10 (1.50)

S/G heat transfer = Q = UA(Tavg - Tstm)

Q, U, and Tstm remain constant;

A1(Tavg1 - Tstm) = A2(Tavg2 - Tstm) (0.50)

GIVEN: A2 = 0.9 X A1

From Steam Tables: Tsat for 750 psia = 511 F (0.50)

A1(562 - 511) = 0.9A1(Tavg2 - 511)

Tavg2 = 567.6 F (567 to 568.5 F acceptable) (0.50)

REFERENCE
CNTO Thermal-Hydraulic Principles, Ch. 12, p.8

ANSWER 1.11 (1.50)

Increases.(0.5) The moderator becomes less dense as temperature increases which allows neutrons to travel further before interacting with water molecules.(0.5) Therefore there is a higher probability of reaching a control rod which increases rod worth.(0.5) (1.5)

REFERENCE
CNTO Core Control p.6-22, 6-23

ANSWER 1.12 (2.50)

a. 1. Void coefficient (0.4 each, 0.3 for correct order)
   2. Moderator temperature coefficient
   3. Doppler power (or fuel temperature) coefficient (1.5)

b. Total power coefficient becomes more negative from BOL to EOL. (1.0)

REFERENCE
CNTO Core Control, P.3-29 TO 3-41

ANSWERS -- KEWAUNEE -87/02/17-VICTOR, F.

ANSWER 1.13 (2.50)

a. Xenon is produced by fission (.25) and Iodine decay (.25)
Xenon is removed by neutron absorption (.25) and Xenon decay (.25) (1.0)

b. Samarium is produced by Promethium decay (.25) and removed by neutron capture (.25) (0.5)

c. Xenon will peak (.25) and then decrease to a new equilibrium below the initial value (.25) (0.5)
Samarium will peak (.25) and then return to the initial value (.25) (0.5)

REFERENCE
CNTO CORE CONTROL p.4-26 to 4-35

ANSWER 1.14 (2.50)

a. SDM is defined as the amount by which the reactor core would be subcritical (.25) at hot shutdown conditions if all control rods were tripped,(.25) assuming that the highest worth control rod remained fully withdrawn,(.25) and assuming no change in Xenon, or boron.(.25) (1.0)

b. 1. To limit the consequences of a hypothetical rod eject accident.(0.5)
2. Assure adequate trip reactivity. (0.5)
3. Assure meeting power distribution limits. (0.5)

REFERENCE
Technical Specifications p.TS 3.10-1, p.TS 3.10-8

ANSWERS -- KEWAUNEE -87/02/17-VICTOR, F.

ANSWER 2.01 (1.50)

1. BAST to BATP(0.2) then to FCV 110A (0.1) then to blender(0.1) then to outlet of VCT.(0.1)
2. BAST to BATP(0.2) to charging pump suction(0.1) via CVC-440.(0.2)
3. BAST to BATP(0.2) to FCV 110A(0.1) to manual valve CVC-405.(0.2) (1.5)

REFERENCE
KEWAUNEE OP No. E-CVC-35; DWG. No. XK100-3G-X and XK100-38-H

ANSWER 2.02 (1.50)

a. 1. Reduce general corrosion (by reducing free oxygen).(0.25)
   2. Scavenges dissolved oxygen at low temperature.(0.25)
   3. Added to raise pH (at EOL when boric acid concentration is low and production of Li from neutron boron reaction is low). (0.25)
   4. Added to assist in purging the RCS of hydrogen.(0.25) (1.0)
   or acts as a cover gas for the holdup tanks
b. Chemicals are flushed from the mixing tank by reactor makeup water(0.1) which flows through the tank inlet line and passes the tank content to the suction of the Charging Pump.(0.2) Flow rate is controlled by an orifice located in the tank inlet line.(.2) (0.5)

REFERENCE
KEWAUNEE SD No. 35 p.3,12,24 , Dwg XK100-37-P

ANSWER 2.03 (2.00)

a. False
b. True
c. False
d. True (0.5 each) (2.0)

REFERENCE
KEWAUNEE SD No.1 p. 2,3,6,9

ANSWERS -- KEWAUNEE -87/02/17-VICTOR, F.

ANSWER 2.04 (2.50)

(a) Component Cooling Water
(b) Component Cooling Water
(c) Service Water
(d) ~~Component Cooling Water~~ Air Cooled
(e) Reactor Makeup Water (0.5 each) (2.5)

REFERENCE
(a) KEWAUNEE SD No.33 p.4
(b) KEWAUNEE OP No. N-CVC-35E
(c) KEWAUNEE SD No. [illegible] p.2
(d) KEWAUNEE SD No. 31 p.2, Dwg XK100-36, m-604
(e) KEWAUNEE SD No. 36 p.8

ANSWER 2.05 (1.50)

a. Loss of Coolant; Steam Generator Tube Rupture; Loss of Secondary Cooling (0.25 each) (0.75)
b. To prevent thermal shock(0.25) to the reactor nozzles(0.25) if the Safety Injection system is inadvertently activated.(0.25) (0.75)

REFERENCE
KEWAUNEE SD No. 33 p.1 and 3

ANSWER 2.06 (1.50)

1. High-high steam flow coincident with SI signal.(0.25) Individual.(0.25)

2. High steam flow coincident with lo-lo Tavg (540 F) and SI signal.(0.25) Individual.(0.25)
3. High-high containment pressure of(17 psig)(0.25) Both.(0.25)

REFERENCE
KEWAUNEE SD No. 6 p.6

ANSWER 2.07 (2.50)

a. The NORMAL supply is the 7.5 KVA Inverter.(0.2) The 7.5 KVA Inverter NORMAL supply is MCC 1-52C.(0.2) The 7.5 KVA Inverter STAND-BY supply is the Battery (BRA-101)(0.2) which is supplied from the Battery Charger (BRA-108)(0.2) which is powered from MCC 1-52C.(0.2) The STAND-BY (ALTERNATE) supply for Instrument Bus No.IV is the AC Power Distrubution Cabinet (BRA-105)(0.2) which is supplied from a 480 V to 208/120 V transformer(0.2) normally supplied from MCC 1-52C (0.2) through a transfer switch.(0.2) The alternate source to the transfer switch is MCC 1-52E.(0.2) (2.0)

b. The breakers in Instrument Bus IV power cabinet are MECHANICALLY interlocked so only one can be closed. (0.5)

REFERENCE
KEWAUNEE SD No. 38 p.2 to 12 and DWG-E233

ANSWER 2.08 (2.50)

a. 1. Protects the pump against excessive temperature during low flow conditions.
   2. Provides cooling water for pump bearing lube oil cooler.
   3. Provides cooling water for the turbine drive bearing cooler.
   (0.5 each) (1.5)

b. Service water suction supplying AFW Pump 1A is lost.(0.25) AFW pump 1B which is supplied from Service Water Train B(0.25) and the TDAFW pump which is supplied by both Service Water Trains.(0.25) are not affected. The TDAFW pump and AFW pump 1B can supply both steam generators.(0.25) (1.0)

REFERENCE
KEWAUNEE SD No. 5B p.2 and DWG M202

ANSWER 2.09 (1.50)

a. 1. RWST
   2. BAST
   3. RHR pump discharge (Sumps)
   The BAST is the first source to inject. (0.25 each) (1.0)

b. Check valves are installed in the SI line near the RCS loops. (0.5)

ANSWERS -- KEWAUNEE -87/02/17-VICTOR, F.

REFERENCE
KEWAUNEE SD No. 33 p.3 and p.5,6

ANSWER 2.10 (2.50)

a. 1. Engine Overspeed (1035 RPM)
   2. Low jacket water pressure (10 psig) if Engine speed > 200 RPM and the Governor Shutdown Solenoid is not energized.
   3. Unit Start Failure
   4. Low lube oil pressure (17 psig) if Engine speed > 200 RPM and the Governor Shutdown Solenoid is not energized.
   (0.5 each) (2.0)
b. True (0.5)

REFERENCE
KEWAUNEE SD No. 10 p.18,42,43 and Alarm Response Sheet 47029-31

ANSWER 2.11 (1.50)

a. Containment spray is automatically activated by a hi-hi containment pressure signal.(0.25) If one of two pressure detectors(0.25) sense a containment pressure of 22.7 +/- 1 psig (0.25) a bistable is activated. When three out of three bistable devices activate(0.25) a hi-hi containment pressure signal results.(0.25) (1.25)
b. Smoke or air is injected into the header. (0.25)

REFERENCE
KEWAUNEE SD No. 23 p.5,10 and DWG E1604; E1609

ANSWER 2.12 (1.00)

An ELECTRICAL interlock(0.25) will trip the Main Turbine(0.25) when a Main Steam Isolation Valve disk(0.25) moves from the full open position. (1.0)

REFERENCE
KEWAUNEE SD No. 6 p.4

ANSWERS -- KEWAUNEE -87/02/17-VICTOR, F.

ANSWER 2.13 (1.50)

a. Air accumulators (0.5) are installed to operate the relief valves.(0.5)
(1.0)

b. To relieve the combined capacity of the pressurizer safety valves.
(0.5)

REFERENCE
KEWAUNEE SD No. 36 p.8,9 and Operating Procedure E-AS-01 p.3

ANSWER 2.14 (1.50)

a. Normal--Demineralized Water Header
Emergency--Service Water System (0.25 each) (0.5)

b. Bus 1-51 (480V) for pump 1A; bus 1-61 (480V) for pump 1B (0.5 ea.)
(1.0)

REFERENCE
KEWAUNEE SD No. 31 p.2,7 and DWG E240

ANSWERS -- KEWAUNEE -87/02/17-VICTOR, F.

ANSWER 3.01 (2.50)

a. 1. The condensate header bypass valves will open.(0.25)
2. After 2 minutes(0.25) (if the pressure has not recovered) the Feedwater Pump will trip.(0.25) (0.75)

b. 1. Need one Condensate Pump running for each Feedwater Pump.
2. Must have seal water flow (5gpm).
3. Need lube oil pressure (8psig).
4. Need sufficient feedwater pump suction pressure (200psig).
(0.25 for each) (1.0)

c. Discharge isolation valve closes;(0.25) recirc line control valve closes;(0.25) as a result of a FW pump breaker opening.(0.25) (0.75)

REFERENCE
KEWAUNEE SD No. 5A,p.8,10; DWG E1624-E; OPERATOR TM p. V-2.5

ANSWER 3.02 (2.00)

a. 1. All step counters on the control board.
2. Master cycler reversible counter.
3. All slave cycler counters.
4. Bank overlap counter.
5. All internal memory and alarm circuits.
6. All P/A converters in the RPI system. (any 5 at 0.3 each) (1.5)

b. Automatic rod control is inhibited.(0.1) Rods can be moved manually (0.2) but only by individual control banks.(0.2) (Except for the bank with the failure.) (0.5)

REFERENCE
KEWAUNEE OPERATOR TM p.IV-3.15

ANSWER 3.03 (1.50)

a. True
b. False
c. False (0.5 each) (1.5)

REFERENCE
KEWAUNEE OPERATOR TM p.IV-1.10,IV-1.11,IV-1.36

ANSWERS -- KEWAUNEE -87/02/17-VICTOR, F.

ANSWER 3.04 (1.75)

1. Source range high flux
2. RCP undervoltage
3. RCP underfrequency
4. Pressurizer low pressure
5. Pressurizer high level
6. Loop low flow
7. Turbine trip (0.25 each) (1.75)

REFERENCE
KEWAUNEE OPERATOR TM P.IV-11.10, IV-4.1

ANSWER 3.05 (2.00)

1. Modulates three way letdown valve(0.3) at 56%(0.2)
2. Full divert to hold-up tank(0.3) at 78%(0.2)
3. Resets three way letdown valve(0.3) at 70%(0.2)
4. Automatic makeup control(0.3) ON at 17%(0.1) OFF at 28%(0.1)
5. Emergency makeup from RWST(0.3) at 5%(0.2) (2.00)

(Any four)

REFERENCE
KEWAUNEE SD No. 35 p.22

ANSWER 3.06 (2.50)

1. 1/2(0.25) IR greater than(35% +/-1%) power.(0.25)
2. 1/4(0.25) PR greater than (103%) power.(0.25)
3 2/4(0.25) OP delta T (5%) less than trip point.(0.25)
4. 2/4(0.25) OT delta T (5%) less than trip point.(0.25)
5. 1/1(0.25) Impulse pressure less than (15%) power.(0.25)
6. Bank D Rod Withdrawal Limit,(0.25) 220 steps.(0.25)
7. Urgent failure.(0.5) (2.5)

REFERENCE
KEWAUNEE OPERATOR TM p.IV-12.21, V-2.3 and IV-1.18

ANSWERS -- KEWAUNEE -87/02/17-VICTOR, F.

ANSWER 3.07 (1.00)

The steamflow-feedwater flow mismatch signal is sensed immediately(0.25) while the level signal is delayed.(0.25) The initial change in feedwater flow reduces the effect of "shrink" or "swell"(0.25) by the time the level controller takes affect.(0.25)
(Similar wording acceptable) (1.0)

REFERENCE
KEWAUNEE OPERATOR TM p.IV-10.5

ANSWER 3.08 (2.50)

a. 1. Both spray valves open.
2. All Pressurizer heaters turn off. (0.75 each) (1.5)
b. The reactor trips (on OT delta-T). (1.0)

REFERENCE
KEWAUNEE OPERATOR TM p.IV-8.6 to IV-8.15; IV-11.6

ANSWER 3.09 (2.00)

a. 1. SI Signal
2. UV on 4160 volt safeguard bus.
3. Turbine Trip. (0.5 each) (1.5)
b. Two additional or a total of three attempts. (0.5)

REFERENCE
KEWAUNEE SD No.10 p. 24,40

ANSWERS -- KEWAUNEE -87/02/17-VICTOR, F.

ANSWER 3.10 (3.00)

a. IN(0.25)---Loop B Tcold increases to Thot causing loop B Tave to increase above Tref.(0.5) (0.75)
b. IN((0.25)---Loop A Tave will become the auctioneered high Tave which is sensed to be higher than Tref.(0.5) (0.75)
c. NO MOTION(0.25)---Loop B Tave will decrease and will not affect the auctioneering circuit.(0.5) (0.75)
d. IN(0.25)---Power mismatch circuit senses a power rate change with turbine power decreasing faster than nuclear power.(0.5) (0.75)

REFERENCE
KEWAUNEE OPERATOR TM p.IV-3.4, IV-3.5

ANSWER 3.11 (1.50)

a. 1. Condenser vacuum > 24psig +/- 2psig.(0.5)
   2. At least one Circulating water pump must be running.(0.5) (1.0)
b. Tave (0.5)

REFERENCE
KEWAUNEE OPERATOR TM P.IV-9.4 to IV-9.9

ANSWER 3.12 (1.50)

1. Safety injection signal
2. Blackout (sequencer step 9) signal
3. High radiation level on R-23
4. Steam exclusion zone SV area signal
(any three at 0.5 each) (1.5)

REFERENCE
KEWAUNEE SD No. 25 p.13

ANSWERS -- KEWAUNEE -87/02/17-VICTOR, F.

ANSWER 3.13 (1.25)

1. Trips the breakers feeding the 4160 V buses from the Main Auxiliary Transformer.
2. Trips generator excitation circuit.
3. Trips main Turbine.
4. Initiates voltage restoration to buses 1-1,1-2,1-3 and 1-4.
5. Starts the Emergency Diesel Generator
6. Trips substation lockout relays (86/MTB1A and 86/MTB1B).

(any five at 0.25 each) (1.25)

REFERENCE
KEWAUNEE SD No. 43 p.28,29 and 44

ANSWERS -- KEWAUNEE -87/02/17-VICTOR, F.

ANSWER 4.01 (2.00)

a. E-0, Reactor Trip or SI (.25) and FR-S.1, Response to Nuclear Power Generation (.25) (0.5)

b. Open the supply breakers(0.5) for Bus 1-33 and 1-43(0.5) to deenergize the Rod Drive MG sets.(0.5) (1.5)

REFERENCE
KEWAUNEE Operating Procedures E-0 AND FR-S.1

ANSWER 4.02 (1.50)

a. Blocked air dryers (0.25) and the dryer bypass valve has not opened.(0.25) (0.5)
b. 60 psig.(0.5) Pneumatic controls for reactor and safeguards systems are not reliable below this pressure.(0.5) (1.0)

REFERENCE
KEWAUNEE Operating Procedure A-AS-01 p.2; E-AS-01 p.1; N-AS-01 p.1

ANSWER 4.03 (1.50)

a. False
b. False
c. True (0.5 each) (1.5)

REFERENCE
KEWAUNEE Operating Procedure A-MI-87 p.1; A-MI-87B p.2;E-FP-08 p.3

ANSWER 4.04 (2.50)

a. 1. The RCS has been borated to the cold shutdown boron concentration.(0.5)
   2. The RCS has been borated to at least the hot shutdown boron concentration and the RCS is being maintained greater than or equal to 540 degrees F.(0.5) (1.0)

b. To prevent inadvertent Safety Injection.(0.5) When pressurizer pressure exceeds 2000 psig.(0.25) Safety Injection is automatically unblocked.(0.25) If either(0.25) Steam Generator is at or below 500 psig Safety Injection is initiated.(0.25) (1.5)

REFERENCE
KEWAUNEE Operating Procedure N-CRD-49B; p.1; N-0-01 p.7;
Operator TM p.IV-11.13

ANSWER 4.05 (2.50)

a. 1. S.G.1A, 1B common blowdown valves shut.
   2. Sample valves for S.G.1A and 1B shut.
   3. Route condenser air ejector discharge to Auxiliary Building exhaust. (0.5 each) (1.5)

b. Surge tank vent valve shuts. (0.5)

c. No action (alarm only) (0.5)

REFERENCE
KEWAUNEE Operating Procedure A-RM-45; SD No. 45 p.9, 10, 12

ANSWERS -- KEWAUNEE -87/02/17-VICTOR, F.

ANSWER 4.06 (2.50)

1. Verify reactor trip.

   a. Trip and bypass breakers open.
   b. Neutron flux decreasing.

2. Verify turbine trip.

   a. All turbine stop valves closed.

3. Check RCS isolated.

   a. Pressurizer PORVs closed.
   b. Letdown isolation valves closed.
   c. Excess letdown isolation valves closed.

4. Verify AFW flow >200 gpm. (10 at 0.25 ea) (2.5)

REFERENCE
KEWAUNEE Operating Procedure ECA-0.0 p.3

ANSWER 4.07 (2.00)

At least one (0.5) Safety Injection pump running(0.5) and RCS pressure(0.5) less than 1240 psig.(0.5) [1400 psig for adverse containment]

REFERENCE
KEWAUNEE Operating Procedure E-1 p.3

ANSWERS -- KEWAUNEE -87/02/17-VICTOR, F.

ANSWER 4.08 (1.50)

Group answers into these categories:
1. All operations affecting the operation of the reactor or major unit equipment.
2. Changes in reactor coolant boron concentration.
3. Changes in reactor power level and generator output.
4. Performance of unit surveillance testing or special testing.
5. Instrumentation or equipment failures.
6. Occurrence of significant annunciator alarms.
7. Time generator placed on or taken off.
8. Changes in plant electrical lineup.

(other answers will be evaluated on a case basis)
(Any five (5) answers at 0.3 each) (1.5)

REFERENCE
KEWAUNEE Administrative Control Directive No. ACD 4.8

ANSWER 4.09 (2.50)

a. 1. Steam Generator 1A
   2. Steam Generator 1B
   3. Residual Heat Removal Train A
   4. Residual Heat Removal Train B (any 2 at 0.5 each) (1.0)
b. Restore the PORV to operable condition within one hour(0.5) or close the associated block valve(0.5) and maintain the block valve closed by adminstrative procedures.(0.5) (1.5)

REFERENCE
KEWAUNEE TS 3.1-1a; TS 3.1-2a

ANSWER 4.10 (1.50)

1. Nuclear Instrumentation
2. Flux tilt indication.
3. Rod motion since last known rod position
4. Any reactivity insertions observed
5. Single or multiple misalignment
6. Characteristic (fluctuating indicators) of misaligned indication
7. Core exit thermocouple indication (any 3 at 0.5 each) (1.5)

ANSWERS -- KEWAUNEE -87/02/17-VICTOR, F.

REFERENCE
KEWAUNEE Standing Night Order dated July 27,1984, "IRPI Technical Specification Interpretation"

ANSWER 4.11 (2.50)

Pit sump valves will automatically close on high level in the sump. (0.5)
Operator Actions:
--Verify automatic action has occurred
--Stop RHR pumps
--Close RHR Return Isolation Valve (RHR-11)
--Close RHR Inlet Isolation Valves (RHR-1A,B and 2A,B)
--Close RHR to Letdown Line (LD-60)
--Close RHR Cross Connection to CVCS (RHR-210 or 211)
-- (Any 4 of the above operator actions at 0.5 each) (2.0)
Establish alternate decay heat removal with the steam generator or if the RCS is depressurized, with step 4.5
REFERENCE
KEWAUNEE Operating Procedure A-RHR-34 p.2

ANSWER 4.12 (1.50)

1. Increase in audible count rate.
2. Increase counts on Source Range NI.
3. Indication of malfunction of Reactor Makeup Water System.
4. High Flux at Shutdown Alarm.
5. Reactor Trip on Source Range High Flux. (any 3 at 0.5 each) (1.5)

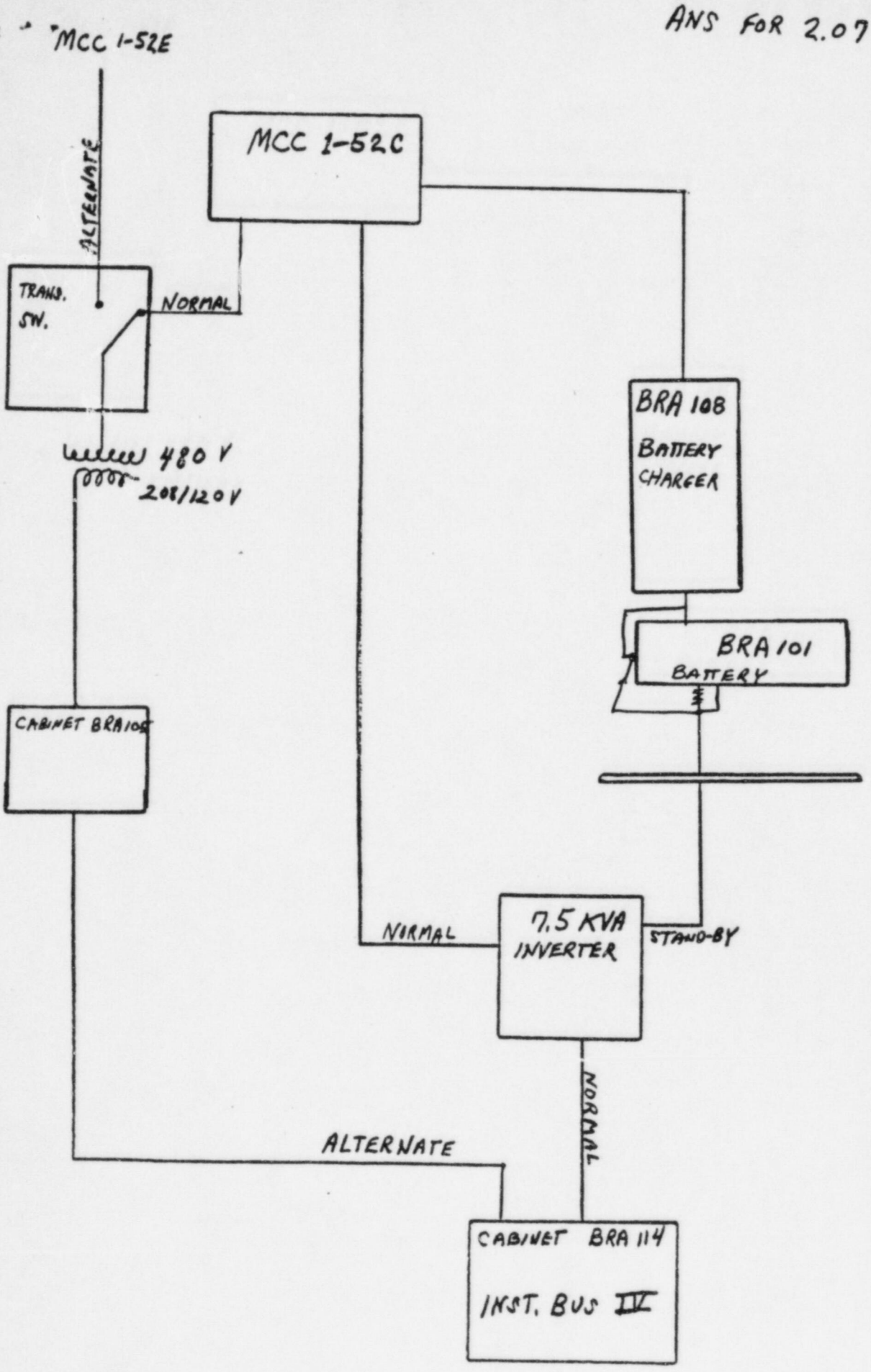
REFERENCE
KEWAUNEE Operating Procedure A-RC-36F, p.1

ANSWER 4.13 (1.00)

a. 1. Originating Department Supervisor
   2. Radiation Protection Supervisor or Designated Alternate
   3. Shift Supervisor (0.25 each) (0.75)
b. Unexpected, or excessive, or if it exceeds 3/4 scale (any one for full credit) (0.25)

REFERENCE
KEWAUNEE Rad Protection TM p.II-1, IV-2 (Plant Specific Section)

ANS FOR 2.07


MCC 1-52E
ALTERNATE
MCC 1-52C
TRANS. SW.
NORMAL
480 V
208/120 V
BRA 108
BATTERY CHARGER
BRA 101
BATTERY
CABINET BRA 108
NORMAL
7.5 KVA INVERTER
STAND-BY
NORMAL
ALTERNATE
CABINET BRA 114
INST. BUS III